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Mental health of disadvantaged children

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Mental health of disadvantaged children

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Editorial: Mental health of disadvantaged children

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Editorial on the Research Topic
Mental health of disadvantaged children

There is a significant amount of research on the mental health of disadvantaged children worldwide. According to the literature, disadvantaged children include children orphaned by HIV/AIDS, children left behind by their migratory parents ("left-behind children"), immigrant children, children with learning disabilities, and children with physical challenges (e.g., deaf children). Further, disadvantaged children face numerous challenges during childhood, such as poverty, disrupted school attendance, lack of parental care, and stigmatization. These negative events can cause significant stress for children and have long-term negative impacts on their mental health. Although previous literature has discussed the development of mental health among different disadvantaged groups, there is limited research that comprehensively examines the developmental trends and intervention strategies for disadvantaged children.

The current Research Topic explores issues among various disadvantaged groups by using psychological research techniques to learn from the collective work across different regions, countries, cultures, and ages. This Research Topic has produced numerous broad representative findings from a total of 15 academic papers that involved 61 authors from 19 schools in four countries: China, United States (US), Zambia, and South Africa. The studies employed a variety of research methodologies including questionnaire surveys, laboratory experiments, literature reviews, and meta-analyses.

Compared to other groups, disadvantaged children have less power, fewer rights, and less access to resources and conditions for daily life, education and future career development, which causes many disorders in their physical and mental development, cognitive function, and academic performance. Furthermore, disadvantaged children are diverse and large in number, which brings the detrimental realities disadvantaged children face to the forefront of larger public conversations. As a result, researchers in various fields have conducted a series of studies on the physical and mental development of disadvantaged children and have achieved many empirical findings and constructive conclusions. Additionally, governments and civil society in general have introduced

numerous policies and programs to promote the healthy physical and psychological development of disadvantaged children.

The health and development of disadvantaged children includes two main themes: physical health development and promotion, and educational and psychological development (including mental health, cognitive, and social development). The vast majority of studies focus on mental health and cognitive development, with far less research focused on social development. Researchers exploring mental health development have focused on the effects of protective and risk factors on mental health. Numerous studies have shown that resilience and social support could significantly predict the mental health of disadvantaged children. For example, Du et al. (1) reported that meaning in life and resilience could significantly predict psychological outcomes (i.e., loneliness and depression) among children affected by parental HIV. More importantly, resilience moderated the relationship between meaning in life and depression. Jiang et al. (2) recently investigated the effects of a resilience-based intervention on the mental health of children affected by parental HIV and found that the intervention yielded significant improvements in positive coping and had benefits on individual depression, loneliness, and anxiety.

Mebrahtu et al. (3) focused on the potential risk and protective factors on children's cognitive development and found that increased maternal education levels protected against lower child developmental scores while increasing child age was a risk factor for lower developmental scores. Zhang Y. et al. showed that perceived social support and trust could positively predict social wellbeing among youths affected by parental HIV/AIDS, implying trust appears to be the most proximate protective factor for social wellbeing. In addition, studies found that stigma had negative effects on the development of psychological wellbeing. For instance, Chi et al. (4) discovered that perceived stigma negatively predicted resilience among children affected by HIV, implying that perceived stigma also affected mental health.

In a study of the effect of stigma on social wellbeing in children affected by AIDS, enacted stigma moderated the relationship between perceived social support and social trust. The effect of enacted social support on social trust was greater for children with low-perceived stigma than for those with high-perceived stigma. Meanwhile, perceived stigma moderated the relationship between social trust and social wellbeing with the positive predictive effect of social trust on social wellbeing being stronger among those adolescents who perceived more stigma (Zhang F. et al.). These studies show that protective factors such as psychological resilience and perceived social support can have a positive effect on mental health, alternatively, risk factors such as stigma have a negative effect on mental health.

Research on cognitive development has explored the cognitive processing of learning. In a study exploring the effects of executive function of students with mathematics or reading disabilities on prospective memory (PM), researchers found that students with mathematics or reading disabilities suffer from the deficits of prospective memory and executive function. Moreover, executive function significantly predicted PM performance (5). In Zhao et al.'s (6) study of children affected by AIDS, children with early adversity suffered from working memory deficits. A mechanistic study of PM in children with learning disability (LD) using event-related potentials found that children with LD have worse PM performance which manifests as a selective deficit in PM cues detection, rather than the absence of PM intention retrieval (Ji et al.).

Some intervention efforts have been made to promote the health and psychosocial development of disadvantaged children. Harrison et al. (7) reported a multilevel psychosocial promotion intervention (child, caregiver, and community) conducted by a Sino-US international collaborative team among children affected by parental HIV/AIDS. The team adopted a multidisciplinary perspective of education, psychology, sociology and physiology to explore the health development and promotion of these children. The study reported that the academic performance, school satisfaction and interest in learning of children who participated in the intervention steadily increased over an 18-month period (7). The study also found that psychological resilience significantly predicted individual support-seeking and positive emotion. The intervention group showed greater growth in psychological resilience, support-seeking and positive emotion than the control group at 6-month follow-up. The intervention group also displayed significantly more post-traumatic growth than the control group at 12-month follow-up.

Research for the health and development of disadvantaged children commonly utilize questionnaire surveys for assessment. While this popular method is more subjective by nature, some studies in this issue demonstrate the utility of objective biological indicators in the exploration of mental health and development of disadvantaged children. For example, diurnal cortisol was used to study the negative family expressiveness and internalizing problems among left-behind adolescents (Li et al.). Multiple papers in this issue have used the event-related potential (ERP) technique to explore the brain mechanisms of psychological development in disadvantaged children. Gu et al. found that the microstate and functional connectivity has altered in children orphaned by HIV and early life stress (ELS) would alter the structure and function of the brain and increase the risk of psychiatric disorders. Ji et al. applied ERP technique to explore the event-based prospective memory (EBPM) in 21 children with LD and 20 non-LD children and found that the poor performance of LD children on PM tasks may result from deficits in PM cues detection. Wan et al. used ERP technique to explore the effect of social exclusion on trust in 31 AIDS orphans (32 age and development status matched controls) and

found that orphans might have formed some self-protective mechanisms to prevent trauma from the negative feedback of others.

Currently, an emerging research theme in the study of disadvantaged children is the exploration of developmental coordination disorders. This growing research field has expanded to advanced cognitive processing processes such as attention, working memory and executive function (8–11). The results show that adolescents with developmental coordination disorder have common cognitive processing defects. Subsequently, the researchers focused on the characteristics of the neural mechanism of visual spatial attention of adolescents with developmental coordination disorder and carried out a series of explorations (12). The results showed that adolescents with developmental coordination disorder had visual spatial attention deficits to varying degrees. In future research, PET, ERP, FMRI and other EEG technologies will be used to further explore the neural mechanism of developmental coordination disorder.

The current Research Topic brings together theoretical and empirical advancements that address the mental health of disadvantaged children. Still, the studies reported here may not be comprehensive and conclusions need to be considered in the light of various conceptual and methodological limitations described within the articles. This issue is also subject to some geographic limitation as most of the studies were conducted in China. However, we hope that this Research Topic will serve as a call for more studies worldwide to build a more comprehensive evidence base (13). We hope that the global community will commit to further exploration of innovative and diligent research for the mental disorders and neurological changes that result from adverse environments, as well as the effective intervention strategies and policies to improve the mental health of disadvantaged children around the globe.

Author contributions

XL and JZ conceptualized the paper. JZ and HG developed the first draft. XL and BG provided critical edits and revisions. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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SYSTEMATIC REVIEW
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Correlations Between Social Support and Loneliness, Self-Esteem, and Resilience Among Left-Behind Children in Mainland China: A Meta-Analysis

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Background: Social support is frequently reported to be correlated with loneliness, self-esteem, and resilience among left-behind children in mainland China. However, to date, there is no consensus on the extent to which those factors are correlated with social support among left-behind children. We thus performed a meta-analysis to quantitatively synthesize the previous findings.

Methods: Two investigators systematically and independently searched PubMed, EMBASE, Web of Science, PsycINFO, Wan Fang, Chinese National Knowledge Infrastructure (CNKI) and China Science Technology Journal Database (VIP) on January 9, 2022. Pooled Pearson's correlation coefficients between social support and loneliness, self-esteem, and resilience were calculated by Stata 16.0 software using random effects model.

Results: Forty-seven studies involving a total of 30 212 left-behind children were identified. A large degree of negative correlation was found between social support and loneliness [summary r: −0.36 (95% CI: −0.42– −0.30), $p < 0.001$]. Large positive correlations were found between social support and self-esteem, and resilience [self-esteem: summary r: 0.33 (95% CI: 0.24–0.41), $p < 0.001$; resilience: summary r: 0.45 (95% CI: 0.38–0.50), $p < 0.001$]. The pooled correlations revealed some discrepancies when stratified by some moderators. Sensitivity analysis also revealed the robustness of the findings. The Egger regression and Duvall and Tweedle trim-and-fill procedure suggest the absence of publication bias.

Conclusion: The current meta-analysis provided solid evidence that social support has a high degree of negative correlation with loneliness and a high degree of positive correlation with self-esteem and resilience among left-behind children in mainland China. This indicated that left-behind children with high levels of social support tend to have lower levels of loneliness and higher levels of self-esteem and resilience. More studies, especially large prospective studies, are warranted to verify our findings.

Keywords: social support, loneliness, resilience, left-behind children, China, meta-analysis

INTRODUCTION

Since China's economic reform and opening up in the 1980's, with the rapid economic development and industrialization, a growing number of rural middle-aged and young labor force have migrated to work in the country's main cities in order to improve their family's economic conditions. China has experienced the largest internal migration in human history (1). Due to the high cost of living and education in cities, as well as the limitations of China's dual urban-rural household registration system, many migrant workers are forced to keep their children in the household registration area and entrust their care to family members (usually grandparents), resulting in the formation of a unique group of children known as "left behind children" (LBC). LBC refers to children under the age of 18 who have to stay in their hometown due to one or both parents going out to work, and are supervised by one parent and/or grandparents, relatives, neighbors for more than 6 months (2). In 2018, the Ministry of Civil Affairs of China conducted a survey on left-behind children, which revealed that China's total number of left-behind children had reached a staggering 6.97 million (3). The situation of LBC in China is a major social and health issue that has attracted widespread concern. Many studies show that LBC has more behavioral and psychological problems than non-left-behind children (NLBC) (4–7). Therefore, the study of this group is not only related to their own destiny, but also provides a Chinese perspective for the development of disadvantaged children around the world.

Social support refers to the respect, care and help that individual perceive from social relations around them (such as their family, friends, important others.), which can make individuals avoid or less affected by negative events of stress (8). For the LBC in the family environment with relatively lack of family affection, social support is their coping resources to adapt to the adverse environment (9). Social support has dual effects, namely main effect and buffer effect (10, 11). The first is to enhance the subjective self-evaluation of the individual and mobilize the positive qualities of the individual to improve the ability to adapt to adverse environments, such as improve self-esteem and resilience (12); the second is to directly buffer the impact of stress on the individual and play a protective role in maintaining individual mental health (10).

An increasing amount of evidence has shown that social support is closely related to many detrimental psychological problems of LBC such as loneliness, low levels of self-esteem, and low levels of resilience (13–15). However, there has been no consensus on the extent to which these factors are correlated with social support among LBC so far in mainland China. Specifically, first of all, as for the correlation between social support and loneliness among LBC in mainland China, some studies have found a relatively large negative correlation (14, 16), while others have found a small negative correlation (17, 18). Secondly, regarding the relationship between social support and self-esteem, some studies have found that there was a small positive correlation,while others have found a lager positive correlation (15, 19). Similarly, the strength of identified associations between social support and resilience among LBC in mainland China has varied considerably thus far, ranging from small ($r = 0.22$) (20) to large ($r = 0.75$) (21).

Using meta-analysis, the outcomes of several studies can be statistically combined to obtain an overall effect size. However, up to now, no meta-analysis has been conducted on the relationship between social support and loneliness, self-esteem, and resilience among LBC in mainland China. Therefore, the purpose of this study is to conducted 3 meta-analysis to explore the relationship between social support and loneliness, self-esteem, and resilience among LBC in mainland China. The potential existence of publication bias was addressed. Because journals may tend to publish studies with significant results and reject those with non-significant results, this may lead to publication bias; In addition, existing null results that have never been published may lead to overestimation of the relationship between variables (22). Furthermore, subgroup analysis was used to analyze the moderating effects of sampling strategy, sample size, gender, educational stage of children, published type, social support measurement instruments, and the measurement instruments for the three targeted variables in the included studies to evaluate whether the relationships between variables were moderated by demographics and study characteristics.

MATERIALS AND METHODS

A systematic review and meta-analysis was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (23). Moreover, the review was registered in PROSPERO (registration number: CRD42022304140).

Searching Strategy

The databases PubMed, EMBASE, Web of Science, PsycINFO, Wan Fang database, Chinese National Knowledge Infrastructure (CNKI) and China Science Technology Journal Database (VIP) were searched on January 9, 2022 using the key words "left-behind," "stay at home," "child*," "adolescent*" "child*," "student*," "support," "social support," "social network," "social relation," "social resource," "social environment," "Chinese" and "China." Finally, appropriate Boolean operators are used to combine these search terms. In addition, Google Scholar and CNKI were used to conduct gray literature search for dissertations that met our inclusion criteria. A detailed search strategy is available in **Supplementary File 1**. Publication languages were limited to English and Chinese. Reference lists of retrieved studies were scanned for further possible articles.

Selection Criteria

Two investigators independently screened the retrieved literature according to the following inclusion and exclusion criteria: (1) LBC living in China; (2) cross-sectional studies offering Pearson's correlation coefficients for the associations between social support and loneliness, self-esteem, and resilience; (3) social support measurement instruments were limited to the Social Support Rating Scale (SSRS), Social Support Questionnaire (SSQ), Multi-dimensional Scale of Perceived Social Support (MSPSS) and Chinese version Perceived Social Support Scale

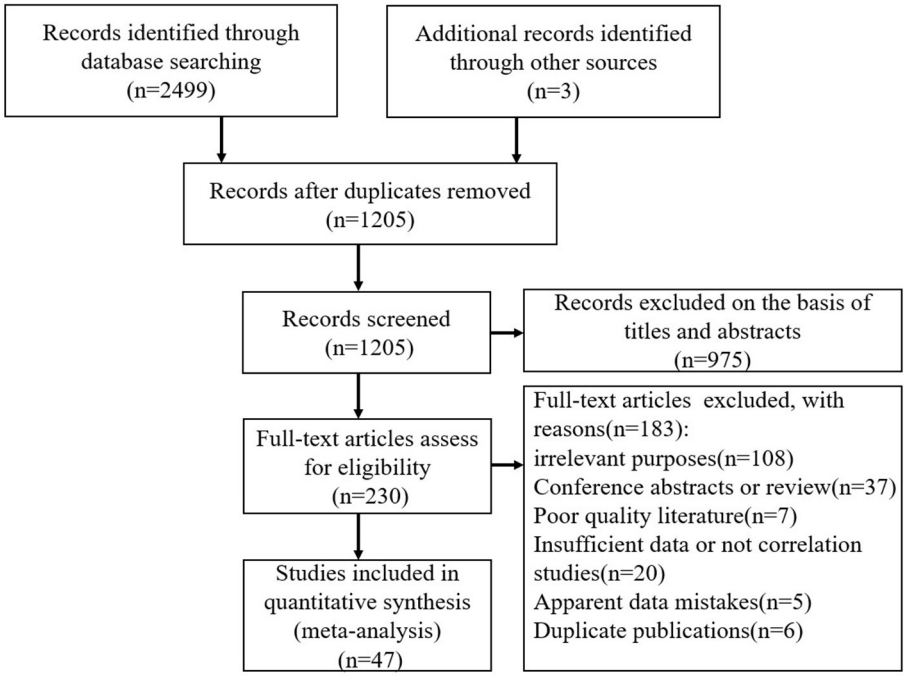

FIGURE 1 | The flow chart of the study selection process.

(PSSS); (4) loneliness measurement instruments were limited to Children Loneliness Scale (CLS), University of California Los Angeles Loneliness Scale (ULS), Mental Health Diagnostic Test (MHT) and Adolescents' loneliness scale (ALS); (5) self-esteem measurement instruments were limited to Self-Esteem Scale (SES) and Collective Self-esteem Scale (CSES); (6) there was no restriction on resilience scales; and (7) published in English or Chinese; The exclusion criteria are as follows: (1) "special" left-behind children, such as orphans or children from single-parent families; (2) conference abstracts and review articles. If more than one paper were published based on the same dataset, we only included the articles using more completed information; and (3) literature with poor quality or apparent data mistakes were also excluded.

Study Selection and Data Extraction

Two researchers (HTH and XW) systematically and independently evaluated the eligibility of the study and extracted data. In case of disagreement during the process, it will be resolved through discussion or consultation with a third researcher (YMD). The following information was extracted: first author, year of publication, geographical area, sampling strategy, sample size, number of males and females, mean age, measurement tool of social support level, instruments used to measure levels of loneliness, self-esteem, and resilience and Pearson's correlation coefficients between social support and the above three variables.

Assessment of the Study Quality

Nine-item Joanna Briggs Institution Critical Appraisal Checklist for Studies Reporting Prevalence Data is used as a quality assessment tool (24). A minor adjustment has been made to the third item of the scale. That is, the appropriate sample size was judged based on Pearson's correlation study design rather than the prevalence study design. The answers to each item include "yes," "no," "unclear" and "not applicable." If the answer is "yes," the item will receive one point; otherwise, it will receive zero points. The higher the score, the better the quality of the method. The methodological quality of all studies included was independently assessed by two researchers (HTH and YMD). A third author was available for resolving differences (CRC). The results showed that all the included studies were of medium or high quality (total score $\geq$ 6). See **Supplementary File 2** for the specific quality evaluation results.

Statistical Analysis

Stata 16.0 was used for statistical analysis (STATA Corp, College Station, TX). The Pearson product-moment correlation coefficient (r) is used as the effect size of this study. Since the variance is strongly dependent on the correlation, the r coefficient is transformed by the formula into Fisher 'z (25). The sample correlation r is converted into Fisher's Z by formula (1), and the standard error is calculated by formula (2), where n is the sample size. Fisher z statistics are assumed to be normally distributed data, and their 95% confidence intervals are calculated by formula (3). In the end, an inverse transformation was performed to report the results on the scale of the r-coefficient by formula (4).

TABLE 1 | Characteristics of studies included in the meta-analysis.

Name (year)	Province	School year	LBC (*n*)	Male/ female	Age range/ mean ± SD	Sampling method	Published types	Social support measurement	Measurement instrument (Pearson's r)		
									Loneliness	Self-esteem	Resilience
Liu et al. (31)	Henan	P, J	181	88/93	10–16	cluster sampling	Journal	SSQ	CLS	N/A	N/A
Zhao et al. (32)	Henan	P, J	218	N/A	14.09	convenience sampling	Journal	SSQ	CLS	N/A	N/A
Chen et al. (17)	Heilongjiang	P, J, S	338	N/A	13–15	cluster sampling	Journal	SSRS	MHT	N/A	N/A
Du (33)	Anhui	J	455	214/241	15.58 ± 0.04	random	Journal	SSRS	MHT	N/A	N/A
Li et al. (34)	Zhejiang	J	561	51.5	N/A	convenience sampling	Journal	SSRS	N/A	N/A	ERS
Li (35)	Henan	J	386	52.6	11.62 ± 0.58	random	Journal	SSRS	N/A	N/A	ERS
Liu (36)	Sichuan	J	1,016	49.3	N/A	convenience sampling	Dissertation	PSSS	N/A	N/A	ERS
Wu et al. (13)	Guangdong	P, J	437	N/A	11–16	random	Journal	SSRS	CLS	N/A	N/A
Zeng (18)	Henan	J	506	37	N/A	convenience sampling	Journal	SSRS	MHT	N/A	N/A
Chen et al. (37)	Sichuan	J	340	176/164	N/A	convenience sampling	Journal	SSRS	N/A	N/A	HKRA
Wu et al. (38)	Guangdong	P, J	427	N/A	11–16	random	Journal	SSRS	N/A	SES	N/A
Wang (39)	Gansu	P	94	52/42	N/A	random	Dissertation	SSRS	CLS	N/A	N/A
Li and Guo (40)	Anhui	P	298	215/83	N/A	stratified sampling	Journal	SSRS	MHT	N/A	N/A
Zhou et al. (41)	Guangxi	J	523	186/337	14.24 ± 1.13	cluster sampling	Journal	SSRS	N/A	N/A	HKRA
Chen et al. (42)	Zhejiang	P, J, S	355	206/149	N/A	convenience sampling	Journal	SSRS	MHT	N/A	N/A
Zhao et al. (43)	Henan	P, J	218	N/A	11–16	convenience sampling	Journal	SSQ	N/A	SES	N/A
Ai and Hu (14)	Hunan, Sichuan	P	414	214/200	10.9 ± 1.07	convenience sampling	Journal	PSSS	CLS	N/A	CD-RISC
Niu (21)	Henan	P	356	220/136	N/A	convenience sampling	Dissertation	PSSS	N/A	N/A	HKRA
Chen and Zhao (44)	Zhejiang	P	335	170/185	N/A	convenience sampling	Journal	SSRS	N/A	SES	N/A
Yue and Lu (45)	Jiangsu, Guizhou	P	387	N/A	10–16	cluster, random sampling	Journal	SSRS	CLS	N/A	N/A
Zhao (46)	Guizhou	N/A	366	192/174	13.23 ± 1.13	random sampling	Journal	SSRS	CLS	N/A	N/A
Xiao and Zhang (47)	Jiangxi	N/A	437	214/223		convenience sampling	Journal	SSRS	CLS	N/A	N/A
Xiao (48)	Guangxi	P, J	1,110	473/637	N/A	cluster sampling	Dissertation	SSRS	N/A	N/A	ERS
Kong et al. (16)	Shandong	J	474	206/268	N/A	cluster, random sampling	Journal	SSRS	UCL-8	N/A	N/A
Lin and Bai (20)	Fujian	J	102	50/52	N/A	random	Journal	SSRS	N/A	N/A	CD-RISC

(Continued)

TABLE 1 | Continued

Name (year)	Province	School year	LBC (*n*)	Male/ female	Age range/ mean ± SD	Sampling method	Published types	Social support measurement	Measurement instrument (Pearson's r)		
									Loneliness	Self-esteem	Resilience
Ma and Yu (49)	Guizhou	J	763	347/415	16.12 ± 1.52	convenience sampling	Journal	PSSS	N/A	SES	RSCA
Fu (50)	Yunnan	J	182	94/88	14.3	cluster sampling	Journal	SSRS	N/A	SES	N/A
Ji et al. (51)	Sichuan	J	1,596	702/884	15.77 ± 0.74	convenience sampling	Journal	SSRS	N/A	SES	N/A
Liu (52)	Hubei	J	280	140/140	N/A	cluster sampling	Journal	SSRS	MHT	N/A	N/A
Man et al. (53)	Hunan	J	1,309	661/648	14.44 ± 1.14	cluster, random sampling	Journal	PSSS	N/A	SES	N/A
Qiao (54)	Yunnan	S	285	125/160	N/A	convenience sampling	Dissertation	PSSS	N/A	N/A	HKRA
Liu and Chen (55)	Guizhou	P	301	N/A	N/A	Random	Journal	SSRS	N/A	CSES	N/A
Shen (56)	Hubei	P	343	196/147	N/A	convenience sampling	Dissertation	SSRS	CLS	N/A	N/A
Fan and Lu (57)	Anhui	P, J	476	244/232	12 ± 1.80	Random	Journal	MSPSS	N/A	N/A	CYRM-28
Yu and Xiang (58)	Sichuan	J	377	N/A	N/A	convenience sampling	Journal	SSRS	N/A	N/A	RSCA
Fang (59)	Guangxi	J	1045	535/510	N/A	convenience sampling	Dissertation	SSRS	MHT	N/A	CD-RISC
Cheng et al. (15)	Anhui	J	220	114/106	13.67 ± 1.04	Random	Journal	SSRS	N/A	SES	N/A
Fan (60)	Guizhou	P	191	N/A	N/A	Random	Dissertation	SSRS	N/A	CSES	N/A
Hua et al. (61)	Eight provinces in central China	N/A	2,188	1,062/1,126	N/A	convenience sampling	Journal	SSRS	CLS	N/A	N/A
Li et al. (62)	Hunan	P, J	797	401/396	12.0 ± 2.0	Random	Journal	PSSS	UCL-8	N/A	N/A
Yang (63)	Yunnan	P, J, S	252	145/107	N/A	convenience sampling	Dissertation	PSSS	N/A	N/A	RSCA
Wang (64)	Henan	P	204	N/A	N/A	Random	Dissertation	SSQ	N/A	N/A	ERS
Ge and Liu (65)	Guizhou	J	316	N/A	N/A	cluster sampling	Journal	SSQ	N/A	N/A	RSCA
Ma and Gao (19)	Guizhou	J	980	461/519	16.12 ± 1.52	convenience sampling	Journal	PSSS	N/A	SES	RSCA
Huang et al. (66)	Eight cities/counties in central China	N/A	307	147/160	N/A	stratified random	Journal	SSRS	N/A	SES	N/A
Fan and Fan (67)	Hunan	P, J	692	326/366	11.99 ± 1.73	snowball sampling scheme	Journal	MSPSS	ALS	SES	ERS
Ma et al. (67)	Guizhou	J	1,095	528/567	16.46 ± 1.76	convenience sampling	Journal	PSSS	N/A	SES	RSCA

P, Primary school; J, junior high school; S, Senior high school. SSRS, Social Support Rating Scale; SSQ, Social Support Questionnaire; MSPSS, Multi-dimensional Scale of Perceived Social Support; PSSS, Perceived Social Support Scale; CLS, Children Loneliness Scale; ULS-8, University of California Los Angeles Loneliness Scale-8; MHT, Mental Health Diagnostic Test; SES, Self-Esteem Scale; ALS, Adolescents' loneliness scale; CSES, Collective Self-Esteem Scale; ERS, Ego-Resiliency Scale; HKRA, Health Kids Resilience Assessment; CD-RISC, Connor-Davidson resilience scale; RSCA, Resilience Scale for Chinese Adolescents; CYRM-28, the Child and Youth Resilience Measure-28.

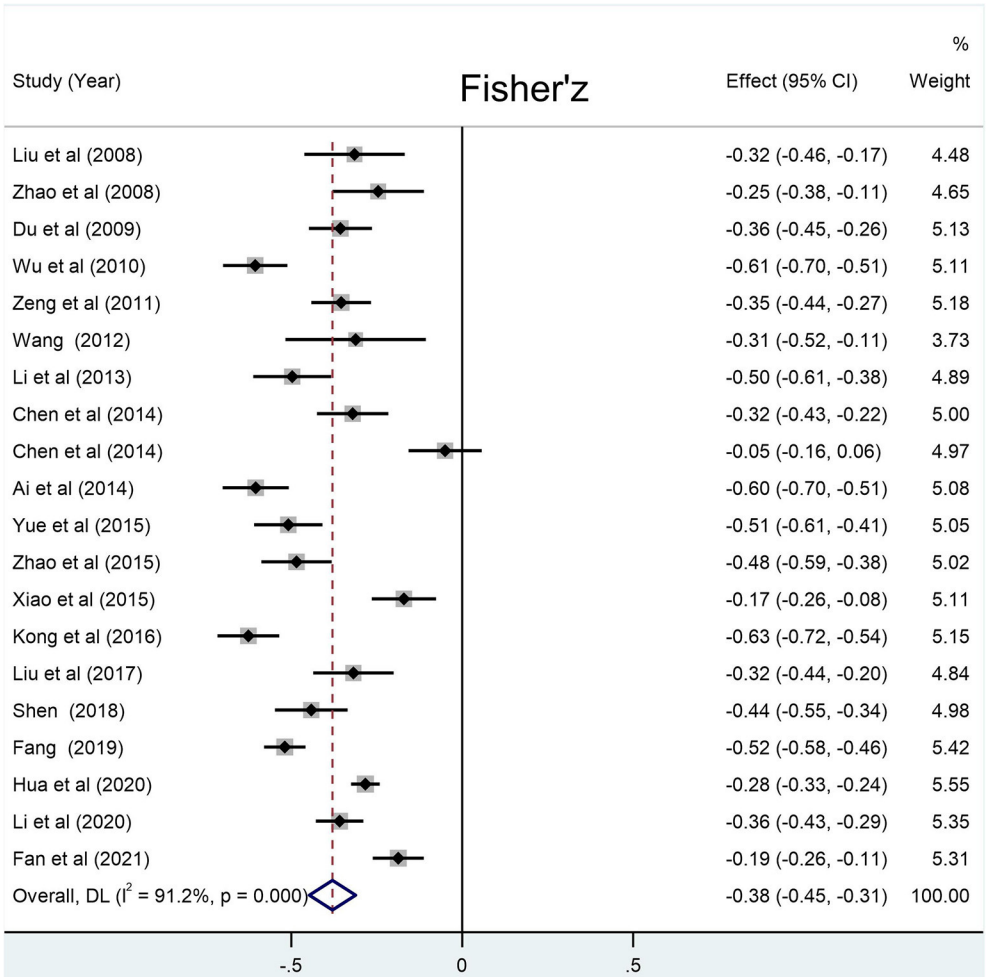

FIGURE 2 | Forest plots for the correlation between social support and loneliness. Weights are from random-effects model.

Moreover, since the reference standard for the interpretation of the correlation coefficient suggested by Cohen (26) (r = 0.1 is low correlation, r = 0.3 is moderate correlation and r = 0.5 is strong correlation) is based on qualitative analysis, which is relatively subjective, so this study adopts the suggestions of Gignac and Szodorai, and r = 0.1, r = 0.2 and r = 0.3 represent relatively small, typical, and relatively large correlation (27).

- $Fisher^{'}s\ Z = 0.5 \ln \frac{1+r}{1-r}$
- $S_E = \sqrt{1/(n-3)}$
- $95\%CI = Z \pm 1.96(SEz)$
- $Summary\ r = \frac{e^{2z}-1}{e^{2z}+1}$ (Z=summary Fisher$^{'}$s Z).

The random-effects model was used for data analysis because it does not assume a common potential effect size for all included studies, making it more suitable than fixed-effects models for meta-analyses based on existing literature (22). The meta-analysis was performed with the Der-Simonian and Laird's method (28), where the weighting of sample size was introduced into the model as the inverse of variance. Heterogeneity was tested by Q statistics and I^2, which measure whether there are differences between the included studies. In addition, we further tested the probable variables that could moderate the correlations between social support and loneliness, self-esteem, and resilience among LBC by subgroup analysis. Studies were grouped by a few available study characteristics, including sampling strategy, sample size, gender, educational stage of children, published type, social support measurement instruments, and the measurement instruments for the three targeted variables. The Q statistic was also used to test the differences between and within groups of studies.

To assess the impact of individual studies on the summary correlation coefficients and evaluate the robustness of the correlations between social support and loneliness, self-esteem, and resilience, sensitivity analyses were conducted by sequentially omitting one study each turn.

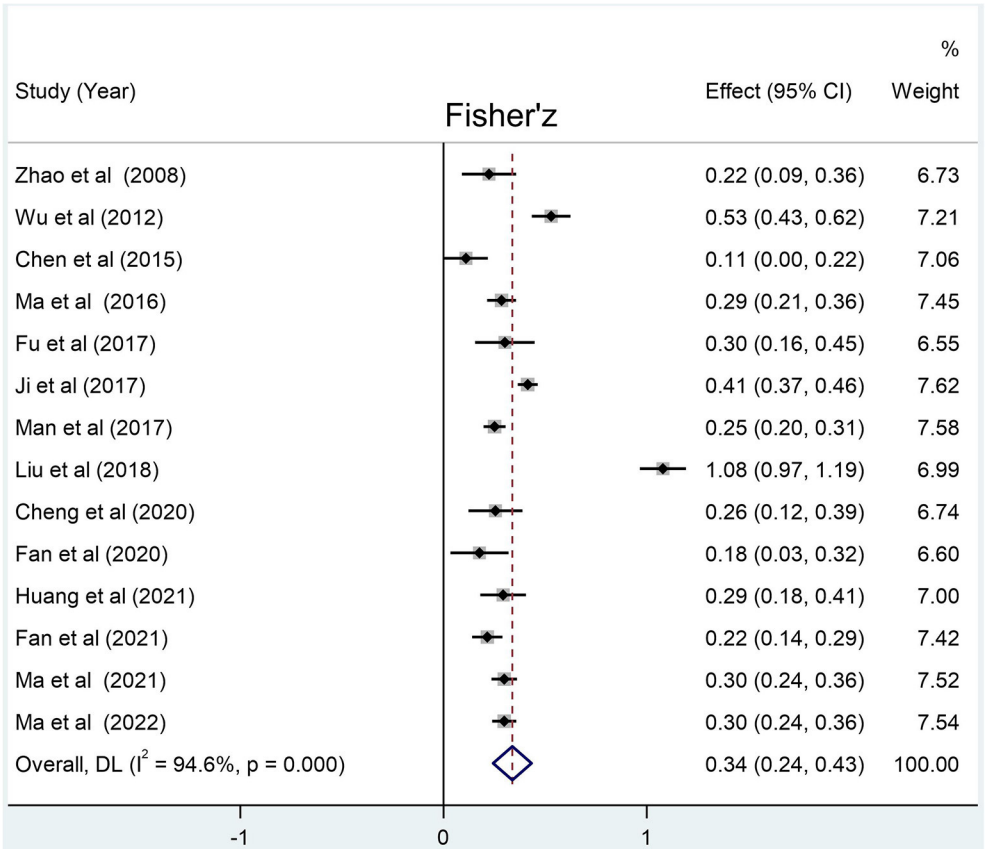

FIGURE 3 | Forest plots for the correlation between social support and self-esteem. Weights are from random-effects model.

Lastly, visual inspection of funnel plots, Egger's linear regression test (29) and Duval and Tweedie's trim-and-fill (30) analysis were performed to help us assess publication bias.

RESULTS

Study Selection and Study Characteristics

Our search strategy identified 1 205 studies without duplicates (**Figure 1**). There were 975 studies excluded after title and abstract screening. Finally, the full texts of 230 articles were reviewed. We excluded 183 studies for the following reasons: irrelevant purposes ($n = 108$), conference abstracts or reviews ($n = 37$), poor quality ($n = 7$), had insufficient data or not correlation studies ($n = 20$), had apparent data mistakes ($n = 5$), or duplicate publications ($n = 6$). As shown in **Table 1**, 47 studies ultimately met the inclusion criteria, involving a total of 30 212 LBC in China. Of these 47 studies, 20 reported Pearson's correlation coefficients between social support and loneliness, 14 reported Pearson's correlation coefficients between social support and self-esteem, and 20 reported Pearson's correlation coefficients between social support and resilience.

The number of LBC involved in the correlations between social support and loneliness, self-esteem, and resilience was 10 305, 8 615, and 11 292, respectively. The results of meta-analysis show that the social support of the LBC in mainland China has a relatively large negative correlation with loneliness (summary r: −0.36 [95% CI: −0.42– −0.30], p<0.001), and a relatively large positive correlation with self-esteem [summary r: 0.33 (95% CI: 0.24– −0.41), $p < 0.001$] and resilience [summary r: 0.45 (95% CI: 0.38– −0.50), $p < 0.001$] (**Figures 2–4**).

Subgroup Analysis

As shown in **Table 2**, the summary correlation coefficient between social support and loneliness did not reveal any significant difference when stratified by sample size, gender, education, published type, and social support measurement instrument (all with $p > 0.05$). However, we found that the summary correlation coefficient for loneliness in studies using random sample were higher than that in studies using non-random sample (random: summary r = −0.44, 95% CI: −0.51– −0.36, p < 0.001; non-random: summary r = −0.32, 95% CI: −0.39– −0.24, $p < 0.001$; $Q_B = 4.81$, $p < 0.05$). Similarly, studies using the ULS-8 measurement tool yielded higher negative correlation than studies using the CLS, MHT, and ALS

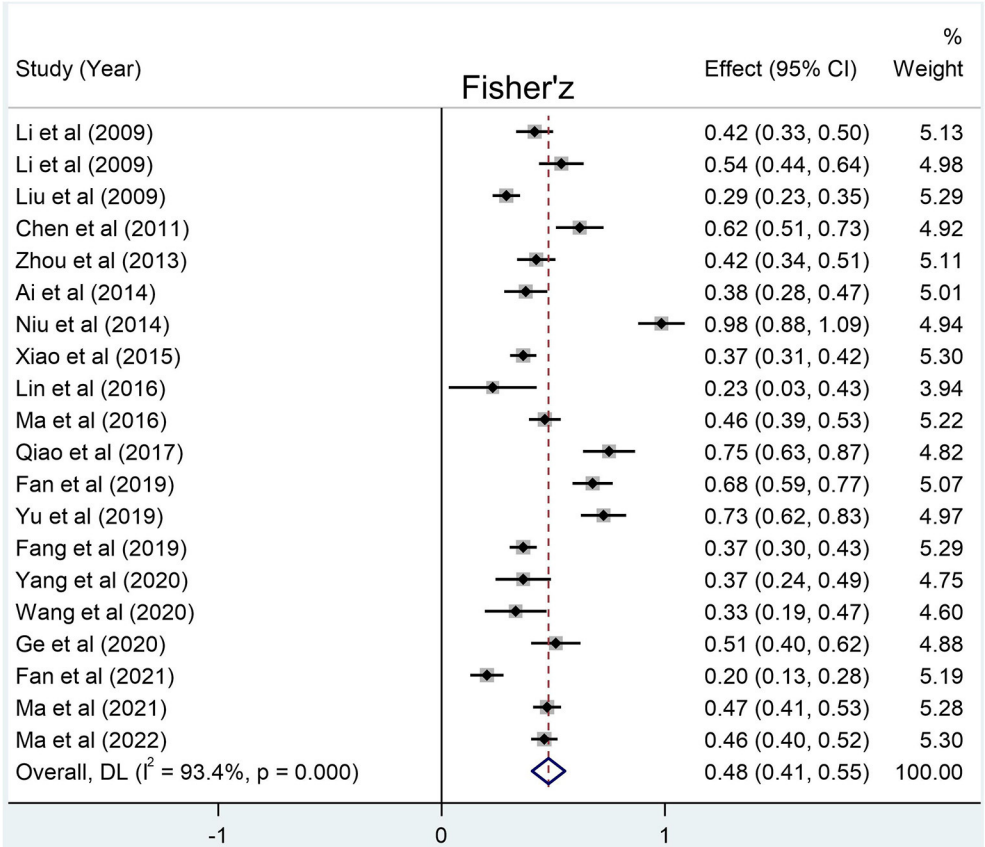

FIGURE 4 | Forest plots for the correlation between social support and resilience. Weights are from random-effects model.

measurement tools (ULS-8: summary r = −0.45, 95% CI: −0.64–−0.22, $p < 0.001$; CLS: summary r = −0.38, 95% CI: −0.46–−0.29, $p < 0.001$; MHT: summary r = −0.33, 95% CI: −0.43–−0.23, $p < 0.001$; ALS: summary r = −0.19, 95% CI: −0.26–−0.11, $p < 0.001$; $Q_B = 15.08$, $p < 0.05$).

As shown in **Table 3**, subgroup analysis showed that sampling method, sample size, gender, education, publication type, social support measurement tool, and self-esteem measurement tool did not significantly affect the relationship between social support and self-esteem (all with $p > 0.05$).

The summary correlation coefficient between social support and resilience was substantially changed when stratified by the sample size and measurement instrument for resilience (all with $p < 0.05$). No difference was observed in subgroup analyses by sampling strategy, gender, education, published type or instrument for social support (all with $p > 0.05$) (**Table 4**).

Sensitivity Analyses

Stability of results was assessed by sequentially excluding one study and then recalculating the pooled correlation coefficient. Sensitivity analyses for summary correlation coefficients between social support and loneliness, self-esteem, and resilience revealed minor changes, indicating that our results were stable (**Supplementary File 3**).

Publication Bias

Judging subjectively, it was difficult to determine whether the funnel plots for the summary correlation coefficients between social support and loneliness, self-esteem, and relisience were symmetric or not (**Supplementary File 4**). The Egger linear regression test showed insignificant results (Loneliness: t = −0.51, $p = 0.62$; Self-esteem:t = 0.23, $p = 0.82$;Resilience:t = 1.62, $p = 0.12$). Duval and Tweedle trim-and-fill procedure suggested that no additional research is needed for all three meta-analyses (**Supplementary File 5**). Taken together, it suggests the absence of publication bias for these meta-analyses.

DISCUSSION

To the best of our knowledge, this was the first meta-analysis exploring the pooled correlation coefficients of social support with loneliness, self-esteem, and resilience among LBC in mainland China. Our results indicated that the social support of the LBC in mainland China has a relatively large negative correlation with loneliness, and a relatively large positive correlation with self-esteem and resilience, with a series of summary Pearson's correlation coefficients of −0.36, 0.33 and 0.45, respectively. The sensitivity analysis results are robust, which indicates that the pooled analysis of correlation coefficients

TABLE 2 | Subgroup analyses of the summary correlation between social support and loneliness among LBC.

	Q_{BET}	k	*N*	Summary r	95% CI	Q_W	I^2
Random sampling	4.81*						
Yes		7	3,010	−0.44	[−0.51, −0.36]	36***	84.2%
No		13	7,295	−0.32	[−0.39, −0.24]	138.61***	91.3%
Sample size	0.58						
≤400		10	2,860	−0.33	[−0.42, −0.25]	58.55***	84.6%
>400		10	7,445	−0.38	[−0.46, −0.30]	157.23***	94.3%
Gender	3.74						
Male predominance (>50%)		8	3,712	−0.42	[−0.48, −0.36]	29.91***	76.6%
Female predominance (>50%)		7	4,933	−0.32	[−0.41, −0.22]	69.22***	91.3%
Education	5.16						
Primary school		5	1,536	−0.46	[−0.52, −0.39]	10.83**	54.7%
>Primary school		6	3,098	−0.36	[−0.48, −0.22]	82.80***	94.0%
Unclassified		6	2,680	−0.32	[−0.43, −0.21]	49.11***	89.8%
Published type	2.04						
Journal		17	8,823	−0.35	[−0.41, −0.29]	188.56***	91.5%
Dissertation		3	1,482	−0.42	[−0.50, −0.34]	24.57**	56.2%
Social support measurement instrument	3.23						
SSQ		2	399	−0.27	[−0.36, −0.18]	0.47	0.0%
SSRS		15	8,003	−0.37	[−0.44, −0.30]	165.51***	91.5%
MSPSS or PSSS		3	1,903	−0.36	[−0.54, −0.16]	44.88***	95.5%
Loneliness measurement instrument	15.08*						
CLS		10	5,065	−0.38	[−0.46, −0.29]	98.35 ***	90.8%
MHT		7	3277	−0.33	[−0.43, −0.23]	63.56***	90.6%
ULS-8		2	1,271	−0.45	[−0.64 −0.22]	21.07***	95.3%
ALS		1	692	−0.19	[−0.26 −0.11]	0.00	0.0%

Q_{BET}: Between groups Q; Q_W: Within groups Q; $^{*}P < 0.05$; $^{**}P < 0.01$; $^{***}P < 0.001$.

is reliable and convincing. Egger linear regression and Duval and Tweedie's trim-and-fill analysis also show that there is no publication bias in our research results.

According to interactionist theory, loneliness is a response to the lack of satisfactory social networks (68). Social support can fill the gap between social network and social contact needs, thus reducing loneliness (69). Research by Ayalon, Shiovitz-Ezra and Palgi suggests that the frequency, content and meaning of social interactions have a significant impact on loneliness (70). The effect of social support on loneliness is also likely to be mediated by other variables, not just directly. Evidence has shown that the association between social support and loneliness could be mediated by gratitude (71). According to the broaden-and-build theory of positive emotions, gratitude as a positive emotion helps individuals to expand their cognitive schema, enhance the flexibility of activities, construct personal psychological and social resources, and eliminate the negative effects of negative emotions (72). Individuals with higher social support levels have more positive emotional experiences such as gratitude, which reduces their loneliness. Interestingly, there is also evidence that psychopathology in turn affects social support (73). The social selection model believes that healthy individuals are more likely to obtain good social relationships, experience more social support, and have more positive evaluations of themselves, others, and the world (74), which may increase individuals' gratitude to others and stimulate others' willingness and behavior to further support individuals (75), thus enabling individuals to experience more social support. Adolescence is a transitional stage from children to adults, when individuals face more psychological conflicts and pressures (32). On the one hand, the psychological sense of adulthood caused by teenagers' physiological maturity coexists with naivety in reality, which makes it easy for teenagers to experience psychological conflicts; On the other hand, adolescent individuals begin to assume some adult roles and obligations (32). This change of social role makes them pay attention to the practical problems of future development, such as further education and employment, and bear great pressure from family, school and society. For LBC who are in the background of relative lack of parental affection, the psychological conflicts and pressures they experience may be more serious than those of ordinary teenagers, so they are more likely to have psychological problems (76). LBC is more prone than NLBC to experience psychological difficulties such as loneliness, according to studies (76). Our findings suggest that there is a substantial negative relationship between social support and loneliness among LBC, and that enhancing social support for these children can help them feel less lonely. As a result, establishing a proper social

TABLE 3 | Subgroup analyses of the summary correlation between social support and self-esteem among LBC.

	Q_{BET}	k	*N*	Summary r	95% CI	Q_W	I^2
Random sampling	1.40						
Yes		6	2,755	0.40	[0.18, 0.59]	190.33***	97.4%
No		8	5,860	0.27	[0.21, 0.33]	38.89*	82.0%
Sample size	0.03						
≤400		7	1,754	0.34	[0.08, 0.55]	189.45***	96.8%
>400		7	6,861	0.31	[0.25, 0.37]	48.33***	87.6%
Gender	0.29						
Male predominance (>50%)		3	1,711	0.25	[0.21, 0.29]	0.41***	0.0%
Female predominance (>50%)		7	5,767	0.27	[0.21, 0.33]	37.47**	84.0%
Education	0.24						
Primary school		3	827	0.43	[0.18, 0.69]	169.71**	98.8%
>Primary school		7	6,144	0.30	[0.25, 0.34]	23.01***	73.9%
Unclassified		3	1,337	0.31	[0.11, 0.49]	28.15***	92.9%
Published type	3.82						
Journal		13	8,424	0.34	[0.25, 0.42]	236.35***	94.9%
Dissertation		1	191	0.18	[0.03, 0.31]	0.00	0.0%
Social support measurement instrument	3.23						
SSQ		1	218	0.22	[0.09, 0.36]	0.00	0.00
SSRS		8	3,559	0.37	[0.21, 0.53]	190.91***	91.5%
MSPSS or PSSS		5	4,838	0.27	[0.24, 0.29]	4.38	95.5%
Self-esteem measurement instrument	0.53						
SES		12	8,123	0.28	[0.23, 0.34]	58.20***	84.5%
CSES		2	492	0.55	[−0.25, 0.90]	93.92***	98.9%

*Q_{BET}: Between groups Q; Q_W: Within groups Q; *$P < 0.05$; **$P < 0.01$; ***$P < 0.001$.*

support system for the mental health development of the LBC is critical.

Consistent with previous literature, self-esteem was positively correlated with social support. Adela's research found that social support is beneficial to improve an individual's self-esteem (77). Rosenberg also put forward a similar point of view, he believed that self-esteem is the result of social support, in adolescence, a harmonious social environment has a very important role in the maintenance of self-esteem (78). Yarcheski's study of 165 adolescents aged 15–17 found that the correlation between social support and self-esteem was 0.30 (79); in 1997, they reported a correlation of 0.38 (80). For LBC in an unfavorable growing environment, they may not be able to receive timely support and affirmation from their parents like NLBC. This kind of support is not satisfied for a long time, which will lead to the LBC often denying themselves, having a low evaluation of self-worth and developing a low self-esteem personality (44). Studies have shown that compared with NLBC, LBC show lower self-esteem (81). The positive correlation between social support and self-esteem reveals that for the LBC who lack parental care, increasing social support may be an effective strategy to help LBC enhance their positive self-identity and improve their self-esteem.

The results of the meta-analysis show that social support is positively correlated with resilience, which is consistent with the results of previous study (82). The resilience is the psychological function that an individual can keep or return to normal after experiencing adversity or trauma (83). It is a successful "self-adjustment mechanism" response and an important protective element against emotional and behavioral issues in adolescents (84). The main effect model of social support believes that social support has a general positive effect, no matter what the current level of social support is, as long as social support increases, it will inevitably lead to the improvement of individual health status (85). In addition, the positive correlation between the two is also consistent with the prediction of the protective-protective model, that one protective factor enhances the effect of another protective factor (86). Research shows that the ability of LBC to adapt to the difficulties such as lack of parental affection, insufficient family education and limitation of intergenerational rearing is related to psychological resilience (87). This suggests that we should provide a good social support environment for the children who have been left behind. LBC can gain problem-solving skills and experience from family, friends, schools and other outsiders by establishing a safe and friendly relationship with others, which will have a positive effect on their psychological resilience, thus effectively buffering the influence of external harmful factors.

Moderating effect analysis showed that sampling methods and loneliness measurement tools may moderate the relationship between social support and loneliness. The former suggests that the quality of research design may affect the relationship between the two, and more accurate conclusions may be obtained

TABLE 4 | Subgroup analyses of the summary correlation between social support and resilience among LBC.

	Q_{BET}	k	*N*	Summary r	95% CI	Q_W	I^2
Random sampling	0.07						
Yes		4	1,168	0.43	[0.27, 0.56]	26.99***	88.9%
No		16	10,124	0.45	[0.38, 0.51]	253.27***	94.1%
Sample size	3.90*						
≤400		9	2,618	0.51	[0.40, 0.61]	109.96***	92.7%
>400		11	8,674	0.39	[0.33, 0.44]	90.36***	88.9%
Gender	2.48						
Male predominance (>50%)		8	3,830	0.49	[0.38, 0.59]	135.88***	94.8%
Female predominance (>50%)		9	6,565	0.39	[0.31, 0.46]	90.06***	91.1%
Education	0.80						
Primary school		3	974	0.51	[0.14, 0.76]	87.02**	97.7%
>Primary school		13	7,788	0.45	[0.39, 0.50]	107.01***	88.8%
Unclassified		4	2,530	0.38	[0.21, 0.53]	63.42***	95.3%
Published type	0.04						
Journal		13	7,024	0.44	[0.38, 0.50]	115.29***	89.6%
Dissertation		7	4,268	0.46	[0.31, 0.58]	168.98***	96.4%
Social support measurement instrument	0.49						
SSQ		2	520	0.40	[0.25, 0.54]	3.95*	74.7%
SSRS		8	4,444	0.43	[0.36, 0.51]	61.44***	88.6%
MSPSS or PSSS		10	6,328	0.46	[0.36, 0.56]	222.92***	96.0%
Resilience measurement instrument	46.54***						
ERS		6	3,969	0.34	[0.26, 0.41]	34.25***	85.4%
HKRA		4	1,504	0.60	[0.42, 0.73]	69.06***	95.7%
CD-RISC		3	1,561	0.35	[0.30, 0.39]	1.85	0.0%
RSCA		6	3,782	0.46	[0.40, 0.52]	26.52***	81.1%
CYRM-28		1	476	0.59	[0.53 0.64]	0.00	0.0%

*Q_{BET}: Between groups Q; Q_W: Within groups Q; *$P < 0.05$; **$P < 0.01$; ***$P < 0.001$.*

by using random sampling methods. The latter may be due to the lack of included literature in some subgroups (e.g., the ULS-8 and ALS groups included only 2 and 1 articles, respectively). Subgroup analysis by sample size showed that the summary social support-resilience correlation coefficients were higher in smaller sample size studies than in larger sample size studies (summary r: 0.51 vs. 0.39, p <0.01) (**Table 3**). Studies with larger sample sizes may be more representative and more likely to yield reliable results. Resilience measurement tools may also regulate the relationship between social support and resilience, which may also be related to the lack of literature in some groups (for example, CYRM-28 group only contains one literature).

LIMITATIONS AND FUTURE IMPLICATIONS

When interpreting the results of the current study, several limitations must be kept in mind. First, to reduce the potential source of heterogeneity, social support measurement tool was restricted to the SSRS, SSQ, MSPSS, and PSSS. Similarly, measurement tool for loneliness was restricted to the CLS, ULS, MHT and ALS; the measurement instrument for self-esteem was restricted to the SES and CSES. As a result, the article included in this meta-analysis was limited. In the future, after the paper is further enriched, it is necessary to further explore the research using other measurement tools. Second, in our search strategy, only a few commonly used databases were searched, which may lead to certain publication bias. Future research can increase the number of retrieval databases, such as Scopus, EBSCO, Springer link, The Cochrane library, to minimize the risk of bias in research results. Third, in view of the limited number of studies included, subgroup analysis based on some moderators should be carefully interpreted to some extent. In addition, even after subgroup analysis, the aggregate correlation coefficient still has substantial heterogeneity. Other possible influencing factors such as pre-existing illness, personality, comorbidity, lifestyle, and living conditions might also account for this correlation. Unfortunately, because the effect size is Pearson correlation coefficient rather than partial correlation coefficient, the correlation between social support and the three clinical variables is calculated without adjusting the related variables. Few studies conducted stratified Pearson's correlation analysis according to these variables. Future research can further focus on other variables (such as personality,

living conditions.) that may directly affect social support and loneliness, self-esteem, and resilience in Chinese LBC, so as to provide clearer intervention ideas for future mental health research. Finally, the articles included in this study are all cross-sectional studies, and no judgment can be made on the causal relationship between variables. Therefore, more longitudinal studies are still needed in the future to test the causal relationship between social support and loneliness, self-esteem, and resilience.

CONCLUSION

Despite the limitations mentioned above, all available evidence supports that the social support of the LBC in mainland China has a relatively large negative correlation with loneliness, and a relatively large positive correlation with self-esteem and resilience. Their summary Pearson's correlation coefficients were −0.36, 0.33 and 0.45, respectively. This means that left-behind children in mainland China with high levels of social support are more likely to have lower levels of loneliness and higher levels of self-esteem and resilience. More studies, especially large prospective studies with long follow-up periods, are warranted to verify our findings.

DATA AVAILABILITY STATEMENT

The data analyzed in this study is subject to the following licenses/restrictions: The datasets presented in this study are available from the authors upon reasonable request. Requests to access these datasets should be directed to HH, huangtaomiss@163.com.

AUTHOR CONTRIBUTIONS

HH and XW: study design, critical revision of the manuscript, and drafting of the manuscript. YL, YZ, QP, YD, GL, and CC: analysis and interpretation of data. All authors approval of the final version for submission.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyt.2022.874905/full#supplementary-material

Supplementary File 1 | Search strategy.

Supplementary File 2 | Quality assessment form for included studies.

Supplementary File 3 | Sensitivity analyses of correlations between social support and loneliness, self-esteem, and resilience.

Supplementary File 4 | Funnel plot of correlations between social support and loneliness, self-esteem, and resilience.

Supplementary File 5 | Duval and Tweedle trim-and-fill procedure of correlations between social support and loneliness, self-esteem, and resilience.

Supplementary File 6 | PRISMA Checklist.

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Diurnal Cortisol in Left-Behind Adolescents: Relations to Negative Family Expressiveness and Internalizing Problems

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Despite the accumulating evidence for increased risks for behavioral problems in left-behind adolescents in China, little research has explored their HPA axis functioning, which is hypothesized to play a central role in the association between early adversity and health. In the present study, we designed a longitudinal study to examine HPA axis function in left-behind adolescents and its mediating role in the association between family emotional expressiveness and internalizing problems. Participants were 81 adolescents (44 female; 37 male) aged 11–16 years. Salivary cortisol samples were collected six times a day for two consecutive days on regular school days. Negative family expressiveness (NFE) and internalizing problems were measured using self-report questionnaires. The results showed that NFE was negatively associated with diurnal cortisol, and diurnal cortisol was negatively associated with internalizing problems. Further analysis showed that diurnal cortisol secretion measured by AUC (area under the curve) mediated the association between NFE and internalizing problems. Our findings extended the existing literature about left-behind children via a psychoneuroendocrinological perspective, documenting the negative consequences of the family environment for youth health and development.

Keywords: HPA axis, diurnal cortisol, left-behind adolescents, family expressiveness, internalizing problems

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INTRODUCTION

In China, more than 61 million children and adolescents aged 16 or younger are left behind in rural areas due to their parents' engagement in rural-to-urban labor migration (1, 2). Adolescence is a period of rapid physical, psychological, and social development. Previous studies found that deteriorated parent–child relations induced by parents' migration led to risks for left-behind adolescence (3–7). Specifically, left-behind adolescence reported higher levels of internalizing problems, such as anxiety, depression, and social withdrawal (8, 9). Internalizing problems in children have been associated with serious long-term consequences during the adult years, such as major depression (10–12), substance abuse (11), anxiety (12, 13), suicidal ideation

(13), and antisocial behaviors (10). Therefore, identifying mechanisms that lead to internalizing problems among left-behind adolescents is essential for designing effective intervention or prevention programs.

FAMILY EMOTIONAL EXPRESSIVENESS AND INTERNALIZING PROBLEMS

Ecological systems theory holds that human development is a process of self-centered interaction with the surrounding environmental system (14). The family, as a central part of the microsystem, plays an important role in adolescents' development (15). Family emotional expressiveness refers to the style of verbal or non-verbal expression of emotions in a family and is an important mechanism through which caregivers' emotional styles affect children's emotional regulation ability (16). Studies of normative families have shown that children living in families with high levels of negative emotional expressiveness are more likely to have poor social adaptation (17), inadequate emotional regulation (18), and more problem behaviors (19). In left-behind children, parental absence as a result of parents' migration weakens parent–child bonding, reduces parent-adolescent communication, and thereby likely induces more negative emotional expressiveness in parent–child interactions (20–22). However, family emotional expressiveness has rarely been examined in left-behind adolescents, overlooking the fact that left-behind adolescents maintain communication with their parents through various channels (i.e., telephone calls and messages).

THE ROLE OF HPA AXIS FUNCTION

The hypothalamic–pituitary–adrenal (HPA) axis is hypothesized to play a central role in the association between early adversity and health (23–26). Across the day, cortisol levels follow a circadian rhythm as cortisol is released in pulses. Cortisol levels are generally higher in the morning, with peak levels occurring ∼30 min after waking, followed by a decline throughout the day until reaching a nadir in the evening with sleep (25). There are several indicators that reflect the function of the HPA axis, such as cortisol awakening response (CAR), diurnal slope, and total cortisol output (AUC). The CAR influenced by sleep may represent adrenal sensitivity to ACTH (27, 28). The diurnal slope reflects the circadian rhythm of cortisol, which is associated with the suprachiasmatic nucleus (SCN) of the hypothalamus (29). The AUC approximates total cortisol production throughout the day, which aggregates indices of circadian functioning with responses to stress across the day (30).

A harsh family environment due, for example, to poverty tends to expose children to higher levels of stress and leads to abnormal HPA axis activity (31). For example, some researchers found that children from low-income families had higher cortisol levels (32, 33). In contrast, some studies found that adverse family factors (such as emotional maltreatment) were associated with lower cortisol levels (34–36). The contradictory results of the studies on the relationship between adverse family environments and cortisol levels conform to two opposing theories: the hypercortisolism hypothesis and the hypocortisolism hypothesis. The hypercortisolism hypothesis suggests that chronic stress causes high HPA axis sensitivity and increases cortisol levels (37), while the hypocortisolism hypothesis suggests that HPA axis activation decreases under chronic stress, with lower cortisol levels and a flatter diurnal rhythm (38). Previous studies have found that adolescents who lived with higher reported parent–child negativity showed higher bedtime cortisol (39). However, little is known about the relationship between the family environment in left-behind adolescents and HPA axis functioning.

An increasing number of studies have suggested that altered HPA axis activity may be a precursor to increased internalizing problems (40). In young children, higher total cortisol output and a flatter diurnal rhythm have been found to be related to elevated internalizing problem symptoms at 36 months (41). Likewise, a meta-analytic review showed that depressed children and adolescents showed increased morning cortisol (42). Adolescents with high basal cortisol were found to exhibit increasingly severe internalizing problems over a 2-year period (43). Despite the above studies showed the association between high cortisol levels and problem behaviors, it should be acknowledged that higher levels of cortisol are not always detrimental and can be adaptive in certain situations. For example, studies have found that high levels of cortisol induced by exercise are beneficial to mental health (44).

In some studies, cortisol played a mediating role in the relationships among chronic stress, poor parenting behavior and problem behaviors (45, 46). A previous study indicated that children's cortisol levels were one of the mechanisms by which parenting factors influenced internalizing problems (47). Taken together, it is reasonable to speculate that cortisol may also be an important physiological mechanism linking a harsh family environment and internalizing problems in left-behind adolescents.

THE PRESENT STUDY

To date, there are few studies investigating left-behind adolescents' HPA axis functioning and its role in the relation between family adversity and mental health. The current study was designed as a longitudinal study to fill several gaps in the literature. The first goal was to investigate the association between negative family expressiveness and various indicators of HPA axis functioning in left-behind adolescents. By collecting saliva from the subjects six times a day across two consecutive days, we were able to calculate the AUC, diurnal slope, and CAR to gain a comprehensive understanding of left-behind adolescents' HPA axis functioning. Second, we also examined the mediating role of the HPA axis functioning between negative family expressiveness and internalizing problems. Based upon the limited existing literature on healthy youth (34–36), we hypothesized that higher negative family expressiveness would be associated with indicators of a downregulated HPA axis: lower cortisol awakening response (CAR), lower total daily

cortisol output (AUC) and flatter diurnal slope. Furthermore, we hypothesized that abnormal diurnal cortisol levels would mediate the relationship between family expressiveness and internalizing problems in left-behind adolescents.

METHODS

Participants

Participants were recruited from a middle school in rural Northwest China. The sample included 81 adolescents (female $n = 44$; male $n = 37$) between 11 and 16 years of age ($M = 13.99$; $SD = 0.90$ years). Their parents were between 32 and 40 years old. At least one of the parents of each child had been away from home for more than 6 months. The duration of parental absence ranged from 0 to 15 years ($M_{\text{Father}} = 6.22$, $M_{\text{Mother}} = 5.16$ years). The proportion of participants with both parents out, only father out, only mother out were 75.9, 15.2, and 8.9%, respectively. In terms of the highest education level achieved, 21% of the fathers did not go to primary school, 6.2% attended primary school for only a brief period, 37% finished primary school, 43.2% junior high school, 6.2% high school, and 1.2% college. Regarding the mothers, 35.8% did not go to primary school, 4.9% attended primary school for only a brief period, 33.3% of the mothers completed primary school, 22.2% junior high school, and 1.2% college.

Procedures

The study was approved by the ethical committee of Tianjin Normal University. All subjects and one of their parents signed the informed consent form. Data were collected in two phases. Family emotional expressiveness and problem behavior data were collected at the participants' home during Chinese New Year (T1, January 2017). Six months later (T2), problem behaviors were reassessed collectively at school, and the subjects' saliva samples were collected six times a day for two consecutive days on regular school days. The questionnaires were completed on computers or smartphones.

Measures

Demographic Questionnaire

The students reported their demographic information, including their gender, grade, the total number of years their parents were away from home and their parents' highest level of education.

Negative Family Expressiveness

The negative expressiveness subscales of the Family Expressiveness Questionnaire (FEQ) was used (48). The subscale includes 20 items which describe an individual's history of negative family expression. It contains two dimensions: dominance and submissiveness. The negative dominance dimension captures expressions of criticism, contempt and anger in the family, whereas the negative submissiveness dimension captures expressions of sorrow, embarrassment, and disappointment in the family. Both dimensions assess negative emotional expressiveness in the family and were aggregated to form a composite score of negative family expressiveness. Individuals circled a rating for each item on a nine-point scale ranging from (1) *"not at all frequently in my family"* to (9) *"very often frequently in my family"* to indicate the frequency with which they experienced the expressive situation while they were growing up in comparison to peers in other families. The internal consistency coefficient of the subscale was between 0.81 and 0.92 in previous studies of Chinese children (49). In the present study, the internal consistency coefficient was 0.82.

Internalizing Problem Behaviors

Adolescents' internalizing problem behaviors were measured using the Youth Self-Report Form [YSR; (50)]. Subjects were asked to rate a list of items describing behavioral characteristics based on their situation in the past 6 months. A 3-point Likert scale was used (0 = *"not true"*, 1 = *"somewhat or sometimes true"*, 2 = *"very true or often true"*). The behaviors evaluated include withdrawal, anxiety, depression and social problems. Item scores were averaged to form a composite of internalizing problem behavior, with higher scores reflecting more internalizing problems. In our study, the internal consistency coefficients of internalizing problem behavior were 0.75 (T1) and 0.83 (T2).

Diurnal Cortisol

Salivary cortisol levels were measured as a marker of HPA axis activity. Saliva was collected using a cotton swab, and the participants were instructed to place between their tongue and cheek for ∼2 min until the swab was completely saturated. The saliva swab was collected in a plastic tube, which was placed directly on ice and stored at −20°C. Saliva samples were assayed in duplicate following standard radioimmunoassay procedures with no modifications (Salivary Cortisol ELISA Kit, Salimetrics, USA) at the Physiological Psychology Experiment Platform of the Institute of Psychology, CAS. The test uses 25 μl of saliva per determination, has a lower limit of sensitivity of 0.007 μg/dl and standard curve range from 0.012 to 3.0 μg/dl. The intra-assay coefficients of variation for the kit ranged from 3.0 to 10%. Saliva samples were taken at ∼6:00 a.m., 6:30 a.m., 9:30 a.m., 11:40 a.m., and 3:50 p.m. and 10:00 p.m. on two consecutive days. For the first two time points, saliva was collected immediately after the subject woke up and half an hour later at home; the specific time was recorded by the subject, and the subject then brought the saliva to the school and gave them to the research assistants. In order to prevent students from forgetting to collect saliva or to mark the time of saliva collection at home, we reminded students the day before they collected saliva. In addition, we also reminded their caregivers to assist in saliva collection and labeling. The children's reported first timestamps of saliva collection ranged from 5:50 to 6:10 a.m. The remaining four saliva samples were collected by the children at school.

Missing Data

Due to the time interval between measurements for all the variables in the study, there were some missing data. Family expressiveness and problem behavior data were not available at T1 for ten children due to incomplete questionnaires. There were two children who had no problem behavior data at T1 or T2. Due to insufficient salivary volume, there was one missing cortisol value separately at each time of the day. To make effective

TABLE 1 | Correlations between key variables.

	Mean	SD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Gender																	
Age	13.99	0.90	0.07														
YM	4.78	3.89	0.26*	0.04													
YF	5.92	4.79	0.10	0.30**	0.45**												
T1-NFE	3.90	1.27	0.34**	0.09	0.06	0.02											
T1 cortisol	0.56	0.36	−0.01	−0.24*	0.17	0.00	−0.27*										
T2 cortisol	0.56	0.39	0.02	−0.16	0.03	−0.04	−0.16	0.69**									
T3 cortisol	0.15	0.09	−0.07	−0.15	−0.02	−0.001	−0.20	0.54**	0.64**								
T4 cortisol	0.18	0.17	0.13	−0.25*	0.10	−0.11	−0.24*	0.44**	0.40**	0.38**							
T5 cortisol	0.13	0.09	0.22*	−0.13	−0.03	−0.13	−0.16	0.49**	0.53**	0.48**	0.38**						
T6 cortisol	0.17	0.23	0.16	−0.09	0.09	0.04	0.02	0.26*	0.46**	0.47**	0.40**	0.29*					
AUC	199.56	124.47	0.13	−0.22	0.05	−0.06	−0.19	0.67**	0.85**	0.73**	0.67**	0.69**	0.29*				
Diurnal slope	0.64	0.40	−0.14	−0.03	0.09	0.12	−0.15	0.19	−0.12	−0.24*	−0.16	−0.18	0.06	−0.40**			
CAR	0.004	0.30	0.04	0.08	−0.16	−0.04	0.11	−0.29**	0.48**	0.20	−0.01	0.11	−0.18	0.31**	−0.40**		
T1- internalizing problems	1.47	0.35	0.25*	−0.05	0.03	0.04	0.45**	−0.20	−0.13	−0.28*	−0.18	−0.17	0.11	−0.21	0.04	0.08	
T2- internalizing problems	1.47	0.40	0.19	0.03	0.07	0.08	0.28*	−0.32**	−0.24*	−0.31**	−0.24*	−0.27*	−0.17	−0.28*	−0.05	0.08	0.44**

*YM, Years of mother's absence; YF, Years of father's absence; NFE, Negative family expressiveness; T1, 6:00 a.m.; T2, 6:30 a.m.; T3, 9:30 a.m.; T4, 11:40 a.m.; T5, 3:50 p.m.; T6, 10:00 p.m.; AUC, Area under the curve; CAR, cortisol awakening response; *p < 0.05; **p <0.01.*

use of the data and reduce biases, the missing values of all the variables involved were treated using the full information maximum likelihood (FIML) method in this study.

Data Analysis

Data were analyzed in SPSS 26.0 and M*plus* 8.30. Cortisol at each time point was averaged across the 2 days to increase the reliability of the measurements (51). The CAR was calculated by subtracting the mean waking cortisol concentration from the mean 30-min postwaking cortisol concentration. The area under the curve with respect to ground (AUC) was the summation of the five trapezoids consisting of the six cortisol measurements and the time distance between the measurements. It was calculated following methods set forth by Pruessner et al. (52). The diurnal slope was calculated by computing the difference between cortisol at bedtime and cortisol at waking divided by the cortisol at waking. A repeated ANCOVA was used to test the diurnal cortisol pattern at all of the cortisol time points. We used hierarchical linear regression to test the continuous relation between NFE and AUC, as well as with the CAR and diurnal cortisol slope. Then, we performed a mediation analysis to test the mediation effect of diurnal cortisol between NFE and internalizing problems. The indirect effects were evaluated using bias-corrected bootstrap confidence intervals with 5,000 draws. All cortisol data were log transformed in the hierarchical linear regression and mediation analysis.

RESULTS

Preliminary Analyses

Table 1 presents the descriptive statistics and bivariate correlations among the study variables. The diurnal cortisol levels showed a significant time effect [$F_{(3,345)} = 3.86$; $p < 0.05$]. Morning cortisol levels peaked and gradually declined until the last time point. However, there was no significant CAR in left-behind adolescents, and the diurnal cortisol levels showed a sharp decline between 6:30 a.m. and 9:30 a.m., with little change between 9:30 a.m. and 10:00 p.m. The diurnal cortisol levels at all time-points are showed in **Figure 1**.

Negative family expressiveness was associated with lower morning and noon cortisol levels ($p < 0.04$) and higher levels of internalizing problems at T1 ($p < 0.01$) and T2 ($p < 0.02$). The cortisol level at 9:30 a.m. was negatively associated with internalizing problems at T1 ($p < 0.05$). The cortisol levels at 6:00 a.m., 6:30 a.m., 9:30 a.m., 11:40 a.m., 3:50 p.m. and AUC were negatively associated with internalizing problems at T2. The scatterplots of the correlations between the pairs of variables are shown in **Figure 2**.

Regression Analysis of Negative Family Expressiveness on Diurnal Cortisol in Left-Behind Adolescents

To investigate the effects of NFE on diurnal cortisol, we conducted a regression analysis with age, gender, years of mother's absence and years of father's absence controlled. For AUC, the results showed that NFE significantly predicted AUC [$b = -0.051$, SE = 0.022, 95% CI (−0.094, −0.007)]. However, the

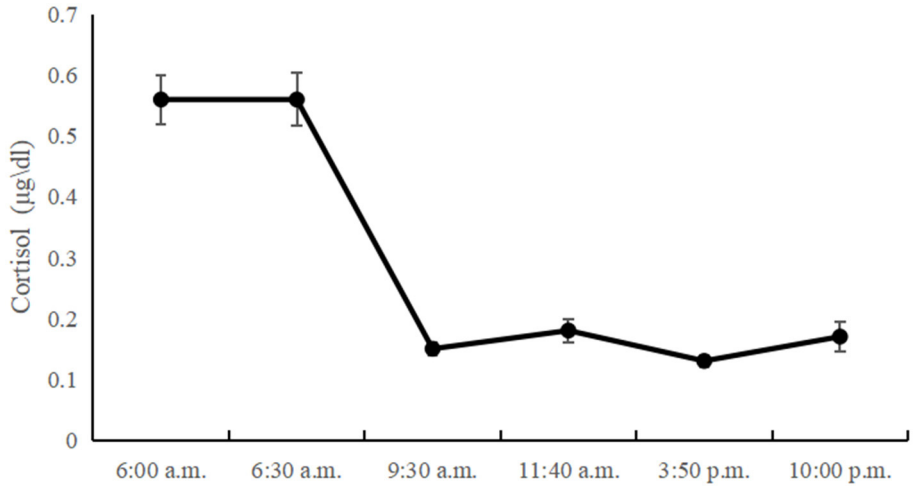

FIGURE 1 | The diurnal cortisol levels at all time-points in left-behind adolescents.

results showed that NFE did not predict the diurnal slope [$b = -0.003$, SE = 0.031, 95% CI (−0.059, 0.066)] or CAR [$b = 0.023$, SE = 0.028, 95% CI (−0.033, 0.077)]. The results were illustrated in **Table 2**.

Family Expressiveness and Internalizing Problems in Left-Behind Adolescents: The Mediating Role of Diurnal Cortisol

Based on the correlation and regression analyses, the mediating role of AUC in the relationship between NFE and problem behaviors at T2 in left-behind adolescents was further tested with age, gender, years of mother and father absence, internalizing problems at T1 controlled. Using 5,000 bootstrap samples selected from the random sampling test, the results showed that the direct effect of NFE on internalizing problems at T2 was not significant [$b = 0.016$, $SE = 0.044$, 95% CI = (−0.077, 0.097)]. The indirect effect of NFE on internalizing problems at T2 was significant [$b = 0.016$, $SE = 0.013$, 95% CI = (0.000, 0.054)], indicating that the AUC had a mediating effect on the relation between NFE and internalizing problems at T2. The mediation model is shown in **Figure 3**.

DISCUSSION

The purpose of this study was to identify the association between negative family expressiveness and various indicators of HPA axis functioning, including CAR, diurnal slope, and AUC in left-behind adolescents. Furthermore, we designed a longitudinal study to test the mediating effect of HPA axis functioning between the NFE and left-behind adolescents' internalizing problems. The results showed that NFE was negatively correlated with diurnal cortisol levels. Further analysis showed that high NFE predicted a lower diurnal cortisol level in left-behind adolescents. Furthermore, the NFE score significantly predicted internalizing problems at T2, with the AUC acting as a mediator. Our study provided evidence for the effects of NFE on internalizing problems from a psychoneuroendocrinological perspective and enriched the existing research on left-behind adolescents.

Left-Behind Adolescents' HPA Axis Functioning

Previous studies have indicated that cortisol is high in the morning, declines throughout the day, and reaches a nadir in the evening with sleep (53). Our results show that left-behind adolescents' diurnal cortisol generally follows the same pattern. However, the diurnal cortisol pattern of left-behind adolescents is somewhat different from that of other adolescents. Previous research found that there was no significant difference between morning cortisol levels and cortisol levels 3 h later but reported a relatively steep drop after 8 h, followed by a more moderate decrease until the lowest point at bedtime (54). In other words, the decrease in cortisol concentration typically occurred in the middle of the day. Our study found that the rapid decrease in cortisol levels occurred in the morning, with little change between 9:30 a.m. and 10:00 p.m. The reason for the inconsistencies across studies may be the different developmental periods of the children: prior studies' children were in late adolescence, and ours were in mid-adolescence. In addition, we speculated that the daily variation pattern of cortisol presented in this study might be unique to left-behind adolescents. To the best of our knowledge, there are few studies on the diurnal variation in cortisol levels in left-behind children and adolescents. Further research is needed to verify this speculation with more rigorous research design and sampling (e.g., including a non-left behind control group).

Negative Family Expressiveness and HPA Axis Functioning

In the present study, we found that children living with a high NFE had a significantly lower AUC. Our results are in line with the hypocortisolism hypothesis that HPA axis activation

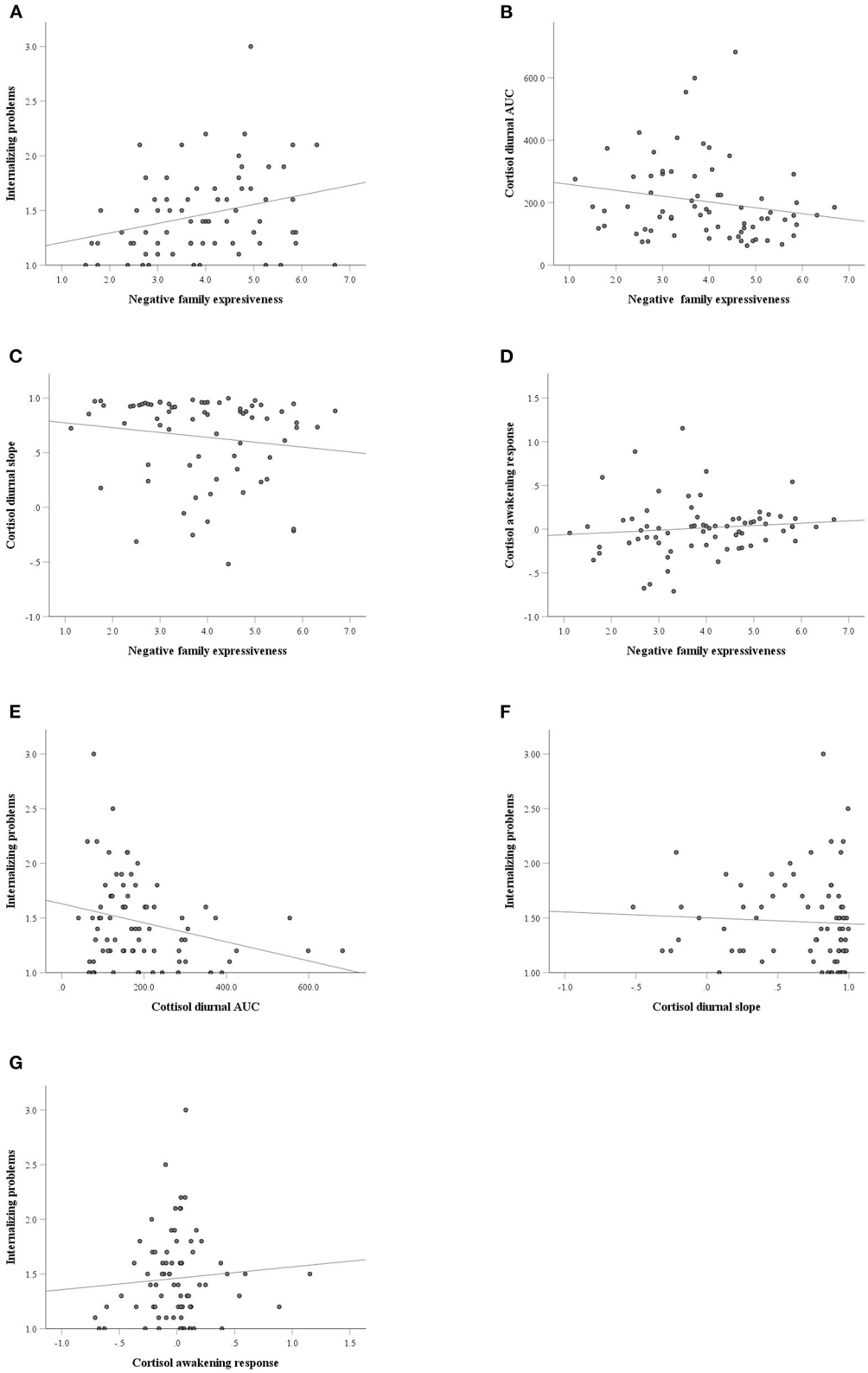

FIGURE 2 | The scatterplots of the correlations between the pairs of variables. **(A)** Negative family expressiveness and internalizing problems; **(B)** Negative family expressiveness and cortisol diurnal AUC (area under the curve); **(C)** Negative family expressiveness and cortisol diurnal slope; **(D)** Negative family expressiveness and cortisol awakening response; **(E)** Cortisol diurnal AUC and internalizing problems; **(F)** Cortisol diurnal slope and internalizing problems; **(G)** Cortisol awakening response and internalizing problems.

decreases under chronic stress, resulting in lower cortisol levels (38). This is consistent with previous studies that found that adverse family factors and long-term stress could reduce cortisol levels (36, 55, 56) (Maureen et al., 2012). Specifically, for morning cortisol, previous research has found that among toddlers reared in lower income households facing higher cumulative adversity, reduced maternal warmth was correlated with blunted early morning cortisol (57). This pattern has been suggested to reflect HPA axis downregulation following excessive stress system activation, which comes with its own costs (34).

However, in contrast to our hypothesis, we found that NFE was not related to CAR or diurnal slope. A previous study also showed that the family environment, such as perceived parental rejection, was not related to CAR in healthy youth (58). The lack of association between NFE and CAR and diurnal slope in this sample of left-behind adolescents may be an indication that NFE was not sufficient to influence the physiological processes that underlie CAR and diurnal slope. It's worth noting that most of the participants in our study had both parents out. Due to the small sample size, we did not examine whether the effect of family atmosphere on children's cortisol differs across types of left-behind adolescents (e.g., both parents out vs. only one parent out). Future research should consider examine this question with a more representative sample of diverse left-behind adolescents.

TABLE 2 | Linear regression for negative family expressiveness with AUC, diurnal slope and CAR.

	Predictors	*B*	*SE*	95% CI
AUC	Gender	0.093	0.060	−0.027, 0.210
	Age	−0.043	0.333	−0.111, 0.019
	YM	−0.005	0.008	−0.021, 0.010
	YF	−0.002	0.006	−0.014, 0.009
	NFE	−0.051	0.022	**−0.094, −0.007**
Diurnal slope	Gender	0.846	0.306	0.244, 1.450
	Age	0.102	0.199	−0.241, 0.541
	YM	−0.009	0.040	−0.090, 0.065
	YF	−0.301	0.379	−1.067,0.432
	NFE	−0.003	0.031	−0.059, 0.066
CAR	Gender	0.027	0.080	−0.123, 0.189
	Age	0.025	0.044	−0.066, 0.110
	YM	−0.014	0.009	−0.030, 0.005
	YF	0.001	0.008	−0.017, 0.016
	NFE	0.023	0.028	−0.033, 0.077

AUC, Area under the curve; YM, Years of mother's absence; YF, Years of father's absence; NFE, Negative family expressiveness; CAR, cortisol awakening response. The bold values means NFE is a significant predictor of AUC.

The Mediating Role of HPA Axis Functioning

Consistent with previous studies that reported a mediating role of HPA axis activity in the relation between early adversity and poor outcomes in children (45, 46), the present study found that NFE was indirectly associated with internalizing problems with diurnal cortisol secretion as a mediator in left-behind adolescents. Because of the role of the HPA axis as a core stress system that has profound effects on neurodevelopment, many studies have explored its mediating effect on adversity-psychopathology relations. For example, cortisol levels at baseline in the laboratory mediated the association between family instability (e.g., caregiver changes, variations in caregiver intimate relationships, and residential mobility) and deficits in children's effortful control at age 4 (59). However, the mediating effect of HPA axis activity has not always been found in other studies (60, 61). A number of factors may account for these inconsistent results, such as the specific types of early adversity experience and the indicators of HPA axis activity used in the studies. Even in one single study, results were mixed across different indicators of HPA axis activity. For example, in a Filipino adolescent cohort, a flatter cortisol diurnal slope, higher evening cortisol, lower total cortisol output, and lower cortisol awakening response (CAR) were associated with lower socioeconomic status across multiple developmental periods (62). To date, although converging evidence supports the mediating role of HPA axis activity in adversity–psychopathology relations, a question remains whether HPA axis activity is a key biological mechanism that is triggered by adversity and eventually affects psychopathology or whether it serves only as a marker for other biological processes that produce psychopathology (53). Additional research is needed to determine the specific meaning

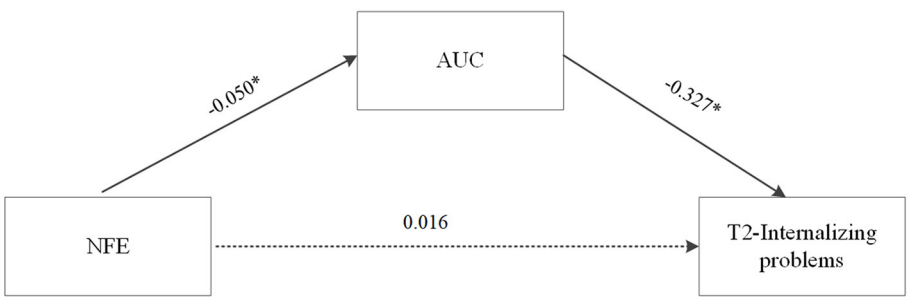

FIGURE 3 | The mediating role of AUC in the relationship between NFE and internalizing problem behaviors at T2 in left-behind adolescents. Unstandardized path coefficients were shown (NFE, negative family expressiveness, $^*p < 0.05$).

of different indicators of HPA axis activity and to examine the roles of other neurophysiological systems.

Strengths and Limitations

In this short-term longitudinal study, we investigated the relations among negative family expressiveness, HPA axis functioning, and internalizing problems in left-behind adolescents. We found that NFE predicted adolescents' increased internalizing problems 6 months later after controlling for their previous internalizing problems, and that cortisol (specifically AUC) played a mediating role in this linkage. Extending the existing literature about left-behind children via a psychoneuroendocrinological perspective, the present study documents the negative consequences of NFE for at-risk youth's mental health.

Several limitations of this work should be noted. First, the sample size was small, and the study needs to be replicated with a larger number of participants before a strong conclusion can be drawn. In addition, the present sample is comprised primarily of adolescents with both parents out. Whether the findings can be generalized to other types of left-behind adolescents (e.g., only father out or only mother out) requires further research. Second, although the results in our study imply longitudinal relations from NFE to diurnal cortisol production and internalizing problems, inference of causal relations require rigorous experimental studies and ideally three waves of data are advised to establish a longitudinal mediation model. Finally, both NFE and internalizing problems were self-reported, which may induce biased views. Future research should collect data from multiple informants.

CONCLUSIONS

In summary, negative family expressiveness is associated with a maladaptive pattern of diurnal cortisol production and internalizing problems. The relationship between NFE and internalizing problems was mediated by diurnal cortisol levels, indicating that aberrant HPA axis functioning may be an important marker for adolescents' problem behaviors. With these in mind, the development and distribution of strategies designed to attenuate feelings of NFE is of paramount importance given its concerning consequences.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Tianjin Normal University's Institutional Review Board. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

ML, LZ, and LQ designed the study. ML, QL, LQ, and FH performed the research and acquired the data. ML, FH, YY, and CZ interpreted and analyzed the data. ML, QL, YY, and LZ drafted, revised, and wrote the paper. All authors contributed to the article and approved the submitted version.

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Relationship Between Socioeconomic Status and Win-Win Values: Mediating Roles of Childhood Neglect and Self-Continuity

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The family plays a key role on the development of children. One with low socioeconomic status was more likely to suffer childhood neglect, which might impact on development of self-continuity and win-win values. Using cross-sectional data from 489 participants, this study conducted a mediation model to examine the roles of childhood neglect and self-continuity between socioeconomic status and win-win values. Our results showed that childhood neglect and self-continuity fully mediated the effect of socioeconomic status on win-win values. Specifically, socioeconomic status might affect win-win values through three roles: the individual mediating role of childhood neglect, the individual mediating role of self-continuity, and the multiple mediation roles of childhood neglect and self-continuity.

Keywords: socioeconomic status, win-win, childhood neglect, self-continuity, mediation effect

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INTRODUCTION

According to previous research, a high rate of childhood neglect was observed worldwide (1). The experience of childhood trauma was extremely prevalent in the Asia-Pacific region, and neglect was the most common form of childhood trauma (2). Childhood neglect meant that a child's basic needs were failed to be met by caregivers (3). Meanwhile, childhood neglect also included emotional neglect (failure to provide for the child's basic emotional needs such as concern and love) and physical neglect (failure to provide for the child's basic material needs such as food, safety, and medical health) (4). Approximately 28% of school-age children experienced emotional or physical neglect in China (5). A lot of studies have indicated that childhood neglect always brings negative effects to individuals. Most of the time, the effect of neglect lasts throughout people's life (6). Moreover, the damage of neglect might cause permanent effects on mental health (7). For instance, some studies found that neglect could lead to loneliness, depression, and negative effects on social-emotion (8, 9). It is well known that the exposure to childhood neglect may increase the risk of several mental diseases. Childhood neglect may increase the risk of psychosis (10) and anxiety disorders (11). Childhood neglect may increase the risk to develop dysfunctional metacognitive beliefs (12) as well as the risk to engage in repetitive negative thinking such as rumination and worry (13). Broadly, childhood neglect limited the development of children and could alter self-perception, trust in others, perception of the world, and values (14).

Values were defined as wide motivational goals that guided one's principles in life (15). Recently, the win-win values have been proposed, mainly reflecting situations where one actively considers

and takes care of others to pursue personal interests (16, 17). Win-win was a combination of self-interest and mutual benefit in this globalized world. Childhood neglect might play a role of mediator between socioeconomic status (SES) and win-win values. First, socioeconomically disadvantaged children were more prone to be ignored. Childhood neglect was more common in low-income families than other traumas (18). Poverty was the most important predictor of child neglect (19). Children born in impoverished families were more likely to experience traumas (20). Second, values were developed during childhood and adolescence (21). Childhood neglect was associated with various adverse conditions in adolescence and adulthood, and it had a long-term effect on thinking, behavior, and relationships (22). Condly (23) thought that the impact of adverse events was that it caused the individual to re-evaluate one's view of oneself and the world rather than the direct harm from these events. Therefore, childhood neglect might be of impact on win-win values.

Furthermore, SES might have a direct effect on win-win values. According to Bronfenbrenner ecosystem theory (24), the impact of the social environment on individuals was summed to a nested system. Among these, the impact of microsystems (including family, school, and peers) was highly significant for individuals. Although some mediating variables influenced the formation of values, families always played a key role on developing values (25, 26). In addition, young people often had similar values to their families (25). All the above evidence illustrated that the family was one of the most critical factors in the development of individuals' values. Given that SES was an important aspect of family, which was defined as the social position or class according to an individual's material and non-material social resources (27), we proposed that SES could affect win-win values.

The pathways from SES to win-win values, however, were complex and multifaceted. First, self-continuity might also play the role of mediator between SES and win-win values. Self-continuity was defined as the connection between one's self in different temporal dimensions, consisting of a fundamental aspect of identity (28–32). According to the identity verification principle, individuals used feedback from their environment to determine the extent to which they achieved their ideal identity (33). In addition, SES played a central role in the construction of self-concept and temporal self (34, 35). As a family environment, SES could impact the individual's self-continuity. Compared to individuals with high SES, those with low SES had poor self-continuity. Further, people would not be able to take responsibility for past actions or cooperate with others to secure future benefits if lacking self-continuity (36), making it difficult to develop win-win values. Second, SES also affected self-continuity through childhood neglect. Studies have shown that young people with low SES were more likely to experience trauma compared to the general population. Such trauma could have many negative consequences for future life (37). For example, childhood trauma could affect the development of the individual's self-continuity, causing a split between different periods of the self (38). Thus, childhood neglect and self-continuity might play multiple mediating effects between SES and win-win values.

The aim of this study is to investigate the mediating roles of childhood neglect and self-continuity in the effect of SES on win-win values via structural equation modeling (SEM). Specifically, the present study proposed the following hypotheses: H1. Childhood neglect mediated the effect of SES on win-win values; H2. Self-continuity mediated the effect of SES on win-win values; H3. Childhood neglect and self-continuity played multiple mediating roles between SES and win-win values.

MATERIALS AND METHODS

Participants

Participants were recruited from three universities by cluster random sampling in Henan province in China. A total of 575 questionnaires were distributed, and all participants completed the questionnaire in the classroom. After excluding invalid questionnaires (e.g., missing values, extreme responses, and outliers), data of 489 participants (112 males, 377 females) remained. Their ages ranged from 17 to 26 years ($M = 20.72$, $SD = 1.43$). This study was approved by the Research Ethics Committee of the Faculty of Education of Henan University. The participants provided their written informed consent to participate in this study.

Measures

Socioeconomic Status Questionnaire

Three categories of socioeconomic status indicators in our measure were used: Parental education level (i.e., primary school or below; junior middle school; high school graduation; college education; or graduate-level education), parental occupation (i.e., agricultural laborer, unskilled worker, or unemployed people; manual worker, self-employed person, or skilled worker; ordinary manager, or junior professional technician; middle manager, or intermediate professional technician; or senior manager, or senior professional technician), and gross monthly family income (CNY) (i.e., less than 2,001; 2,001–3,000; 3,001–4,000; 4,001–5,000; 5,001–6,000; 6,001–7,000; 7,001–8,000; 8,001–9,000; 9,001–10,000; 10,001–11,000; 11,001–12,000; or more than 12,000).

We calculated a composite measure of the total socioeconomic class scores by summing the standard Z-scores of parental education level, parental occupation, and gross monthly family income (39–41). Higher scores meant higher SES.

Childhood Neglect Scale

Childhood neglect scale was a brief (10-item) self-report version of the neglect dimension extracted from the childhood trauma questionnaire (CTQ-SF) compiled by Fink and Bernstein (42), and Chinese version was revised by Fu et al. (43).

Childhood neglect scale included two dimensions: Emotional neglect and physical neglect (sample items: "I didn't have enough to eat," "I had to wear dirty clothes"). Participants scored each item on a 5-point Likert-type scale (1 = never true, 5 = very often true). The total scores per subscale ranged from 5-25, with the total scores ranging from 10 to 50. The Cronbach's

alpha coefficient of the childhood neglect scale in the current sample was 0.857.

Self-Continuity Questionnaire

The self-continuity questionnaire (44) consisted of an eight items (four personal-continuity items and four temporal-continuity items, e.g., "I feel connected with my past," "The past and present flow seamlessly together"), and it measured relatively concrete perceptions of continuity between one's past and present (44), using a 7-point Likert-type scale (1 = strongly disagree, 7 = strongly agree). Participants indicated how they felt about the relationship between their past and present selves (45). The Cronbach's alpha coefficient of the questionnaire was 0.866 in this study.

Win-Win Scale

Participants completed the win-win scale (17) to assess their win-win values. It consisted of five dimensions such as integrity, advancement, altruism, harmoniousness, and coordination. It was comprised of 16 items (e.g., "I think honesty is the basis of win-win," "I often think from the perspective of others," "I often discuss problems with others"), and assessed with a five-point Likert-type scale (1 = completely disagree, 5 = completely agree). The Cronbach's alpha coefficient of the win-win scale was 0.892 in the present study.

Statistical Analysis

All statistical analyses were performed using SPSS 22.0 and Mplus 7.4. First, Harman's one-factor test was performed (46) to test the common method bias of this study. Then, descriptive statistics were reported as mean and standard deviation. And the correlations coefficients among all variables were obtained. Next, our hypothetical mediation model was tested using structural equation modeling (SEM). Goodness of fit indices for SEM were as follows: ratio of Chi-square to the degree of freedom (χ^2/df), root mean square error of approximation (RMSEA), comparative fit index (CFI), Tucker-Lewis index (TLI), and standardized root mean square residual (SRMR). In general, χ^2/df should not exceed 3, RMSEA should be smaller than 0.08, CFI and TLI should be higher than 0.90, and SRMR should be smaller than 0.05 (47). Last, Mplus 7.4 was used to examine the indirect effect in the mediation model. 95% bias-corrected bootstrap confidence intervals (CI) were calculated using bootstrap methods (5,000 bootstrap samples) (48).

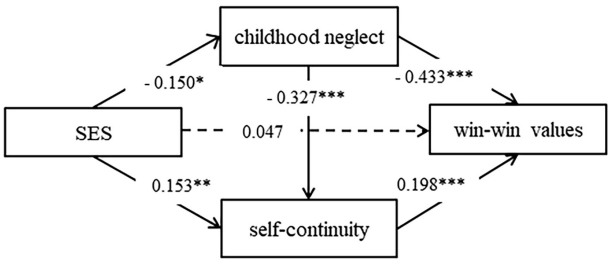

FIGURE 1 | Path diagram of the mediation model. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$; dotted lines indicate the paths are not significant.

RESULTS

Test of Common Method Bias

In the study, Harman's one-factor test was employed to test for common method bias (46). All items were included in the factor analysis, and the result indicated that the first common factor explained 17.53% of the total variance, which was below 40%. Therefore, common method bias was not serious in our study.

Descriptive Statistics and Correlation Analysis

The descriptive statistics and bivariate correlation results were shown in **Table 1**. SES had significantly positive correlations with self-continuity and win-win values. Both emotional and physical neglect had significantly negative correlations with SES, self-continuity, and win-win values. Win-win values had a significantly positive correlation with self-continuity.

Examination of Multiple Mediation Model

In our structural equation model, gender and age were controlled as covariates. Before testing the mediation model, we conducted a structural equation modeling test on the relationship between SES and win-win values. The results showed that SES significantly predicted win-win values ($\beta = 0.108$, $t = 2.391$, $p = 0.017$, $R^2 = 0.012$).

TABLE 1 | The Mean, *M* standard deviation (*SD*), and Pearson's correlation coefficient.

Variables	*M* (*SD*)	1	2	3	4	5	6
1 Age	20.72(1.432)	–					
2 SES	0.002(1.829)	−0.074	–				
3 Childhood neglect	16.297(5.094)	−0.002	−0.121**	–			
4 Emotion neglect	8.875(3.357)	0.012	−0.101*	0.920**	–		
5 Physical neglect	7.422(2.400)	−0.020	−0.116*	0.836**	0.553**	–	
6 Self-continuity	4.847(0.870)	0.142**	0.147**	−0.250**	−0.209**	−0.238**	–
7 Win-win values	62.057(7.722)	0.040	0.108*	−0.399**	−0.345**	−0.364**	0.288**

*$p < 0.05$.
**$p < 0.01$.

TABLE 2 | Mediation effect analysis and 95% confidence interval.

	Structural path	Effect	Ratio	95% CI	
				LL	UL
Direct effect	SES → win-win values	0.065		−0.075	0.205
Mediating effect	SES → childhood neglect → win-win values	0.090	61.6%	0.025	0.188
	SES → self-continuity → win-win values	0.042	28.8%	0.010	0.100
	SES → childhood neglect → self-continuity → win-win values	0.014	9.6%	0.004	0.037
Total indirect effect		0.146	100%	0.067	0.264

Then, we carried out a test of the mediation model. This model produced appropriate fit indices ($\chi^2/df = 1.893, p < 0.001$, RMSEA = 0.043, CFI = 0.967, TLI = 0.953, SRMR = 0.034). **Figure 1** showed that all other path coefficients were significant in this model ($ps < 0.05$) except for the direct path from SES to win-win values.

The confidence intervals for the mediating effect did not include 0, indicating significant mediation effects. And the confidence interval for SES effect on win-win values included 0, which indicated that the direct effect was not significant (see **Table 2**). Complete mediation was present when the total and indirect effects were significant, while the direct effects were non-significant (49). As a result, the multiple mediation effects of childhood neglect and self-continuity between SES and win-win values were statistically significant.

DISCUSSION

Childhood is the key and fragile stage of an individual's life. Childhood neglect is at least as damaging as other traumas in the long term (50). Our study indicated that childhood neglect had significantly negative correlations with SES, win-win values, and self-continuity. Previous research found that families with low SES reported a high level of adverse events (51, 52). This included not only neglect from parents in a family, peers, and teachers in school, but also surroundings insecurity and other potential threats. These factors damaged children's personality structure and adaptive functions. Living in an adverse family and social environment during childhood led to poor physical and mental problems, such as malnutrition and domestic violence (53). These problems hampered the development of cognition, psychology, and behavior (53), and may increase mortality and morbidity (54, 55). The results of the above studies might explain why childhood neglect was significantly negatively related to these research variables such as SES, win-win values, and self-continuity.

The present study further examined the mediation effect of childhood neglect between SES and win-win values, and the results showed that childhood neglect played a fully mediating role. It confirmed our first hypothesis (H1). First, chronic poverty was a significant risk factor for child neglect (56). Low SES was more strongly associated with neglect than other forms of childhood trauma (57, 58) and was also one of the most common risk factors in those experiencing chronic neglect (59). Second, a basic definition of childhood neglect was the parent or caregiver's failure to meet children's basic needs. Childhood neglect was often manifested in inadequate supervision and lack of concern for children's well-being. Parents who were neglectful might provide the least cognitive enrichment (60). Third, parents were the predominant unit of socialization for children. Children might internalize and practice the values expressed in their parents' behaviors. According to the above considerations, children with low SES lacked both rich cognitive stimulation and positive emotional connection with parents, which promoted maladaptive behavior and poor cognition. This situation might influence their values (14, 23), and it was subsequently difficult for them to build win-win values.

We found that self-continuity played a fully mediating role between SES and win-win values. The result confirmed our second hypothesis (H2). Additionally, our study revealed that childhood neglect and self-continuity played multiple mediating roles between SES and win-win values. The result confirmed our third hypothesis (H3). People from disadvantaged environments (e.g., low SES) were more likely to have experienced trauma (e.g., childhood neglect). Trauma-exposed people tended to experience a wide range of negative outcomes (e.g., low self-continuity) (37). Low self-continuity was associated with high social loneliness (61) and a mean-level decrease in agreeableness (62). It was very hard for people with low levels of self-continuity to develop win-win values. Therefore, lower SES individuals had lower win-win values in our study.

LIMITATIONS

There are some limitations in this study. Our data collection and study design were cross-sectional. We cannot obtain causal effect among these variables, so causal interpretation should be cautious here. Moreover, in the present research, we focused solely on the mediating roles of childhood neglect and self-continuity. Future research could investigate other mediator or moderator variables to explore the influence adverse childhood experiences on the relationship between SES and win-win values in depth. Finally, we did not explore the differences between individuals who had suffered other childhood adversities (e.g., childhood abuse) and individuals who suffered childhood neglect. This issue should be explored in future studies.

CONCLUSION

We concluded that socioeconomic status might influence win-win values by childhood neglect and self-continuity. Childhood neglect and self-continuity played multiple mediating roles between SES and win-win values.

Our study shed light on the mediating roles of childhood neglect and self-continuity between SES and win-win values, and thus confirmed the indirect mechanisms of SES effect on win-win values. First, low SES affected an individual's experiences that brought childhood neglect, and indirectly affected an individual's values. Second, low SES individuals who suffered physical and emotional neglect would be difficult to develop high self-continuity, and so their win-win values might be impacted. These results extended previous studies between SES and values.

At the same time, our results also suggested that low SES remained a significant risk factor for individual development. It was also prone to cause a series of subsequent problems of development. These problems would influence self-continuity and win-win values. Furthermore, values were meaningful predictors of mental health (63), we could increase self-continuity by reducing childhood neglect in order to develop win-win values. As a caregiver, parents could change their behaviors to reduce childhood adverse events. Thus, we should focus on the healthy development of childhood to lay a good foundation for the development of lifespan. In addition, our findings have clinical implication for the prevention of childhood neglect, and may be used for psychological interventions to form win-win values and construct higher self-continuity. When conducting psychological interventions, clinical counselors need to pay more attention to individuals with low SES in order to prevent childhood neglect.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Research Ethics Committee of the Faculty of Education of Henan University. The participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

FZ and SZ contributed to conception and design of the study. XG performed the statistical analysis. SZ wrote the manuscript. All authors contributed to manuscript revision, read, and approved the submitted version.

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Social Class-Based Discrimination and Psychological Symptoms Among Socioeconomically Disadvantaged College Students: The Moderated Mediation Role of Stress Mindset and Rumination

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Discrimination as a crucial stressor damages the mental health of socioeconomically disadvantaged individuals through increased ruminative thinking. A "stress-is-enhancing" mindset may protect the mental health of socioeconomically disadvantaged individuals under the pressures of perceived discrimination and rumination. This study examined the mediating role of rumination and the moderating role of stress mindset in the relationship between perceived discrimination and psychological symptoms among socioeconomically disadvantaged college students. A total of 919 socioeconomically disadvantaged undergraduate students (48.4% female, ages 17–25) were recruited. The results indicated that perceived discrimination was positively associated with psychological symptoms among socioeconomically disadvantaged undergraduate students through rumination (B = 0.11, boot SE = 0.01, boot 95% CIs = [0.08, 0.13]). Importantly, stress mindset moderated the indirect association between perceived discrimination and psychological distress through rumination (B = −0.18, boot SE = 0.08, boot 95% CIs = [−0.32, −0.03]). Specifically, compared with individuals with low levels of the stress-is-enhancing mindset, the indirect effect of perceived discrimination on psychological distress through rumination was weaker among individuals with high levels of the stress-is-enhancing mindset. The findings provide support for future intervention practice to promote a stress-is-enhancing mindset to protect the mental health of socioeconomically disadvantaged college students under the pressures of perceived discrimination and rumination.

Keywords: perceived social class-based discrimination, rumination, stress-is-enhancing mindset, psychological symptoms, socioeconomically disadvantaged college students

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INTRODUCTION

College students from economically disadvantaged families are vulnerable to the risk of social exclusion and poor life situations, such as low possibilities of completing a college course or earning a degree and unfairness in accessing employment opportunities (1, 2). In China, around 20% of college students were supported by various national financial aids per year due to their economically

disadvantaged family's economic status (3). Because they are either suffering from chronic poverty or have been affected by a serious natural disaster, their family income is insufficient to cover their tuition fees and the other costs involved in studying at college. Although the Chinese government has issued a series of financial assistance policies to help these students completing college courses and earning a degree, their health and wellbeing is still significantly threatened by widespread social class-based discrimination (4).

As an important stressor for socioeconomically disadvantaged populations, perceived social class discrimination represents the negative effects of poverty on their mental health (5). Perceived discrimination refers to individuals' subjective perceptions of a devalued and threatened social identity due to experiences of mistreatment in the course of their interactions with others in the society (6). Perceived social class-based discrimination commonly occurs among populations living in poverty or in a socioeconomically disadvantaged situation caused by serious natural disaster, chronic disease of family members, and other economic challenges.

Perceived Discrimination and Psychological Symptoms

Perceived discrimination is a significant risk factor for the wellbeing of college students who are from socioeconomically disadvantaged families (4, 7). These students are likely to have less access to useful resources (e.g., adequate financial support) to facilitate their academic achievement before graduating (8) and are more likely to experience unfair treatment (e.g., a lack of fair employment opportunities) and relatively poor life situations (9). Studies have found that perceived social class discrimination is associated with symptoms of depression and anxiety among college students from socioeconomically disadvantaged families (10, 11). The response styles theory indicates that paying repetitive and passive concern to the causes and results of stress events and situations may lead to psychological symptoms (12). This model of responding to stress is called rumination. It has been widely found that rumination has a negative effect on wellbeing; for example, Liao et al. (13) found that ruminative thoughts was a key mediator in the relationship between discrimination experience and wellbeing among minority sexualities. However, it remains unclear whether this mechanism operates in the relationship between perceived social class discrimination and psychological symptoms among individuals in socioeconomic disadvantaged situations.

It is noteworthy that some individuals are less likely to report severe psychological symptoms despite the experience of discrimination (14). For example, Li et al. (15) found that despite being affected by parental HIV and discrimination, some children did not report clinically significant mental health problems. Moreover, stress does not always bring negative consequences to individuals. If individuals believe that stress is an opportunity that can be utilized for their personal development, it can improve their performance and stimulate effective coping (16). Implicit theory indicates that individual's understanding of and response to complex information and situations depends on a simplifying system (i.e., mindset) of which they are unaware (16, 17). Stress mindset refers to the extent to which an individual believes that stress has an enhancing or debilitating effect on learning, performance, health, and wellbeing (16). Specifically, individuals who have the mindset that stress is enhancing are less likely to interpret a stressful event or situation as always having a debilitating influence on their performance and wellbeing, and this can diminish the negative effects of adversity (16). However, there has been limited research into the protective effect of a stress-is-enhancing mindset on mental health and wellbeing among population from socioeconomically disadvantaged families. Simultaneously investigating the roles of rumination and stress mindset in the relationship between perceived social class discrimination and psychological symptoms may enhance our understanding of why some socioeconomically disadvantaged population adapts better than others in a discriminatory situation.

The Mediating Role of Rumination

According to the response styles theory, rumination is one major maladaptive cognitive response to individuals' unfavorable experiences, and it involves repetitive and passive attention to disadvantaged settings and related problems (12). Perceived threats and uncontrollable negative events increase the rumination activity (18). Social class discrimination experiences, such as being disrespected in the course of interpersonal communications and being treated unfairly by others due to low socioeconomic status (SES), can lead individuals to perceive a discrepancy between the prevailing and desired status. Thereafter, they are likely to think repetitively over the deeper implications of this discrepancy and experience negative affect when the discrepancy persists (19).

Rumination leads to increased negative thoughts and moods and poor problem solving, which may further exacerbate psychological symptoms, such as depression and anxiety (18). Individuals with increased ruminative thoughts may perceive more hopelessness and overgeneralize that all their efforts are fruitless in a disadvantaged situation (19). Rumination partially mediates the association between stressful life events (e.g., discrimination) and psychological symptoms (18, 20). Accordingly, perceived social class discrimination may be positively associated with increased rumination, which could in turn be positively related to psychological symptoms among socioeconomically disadvantaged populations.

The Buffering Role of Stress-Is-Enhancing Mindset

Although psychological symptoms arising from perceived social class discrimination and rumination have potentially debilitating impacts on the mental health of individuals (6), certain understandings of the nature of stress may help individuals to alleviate the negative effect of these negative experiences (16). The acquired mindset about stress is considered as a cognitive frame that influences individuals' understanding of complex and conflicting situations and triggers certain reactions (16,

17). According to stress mindset theory, individuals holding the "stress-is-enhancing" mindset are more likely to focus on the positive and enriching consequences (e.g., wellbeing, learning, and thriving) of stress and to believe stress could be utilized positively. Conversely, individuals holding the "stress-is-debilitating" mindset are more likely to focus on the negative and detrimental consequences (e.g., psychological symptoms) of stress and to believe that stress should be avoided (16).

Empirical studies have demonstrated that the effects of stress on health-related outcomes may differ based on various stress mindsets (16, 21, 22). Individuals with a stress-is-enhancing mindset are more likely to focus on the positive effects of stress (16) and accept the prevailing situation and its consequences. Acceptance rather than avoidance of stress experiences may help individuals minimize the negative effects of stressful events and ruminative thoughts on mental health [(23); refer also to the review by Nolen-Hoeksema et al. (19)]. These individuals are more inclined to consider the likelihood of positive consequences despite experiencing adversity, for example, by believing that their capacity to cope with stress will be improved (24). Therefore, college students from socioeconomic disadvantaged families with the stress-is-enhancing mindset might be more likely to focus on the positive aspects of a stress rather than engage in repetitive and passive attention to its negative effects. In contrast, holding the stress-is-debilitating mindset might increase the negative effects of stress on those individuals' health outcomes, with more negative psychological symptoms reported (16). Therefore, the stress-is-enhancing mindset could minimize the negative effects of stress on individuals' mental health when the stimuli are persistent or do not diminish within a short period (16).

Increasing empirical evidence suggests that the stress-is-enhancing mindset protects the mental health, physical health, and academic performance of individuals experiencing stressful events, such as discrimination (21, 22, 25). Individuals with a stress-is-enhancing mindset reported fewer depressive symptoms when facing stressful life events (26). However, limited studies explored whether the association between perceived social class discrimination and psychological symptoms is weaker among socioeconomic disadvantaged college students with a stress-is-enhancing mindset than those students with a stress-is-debilitating mindset. Inspired by stress mindset theory, we expected the negative effect of discrimination experiences on mental health status to decline among those socioeconomic disadvantaged college students with a stress-is-enhancing mindset.

Furthermore, the negative effect of rumination on individuals' mental health may be buffered by the stress-is-enhancing mindset. When individuals have a stress-is-enhancing mindset, they are more likely to interpret the prevailing stress as potentially improving their resilience, leading them to thrive in the stress reappraising process and accept the situation (19). Therefore, it is critical to investigate if the association between rumination and psychological symptoms in individuals under the pressure of discrimination experiences is weaker among those with a stress-is-enhancing mindset and stronger among those with a stress-is-debilitating mindset.

This Study

Our previous study found that perceived social class discrimination negatively associated with college students' wellbeing (7). The potential role of rumination and the buffering effect of stress mindset in the relationship between perceived social class discrimination and psychological symptoms were investigated in this study. We proposed a moderated mediation model to examine the association between perceived social class discrimination and psychological symptoms among socioeconomically disadvantaged college students and the mediating role of rumination and the moderating role of stress mindset in this association (refer to **Figure 1**). We used the symptoms of depression, anxiety, and stress as indicators of psychological symptoms. The following hypotheses were proposed:

Hypothesis 1 (H1): Perceived social class discrimination is positively associated with psychological symptoms among socioeconomically disadvantaged individuals.

Hypothesis 2 (H2): Perceived social class discrimination is indirectly associated with psychological symptoms through increased rumination. Specifically, perceived social class discrimination is positively associated with rumination, which in turn increases psychological symptoms among college students from socioeconomically disadvantaged families.

Hypothesis 3 (H3): The direct effect of perceived social class discrimination on psychological symptoms is buffered by the stress-is-enhancing mindset. Specifically, the association between perceived social class discrimination and psychological symptoms is weaker among individuals with high levels of the stress-is-enhancing mindset and stronger among individuals with low levels of the stress-is-enhancing mindset.

Hypothesis 4 (H4): The indirect association between perceived social class discrimination and psychological symptoms through rumination is moderated by the stress-is-enhancing mindset. Specifically, the negative association between perceived social class discrimination and rumination is weaker among college students with high levels of the stress-is-enhancing mindset and stronger among those students with low levels of the stress-is-enhancing mindset. Moreover, the negative association between rumination and psychological

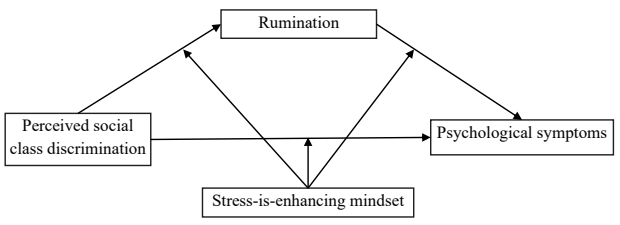

FIGURE 1 | The proposed moderated mediation model. Controlling for age, gender, family income, parents' education attainment, and subjective socioeconomical status.

symptoms is weaker among college students with high levels of the stress-is-enhancing mindset and stronger among those students with low levels of the stress-is-enhancing mindset.

MATERIALS AND METHODS

Participants and Procedure

The sample consisted of 919 (i.e., 447 female and 472 male) undergraduate students with low family SES enrolled in the first, second, or third year of their studies in a university in Guangzhou, China (7). Eligible students were those who applied for financial aid in the last year. The eligibility criteria for this financial aid were (1) average annual per capita household income below the amount stipulated for the application for financial aid at the university and (2) family members suffering from serious disease or experienced major natural disasters and experiencing economic challenges. Undergraduate students in their final year were not recruited due to their imminent graduation at the time. The ages of the participants ranged from 17 to 25 years (M = 20.46 years, SD = 1.33 years). The convenience sampling method was applied to recruit eligible participants from the eligible students list, and their personal information (e.g., name and family members' information) was kept strictly confidential. The eligible students' list was identified by the student affairs office of the university. All participants answered the online questionnaire through Qualtrics (Qualtrics, Provo, UT, United States) after providing individual written consent. The written informed consent was obtained from all the participants. If the student aged $<$ 18 years, the electronic copy of written consent would be obtained from participants' legal guardian (e.g., parents) through the WeChat (an instant messaging app). The research procedures performed in studies involving human participants were approved by the Institutional Review Board of the Guangzhou City University of Technology.

Measurements

Demographic Variables

The demographic variables were participants' age, sex, father's educational level and mother's educational level, household annual income, and subjective SES (SSES). The participants responded to their parents' educational attainment by four options (1 = "elementary school and below," 2 = "junior high school," 3 = "senior high school," and 4 = "bachelors and above"). In addition, the SSES was measured by a visual scale with 10-rung ladders (27). The participants responded by ranking their perception of family SES on the ladder relative to other students in the university. The score ranged from 1 to 10, and a higher score indicated higher subjective SES.

Perceived Social Class Discrimination

The Perceived Discrimination Scale (28) with six items was used to measure the college students' perception of discrimination experiences due to their low family SES. The participants responded based on their feelings of discrimination (e.g., "I feel that people treat me differently because of my family social class background") on a 5-point Likert scale (from 1 = *strongly disagree* to 5 = *strongly agree*). A previous study reported that the scale had adequate consistency and reliability for measuring the perception of discrimination among Chinese college students (29). Higher mean scores were taken to indicate higher perceived social class discrimination (Cronbach's α = 0.89).

Rumination

The ten-item Chinese version of the Short Ruminative Responses Scale (SRRS) [(30); H. (31)] was used to measure participants' tendencies to engage in ruminative thoughts (e.g., "Think about how passive and unmotivated you felt" and "Think about a recent situation, wishing it had gone better"). The responses were rated on a 4-point scale (from 1 = *never* to 4 = *always*). Higher mean scores were taken as reflecting higher frequencies of ruminative thoughts (Cronbach's α = 0.88).

Stress Mindset

The eight-item Chinese version of the Stress Mindset Measure (16, 26) was used to assess participants' beliefs about the nature of stress (i.e., stress is enhancing vs. stress is debilitating). Participants responded on a 5-point Likert scale (from 1 = *strongly disagree* to 5 = *strongly agree*). Example items were "The effects of stress are positive and should be utilized" and "Experiencing this stress depletes my health and vitality." After reversing the negatively worded items, a higher mean score indicated a higher level of the stress-is-enhancing mindset. We used the term "stress-is-enhancing mindset" consistently in the results to avoid confusion, with high levels of the stress-is-enhancing mindset equivalent to low levels of the stress-is-debilitating mindset (Cronbach's α = 0.76).

Psychological Symptoms

Participants' psychological symptoms were measured by the Chinese version of the Depression Anxiety Stress Scale with 21 items (DASS-21) (32, 33). The participants rated the extent to which they felt certain symptoms (e.g., "I was worried about situations in which I might panic") on a 4-point scale (from 0 = *did not apply to me at all* to 3 = *applied to me very much*). According to the recommendation of the developers of the scale (32), the sum score was multiplied by 2 to obtain a final score. A higher final score indicated a higher level of psychological symptoms (Cronbach's α = 0.94).

Data Analysis

To minimize the common method bias, all participants were informed that there were no correct or incorrect responses for the items in the survey. Moreover, we conducted the Harman's single-factor test to evaluate whether the common method bias was serious (34). According to an exploratory factor analysis on all key variables, the extracted first component accounted for 26.3% of the total variance. This indicated that the common method bias was not severe in this study.

In the preliminary analysis, Pearson correlation coefficients were used to analyze bivariate correlations among the key variables. Furthermore, the proposed moderated mediation model was examined by the PROCESS macro [model 59; (35)], which tested the direct and indirect effects of perceived

social class discrimination on psychological symptoms and the potential moderating role of stress mindset. First, assisted by PROCESS macro, the bootstrapping approach was used as the robust analysis to test the indirect effect of perceived social class discrimination on psychological symptoms through rumination (36). The indirect effects were considered significant if the bootstrapped 95% confidence intervals (boot 95% CIs) did not include zero (37). Second, the conditional indirect effect analysis was used to examine whether the indirect effects of perceived social class discrimination on psychological symptoms at high (M + 1SD) and low (M - 1SD) levels of the stress-is-enhancing mindset were significantly different. Third, the simple slope analysis was performed to analyze the nature of the moderation effects.

RESULTS

Preliminary Analyses

The participants' demographic characteristics are presented in **Table 1**. The results of bivariate correlation (refer to **Table 2**) showed that perceived social class discrimination was positively associated with rumination and psychological symptoms and was negatively associated with the stress-is-enhancing mindset. The stress-is-enhancing mindset was negatively associated with rumination and psychological symptoms. Rumination was positively associated with psychological symptoms. In addition, SSES was negatively associated with perceived social class discrimination, rumination, and psychological symptoms and was positively associated with the stress-is-enhancing mindset.

Testing for Proposed Moderated Mediation Model

After controlling for age, sex, family income, parents' educational level, and SSES, the results showed that perceived social class discrimination was positively associated with psychological symptoms through rumination (direct effect: B = 0.12, boot SE = 0.02, boot 95% CIs = [0.09, 0.16]; indirect effect: B = 0.11, boot SE = 0.01, boot 95% CIs = [0.08, 0.13]). Moreover, the interaction between perceived social class discrimination and stress mindset had no significant effect on psychological symptoms (B = 0.02, boot SE = 0.05, boot 95% CIs = [−0.08, 0.11]), which indicated that the direct association between perceived social class discrimination and psychological symptoms was not moderated by the stress-is-enhancing mindset. Furthermore, the interaction between perceived social class discrimination and the stress-is-enhancing mindset had no significant effect on rumination (B = −0.02, boot SE = 0.04, boot 95% CIs = [−0.09, 0.06]), whereas the interaction between rumination and the stress-is-enhancing mindset had a significant effect on psychological symptoms (B = −0.18, boot SE = 0.08, boot 95% CIs = [−0.32, −0.03]). This finding indicated that the indirect association between perceived social class discrimination and psychological symptoms through rumination was moderated by the stress-is-enhancing mindset, specifically in the association between rumination and psychological symptoms **Table 3**.

TABLE 1 | Sample demographics.

Variable	Overall *n* (%)	Females *n* (%)	Males *n* (%)
n	919 (100%)	447 (48.4%)	472 (51.6%)
Year in College			
Freshman	257 (28%)	133 (29.7%)	124 (26.0%)
Sophomore	294 (32%)	112 (25.2%)	182 (38.7%)
Junior	367 (40%)	202 (45.1%)	165 (35.3%)
Father's education attainment			
Elementary school and below	283 (30.8%)	132 (29.5%)	151 (32.0%)
Junior high school	444 (48.3%)	225 (50.3%)	219 (46.4%)
Senior high school	171 (18.6%)	85 (19.1%)	86 (18.2%)
Bachelors and above	21 (2.3%)	5 (1.1%)	16 (3.4%)
Mother's education attainment			
Elementary school and below	466 (50.7%)	225 (50.3%)	241 (51.1%)
Junior high school	359 (39.1%)	178 (39.8%)	181 (38.3%)
Senior high school	85 (9.2%)	44 (9.7%)	50 (8.9%)
Bachelors and above	9 (1.0%)	1(0.2%)	8 (1.7%)
	M (*SD*)	*M* (*SD*)	*M* (*SD*)
Age	20.46 (1.33)	20.32 (1.33)	20.58 (1.32)
SSES	5.32 (1.22)	5.21 (1.20)	5.41 (1.24)
PSCD	2.57 (0.77)	2.54 (0.78)	2.59 (0.76)
Rumination	2.13 (0.44)	2.13 (0.43)	2.12 (0.45)
SIEM	3.42 (0.45)	3.39 (0.46)	3.44 (0.45)
Psychological symptoms	66.90 (19.73)	65.60 (17.34)	68.12 (21.67)

SSES, subjective socioeconomic status; PSCD, perceived social class discrimination; SIEM, stress-is-enhancing mindset.

TABLE 2 | Correlations between key variables.

	1	2	3	4	5
1. SSES	–				
2. PSCD	−0.23**	–			
3. Rumination	−0.24**	0.43**	–		
4. SIEM	0.20**	−0.26**	−0.14**	–	
5. Psychological symptoms	−0.26**	0.46**	0.58**	−0.29**	–

SSES, subjective socioeconomic status; SIEM, stress-is-enhancing mindset.
***$p < 0.01$.*

According to the results of the conditional indirect effect analysis, compared with individuals with low levels of the stress-is-enhancing mindset (i.e., the level of stress mindset at M - 1SD), the indirect positive effect of perceived social class discrimination on psychological symptoms through rumination was weaker among individuals with high levels of the stress-is-enhancing mindset (i.e., the level of the stress mindset at M + 1SD). A simple slope analysis was performed **Table 3**, and the result showed a significant difference between the two conditional indirect effects (contrast = −0.04, boot SE = 0.02, boot 95% CIs = [−0.09, −0.01]). Furthermore, the relationship between rumination and psychological symptoms in the participants with low and high levels of the stress-is-enhancing mindset is plotted in **Figure 2**. In summary, the results indicate that the direct effects of perceived social class discrimination on psychological symptoms were not moderated by the stress-is-enhancing mindset, whereas the indirect effects of perceived social class discrimination on

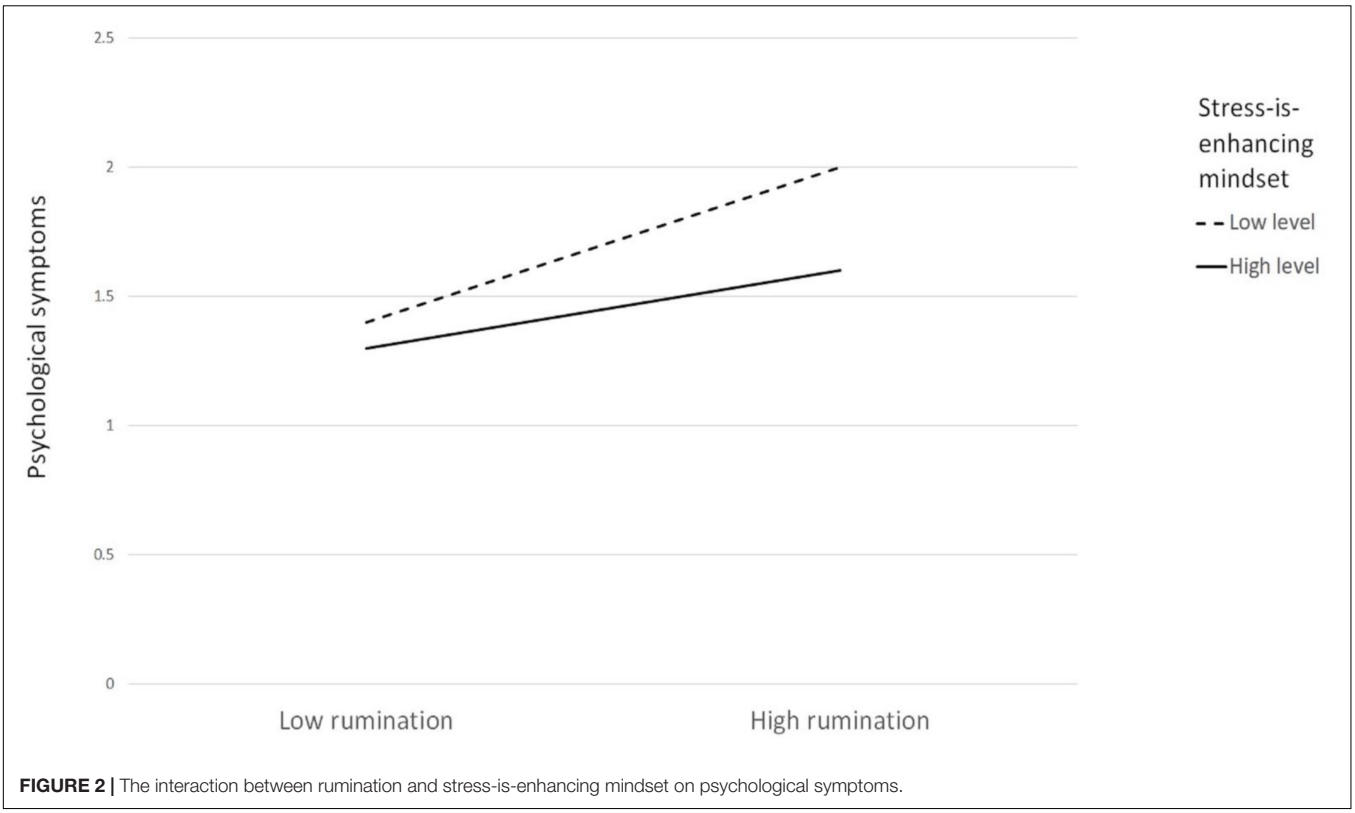

FIGURE 2 | The interaction between rumination and stress-is-enhancing mindset on psychological symptoms.

psychological symptoms through rumination were significantly moderated by the stress-is-enhancing mindset.

DISCUSSION

This study empirically demonstrated how the stress mindset influences the complex relationships among perceived social class discrimination, rumination, and psychological symptoms among socioeconomically disadvantaged populations. The findings of this study partly support our hypotheses (H3 was not supported, and H4 was partly supported). Consistent with the results of a previous study (18), the findings of this study indicate a positive association between perceived social class discrimination and psychological symptoms among college students from socioeconomically disadvantaged families and a mediating role of rumination in this relationship. Importantly, the finding highlights the stress-is-enhancing mindset as a buffer in the indirect association between perceived social class discrimination and psychological symptoms through rumination, although the stress-is-enhancing mindset may not buffer the direct association between perceived social class discrimination and psychological symptoms.

Perceived Social Class Discrimination and Psychological Symptoms

The finding indicates that when socioeconomically disadvantaged college students perceive higher discrimination, they report higher psychological symptoms. The finding supports perceived social class discrimination as a key risk factor for the mental health status of socioeconomically disadvantaged population (6, 9). Among this population, financial pressures and limited external and personal resources increase individuals' awareness of the difference between their family backgrounds and those of their peers (38), which in turn enhances their perception of discrimination and leads to poor psychological wellbeing and negative health outcomes (6, 9). The findings implicate that the education and services of mental health for college youths should focus on reducing the threat of social class discrimination, especially for socioeconomically disadvantaged students.

The Mediating Role of Rumination

The findings reveal that perceived social class discrimination was positively associated with psychological symptoms through increased rumination, which supported previous findings (13, 18). Rumination is a maladaptive response for individuals facing adversity and stress events (19). When individuals succumb to these negative and repetitive responses to discrimination experiences, they may feel hopeless in adapting to the prevailing adversity and trigger more psychological symptoms. Furthermore, considering the characteristics of intergenerationally transmitted poverty (39, 40), socioeconomically disadvantaged college students may believe that their low family SES is fixed for the long term, and those pessimistic and fatalistic thoughts can lead to rumination

TABLE 3 | The moderated mediation model analysis.

Variable	*B*	Boot SE	Bias-corrected boot 95 CIs	
			LLCI	ULCI
Outcome: rumination				
Age	−0.01	0.01	−0.03	0.01
Sex (male = 1)	−0.02	0.02	−0.07	0.04
Family income	0.06	0.05	−0.04	0.16
Parents education attainment	0.03	0.02	−0.01	0.08
SSES	−0.05***	0.01	−0.07	−0.03
PSCD	0.23***	0.02	0.18	0.27
SIEM	−0.01	0.03	−0.08	0.05
Perceived discrimination × SIEM	−0.02	0.04	−0.09	0.06
Outcome: psychological symptoms				
Age	0.01	0.01	−0.01	0.02
Sex (male = 1)	0.07**	0.02	0.02	0.12
Family income	0.00	0.05	−0.09	0.09
Parents' education attainment	0.00	0.02	−0.05	0.04
SSES	−0.03**	0.01	−0.05	−0.01
PSCD	0.12***	0.02	0.08	0.16
Rumination	0.48***	0.04	0.40	0.55
SIEM	−0.17***	0.03	−0.23	−0.11
Perceived discrimination × SIEM	0.02	0.05	−0.08	0.11
Rumination × SIEM	−0.18**	0.08	−0.32	−0.03
Conditional indirect effect analysis				
Low SIEM (*M* − 1*SD*)	0.13	0.02	0.09	0.17
High SIEM (*M* + 1*SD*)	0.09	0.02	0.06	0.12

Bootstrap sample size = 5,000. LLCI, lower limit confidence interval; ULCI, upper limit confidence interval; SE, standard error; SSES, subjective socioeconomic status; SIEM, stress-is-enhancing mindset.
***p < 0.01, ***p < 0.001.*

and threaten their mental health (41, 42). The future practice could explore the effective approach (e.g., mindfulness training) in decreasing the ruminative thoughts among socioeconomically disadvantaged college students, which may be helpful for diminishing the psychological symptoms of the college student when they suffer from discrimination.

The Buffering Role of Stress-Is-Enhancing Mindset

Importantly, the findings indicate that a stress-is-enhancing mindset can weaken the effects of the rumination on psychological symptoms among socioeconomically disadvantaged college students when they are exposed to stressful situations (21, 22, 25), particularly when they engage in rumination due to perceived social class discrimination. The benefit of a stress-is-enhancing mindset in buffering the negative effect of stress may be more likely to be realized when individuals evaluate stress as a challenge rather than a threat (43). Researchers have suggested that rumination is a type of a coping strategy involving positive and negative aspects (44). When individuals interpret rumination as a useful coping strategy (45), they may anticipate positive effects of rumination on downstream outcomes, such as resilience. For instance, college students experiencing discrimination due to their low family SES backgrounds might engage in rumination. However, when they believe that rumination does not always have negative consequences, they can reappraise the prevailing stressful situation positively, which may motivate them to focus more on how to adapt and thrive under such environments based on their strengths (e.g., academic ability) rather than perceived weaknesses (e.g., a socioeconomically disadvantaged background), and this will in turn protect their mental health (16). Although perceived discrimination causes rumination and psychological symptoms, holding the belief of the stress-is-enhancing mindset could buffer the negative effect of rumination on mental health among socioeconomically disadvantaged college students. The school health care services could consider developing and providing a stress-is-enhancing mindset intervention to protect student's mental health.

Moreover, the findings indicate that the moderating role of stress mindset in the association between perceived social class discrimination and rumination is not significant. It is possible that when the perceived social class discrimination is perceived as a key threat directly leading to ruminative thoughts and affecting college students' mental health (e.g., symptoms of depression and anxiety), the stress-is-enhancing mindset may not protect against repeated negative thoughts and thus the negative effects of discrimination on mental health in highly stressful situations (43). This might explain why the findings of this study did not support the view that a stress-is-enhancing mindset buffers the direct effects of perceived social class discrimination on psychological symptoms in college students. Future studies may examine the buffering effect of the stress-is-enhancing mindset in the relationship between perceived social class discrimination and wellbeing in other populations.

Limitations

Some limitations of this study should be considered. First, this study is the first to examine the stress mindset of the target population with a large-scale survey and is therefore implemented as a preliminary investigation with data collected at one specific time point and with no experimental manipulation of the natural environment. Although inferences can be made from the findings about the relationships among the variables of interest, the cross-sectional design of the study means that it cannot reveal the causal relationships among these variables. Future studies should apply rigorous study designs to explore whether the negative effects of perceived social class discrimination and rumination can be buffered by the stress-is-enhancing mindset. Second, it remains unclear whether a stress mindset can protect an individual's mental health status over time under the sustained threat of perceived social class discrimination and rumination. Third, this study recruited participants from university students. The findings may lack generalizability across different areas and cultures. Future studies may examine the protective effect of the stress-is-enhancing mindset on mental health among other socioeconomically disadvantaged population, such as children affected by parental HIV/AIDS.

CONCLUSION

The findings of this study suggest that stress mindset could buffer the effects of stress on vulnerable individuals' mental health (16, 22). The findings facilitate our understanding of how stress-is-enhancing mindsets influence individuals' capacities to maintain good mental health and resist psychological symptoms despite the pressures of poverty. Moreover, the findings make a theoretical contribution in expanding the understanding of the buffering effect of a stress-is-enhancing mindset in the indirect association between stress and mental health outcomes. In particular, it appears that reducing the negative effects of rumination is important in highly stressful situations when the stress-is-enhancing mindset cannot directly protect individuals' mental health. This study provides insights in designing future stress-is-enhancing mindset-based interventions for socioeconomically disadvantaged students. Such intervention may help vulnerable individuals to focus on the positive consequences of stress, use it as a strategy to reduce the potential of severe psychological symptoms, and maintain a positive outlook regarding their disadvantaged life situations.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding authors.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Research Ethics Committee of the Guangzhou City University of Technology. Written informed consent to participate in this study was provided by the participants or their legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

JW: designed and executed the study, collected the data, and wrote the manuscript. QFL: designed and executed the study, developed conceptual framework, wrote the manuscript, and critically reviewed the manuscript. QW: developed conceptual framework and critically reviewed the manuscript. QLL: edited and critically reviewed the manuscript. All authors approved the final version of the manuscript for submission.

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Life-Events Mediate the Prediction of Parental Alienation on Depression in Rural Left-Behind Children: A Longitudinal Study

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Objectives: Long-time separation with parents during early life, such as left-behind children (LBC, one or both of whose parents are leaving for work for at least a period of 6 months), may contribute to high alienation toward parents and endanger their mental health (e.g., depression). However, the dynamic status of depression and potential prediction of alienation on depression in LBC remained largely unknown. This study aimed to examine the dynamic status of depression, prediction of alienation toward parents on later depression in rural LBC, and a potential mediation of life-events.

Methods: A total of 877 LBC in rural areas of China were recruited and surveyed at five time-points (baseline, T0: 1-month, T1: 3-months, T2: 6-months, T3: 12-months, T4) with the Inventory of Alienation Toward Parents, Childhood Depression Inventory, and Adolescent Self-Rating Life-Events Checklist. The Hierarchical Linear Model (HLM) and Hayes's PROCESS macro model were conducted to estimate the developmental trend and hierarchical predictors of depression.

Results: The left-behind children aged 9-years old experienced higher depression than the children with other ages. At baseline, the children in the family atmosphere of frequent quarrels and compulsive parenting style reported a higher level of alienation toward parents, life-events, and depression. Alienation toward parents, life-events, and depression were positively and moderately correlated with each other ($r = 0.14 \sim 0.64$). The HLM model depicted a linear decline in depression, alienation, and life-events with an average rate of 0.23, 0.24, and 0.86, respectively, during the five time-points. Also, T0 alienation toward parents and T0 life-events positively predicted the developmental trajectory of depression over time, and T0 life-events positively predicted the descendant rate of depression. Notably, life-events mediated the prediction of baseline alienation toward parents on T4 depression in LBC.

Conclusion: This study is among the first to reveal that alienation toward parents predicts the developmental trajectory of later depression in LBC. The findings that life-events mediate the prediction of alienation on later depression further suggest the importance of family and social factors in the occurrence of depression in LBC. The

findings warrant the necessity to consider the family and social factors when evaluating and reducing risks for mental health problems in LBC, i.e., relationship with parents (especially alienation toward parents) and life-events need further attention.

Keywords: alienation toward parents, depression, Hierarchical Linear Model, left-behind children, life-events

INTRODUCTION

Along with the acceleration of industrialization and urbanization in China, a large number of rural labors migrate to prosperous cities with the hope of seeking better financial conditions for their families. Due to the household registration policy and other financial barriers, it is of great difficulty for migrant workers to solve the problems of education and medical care for their children in the place where they are employed; therefore, a large population of children are left behind in rural areas (1), named left-behind children (LBC). The LBC refers to the children under the age of 18, who are left at home for a period of at least 6 months with one or both of their parents leaving home for work (2). According to the 2015 survey conducted by the Chinese Ministry of Civil Affairs, the Ministry of Education and the Ministry of Public Security, the number of rural LBC in China are 40.51 million (3). The biggest problem of LBC faced is that their living condition lacks the companionship and care of parents, which may have a profound impact on their health and growth. A recent systematic review shows that 91 of 111 studies have reported poor health outcomes of LBC in China (4). In general, LBC are susceptible to many health problems (5), including emotional, behavioral, and mental health problems, such as depression (6, 7). The poor developmental conditions of LBC have attracted widespread attention in Chinese society currently.

Depression, a common negative emotion, may be expressed when people fail to cope with external pressure (7). A national survey of 10,123 adolescents aged 13–18 years in the USA found that lifetime and 12-month prevalence of major depressive disorder rates were 11.0% and 7.5%, respectively (8). In adolescence, the rates of depression increase substantially, and the estimated cumulative incidence in this population approximates the lifetime prevalence rate in adult (9). For LBC, the prevalence rates of depression in China have been reported with a range of 12.1–51.4% using different depression scales (10). Compared with the non-LBC, the LBC seem to be especially vulnerable to depression (10, 11). Moreover, it was found that the more serious symptom of depression, the higher occurrence of the non-suicidal self-injury in LBC (12). These findings suggest a great practical significance to observe the status of depression in LBC. In addition, the depression status in LBC might fluctuate due to a variety of influential factors (13). Thus, a multi-time-point investigation was warranted to observe the dynamic status of depression in LBC.

Higher levels of depression in LBC would be explained mainly by difficulties in establishing a good parent–child relationship because of the parent–child separation and the absence of parental care (7). In fact, a prolonged separation with parents during early life may increase the alienation toward parents in adolescents (14), in which alienation toward parents is defined as negative feelings, such as being emotional distant, possessive, even been controlled during the interaction with parents (15, 16). Compared with the non-LBC, the LBC tasted more and stronger feeling of alienation toward their parents (17, 18). Alienation toward parents may increase individual vulnerability to stress, and result in significant short- and long-term negative outcomes, such as depression and alienating from their own children (19). Consistently, the adolescents with a strong sense of alienation toward their parents were more susceptible to depressive symptoms (20). The retrospective studies further revealed that alienation toward parents caused various behavioral and emotional problems, such as depression in adults (21, 22). Importantly, the prior investigation confirmed a direct connection between alienation toward parents and depression in LBC (6). However, the prediction of alienation toward parents on depression in LBC still remains unexplored, which necessitates a longitudinal follow-up investigation.

The effect of alienation on depression may be mediated by other factors. Existing evidence show that the negative life-events positively relate to the incidence of depression at different ages (23, 24), which might be a possible risk mediator between alienation and later depression. Life-events refer to events or situations that threaten, challenge, exceed, or damage individual psychological or physical health (25). According to Erikson's psychosocial theory, parent–child relationship plays an important role in the process of children's growth; life-events may affect parents' behavior and parent–child relationship (26), which may boost the occurrence of adolescent depression. Adolescents with high levels of alienation toward parents may have problems in dealing with negative life-events effectively, while high levels of parent–child attachment can be buffering against the negative consequences (27). Moreover, the previous investigations indicated that LBC who were experiencing negative life-events had stronger alienation toward parents (6). They also showed stronger stress when experiencing negative events and exhibited more depressive symptoms than the non-LBC (28). Indeed, those painful experiences exposed to early parental loss or separation may increase youths' distance toward parents and heighten their reactivity to subsequent stressful life-events, and further result in depression (29). All these results indicated a connection between alienation toward parents and depression in adolescents and potential mediation of life-events. However, these effects were not tested directly, and none of these studies used longitudinal data. Thus, the mediation of life-events between predictive pathway from alienation to depression in LBC remains unsettled, which is potentially important to better understand and prevent the occurrence of depression in LBC.

To sum up, this study aims to reveal the dynamic status of depression in LBC with a longitudinal study, and further explores the prediction of alienation toward parents on later depression

of LBC, and potential mediation of life-events. Specifically, the following hypotheses were proposed:

1) There may be a certain level of depression in LBC with a variation across the time.
2) There may be a positive prediction of alienation toward parents on the depression of LBC.
3) Life-events may mediate the prediction of alienation toward parents on the depression of LBC.

METHODS

Participants

Students in fourth to sixth grade of primary school were eligible for this longitudinal investigation from rural area in Chongqing, China, in which the left-behind phenomenon is quite common. According to a survey in 2015, the proportion of LBC in rural Chongqing was estimated to be 76.37% (30). The inclusion criteria for sampling population included the following: 1) Children who can read and write Chinese. 2) One or both parents are leaving for work for a period that is longer than 6 months. Children with obvious physical or developmental disabilities were excluded. Children filled in self-rating scales about the alienation toward parents, depression, and life-events at five time-points (baseline, T0: 1-month, T1: 3-months, T2: 6-months, T3; and 12-months, T4). The reason that we chose students from fourth to sixth grade of primary school stemmed from the fact that the children in third grade or below had difficulties in understanding or answering some questions accurately (31). Among the 1,090 questionnaires collected with convenience sampling, 153 participants were the non-LBC. Sixty participants, who did not entirely complete all the measures or whose left-behind types changed during the four follow-up surveys, were excluded from the final analysis. The final sample size was reduced to 877. By applying the Wilcoxon rank–sum test (32), there was no significant difference in the scores of alienation toward parents ($Z = -0.99$, $p = 0.324$), life-events ($Z = -0.40$, $p = 0.687$), and depression ($Z = -0.05$, $p = 0.960$) between the exclusion subjects ($n = 60$) and the effective subjects ($n = 877$) who fully participated in the longitudinal survey. The median and interquartile range (IQR) age was 10 (10, 11) years. Of them, 466 were male, resulting in almost equal proportion of male and female.

Instruments

Socio–demographic information, including gender, grade, age, family atmosphere (harmony, occasional quarrel, and frequent quarrel), parenting style (compulsive, indulged, spoiled, and democratic), and parents' marital status (un-divorced, divorced, father remarried, mother remarried, and both remarried), were collected.

Alienation toward parents was measured by the Inventory of Alienation toward Parents (IAP), which was designed in our previous work (18). This scale consists of 18 items assessing 2 dimensions covering maternal alienation (9 items; sample item: "I feel abandoned by my mother") and paternal alienation (9 items; sample item: "I feel unable to communicate with my father"). All items are rated on a 5-point Likert scale from 1 (totally inconsistent) to 5 (totally consistent), and scores are calculated by summing all of the responses, with higher scores that mean higher level of alienation toward parents. This scale has shown good reliability and validity in the previous research (17). The Cronbach's alpha coefficients measured in this study were 0.871, 0.890, 0.889, 0.905; and 0.922 for the five surveys, respectively.

Depression was measured by the Childhood Depression Inventory (CDI) which was revised by Wu (33). It is used to assess depression symptoms in children aged 7 ∼ 17 years, including 27 items and 5 dimensions covering anhedonia, negative emotions, low self-esteem, inefficient sense, and interpersonal problems. All items are rated on a 3-point Likert scale ranging from 0 (occasionally) to 2 (always). Scores are calculated by summing all of the responses, with higher scores indicating a higher level of depression. This scale has demonstrated a good reliability and validity in Chinese children (34). The Cronbach's alpha coefficients of this scale in this study were 0.869, 0.880, 0.887, 0.889; and 0.895 for the five surveys, respectively.

Stressful life-events were measured by the Adolescent Self-Rating Life-Events Checklist (ASLEC) (35). This measure consists of 27 items and 6 dimensions covering interpersonal relationship (5 items; e.g., "Been misunderstood or blamed"), study pressure (5 items; e.g., "Heavy learning burden"), punishment (7 items; e.g., "Been criticized or punished"), losing (3 items; e.g., "Bereavement"), healthy adaptation (4 items; e.g., "Prolonged separation with families"), and something else (4 items; e.g., "Fighting with people"). Items are rated on a 6-point Likert scale ranging from 0 (none) to 5 (extremely serious), and higher total scores reflect more life-events. The ASLEC has shown good reliability and validity in the previous research (36). The Cronbach's alpha coefficients in this study were 0.916, 0.924, 0.927, 0.933, and 0.936 for the five surveys, respectively.

Procedure

Written informed consent was obtained from both students and their parents, which was approved by the Human Research Ethics Committee, Army Medical University. The researchers explained the study to children and their parents in written and verbal. After this, children applied for participation independently. The self-report questionnaires were investigated in the classrooms of primary school at five time-points (baseline, T0: 1-month, T1: 3-months, T2: 6-months, T3: 12-months, T4): IAP, CDI, and ASLEC. The children were debriefed and received incentives after the fifth survey.

Analysis

The scores of depression, life-events, and alienation were described as median and interquartile range (IQR) since the variables were not normally distributed, and the categorical variables were described by number and percentages. The independent-sample Mann–Whitney U test as well as the Kruskal–Wallis test were used to compare the differences on the scores of alienation toward parents, life-events, and depression among the different demographic variables. Spearman correlation was carried out to examine the association between alienation toward parents, life-events, and depression.

The Hierarchical Linear Model (HLM) was further utilized to analyze the developmental trend of depression, and the prediction of alienation and life-events at baseline on later depression. The HLM is basically consisted of a null model, an unconditional model, and a full model. 1) The null model, a model including depression at five different test time-points as the outcome variable without any predictive variables, was mainly applied to judge whether there was a hierarchical structure in the developmental trajectory of depression, i.e., whether the data was suitable for HLM analysis. 2) An unconditional model was constructed to estimate whether the developmental trajectory of depression in LBC was linear. According to the analysis principle of the HLM (37), time was considered as an independent variable of Level 1 (first to fifth investigation time-point), and the developmental trajectory of depression during five time-points were considered as the outcome variable. Then, an unconditional linear growth model was built. On the one hand, the model can judge whether time (variable of Level 1) has a significant effect on the developmental trajectory of depression; on the other hand, it can further determine whether variables of Level 1 are significantly affected by Level 2, and if so, appropriate variables should be introduced in Level 2 for further analysis in the full model. The Level 1 model was represented by the equation, Depression $= B_0 + B_1 \times$ (Time) + R. 3) The full model utilized the Level 1 model to observe the influence of the time (within-individual variable) on the developmental trajectory of depression, and the Level 2 model was used to investigate the effect of the between-individual variables (alienation toward parents, life-events) or the combined effect (alienation toward parents and life-events) on the developmental trajectory of depression. Level 2 variables centered on their grand means and the following two variables were included: T0 alienation toward parents and T0 life-events, with age, family atmosphere, and parenting style as controlled variables. The full model was represented as the following equation: Level 1 Model: Depression $= B_0 + B_1 \times$ (Time) + R; Level 2 Model: $B_0 = \gamma_{00} + \gamma_{01} \times$ (T0 Age) $+ \gamma_{02} \times$ (T0 Family atmosphere) $+ \gamma_{03} \times$ (T0 Parenting style) $+ \gamma_{04} \times$ (T0 Alienation toward parents) $+\gamma_{05} \times$ (T0 Life-events) $+ U_0$; $B_1 = B_{10} + B_{11} \times$ (T0 Age) $+ \gamma_{12} \times$ (T0 Family atmosphere) $+ \gamma_{13} \times$ (T0 Parenting style) $+ \gamma_{14} \times$ (T0 Alienation toward parents) $+ \gamma_{15} \times$ (T0 Life-events) $+ U_1$.

Hayes's PROCESS macro model was also applied to investigate the possible mediation of life-events in linking the baseline alienation toward parents and T4 depression (38). Bootstrap tests (2,000 repeated samples and 95% confidence interval) were used to test the significance of the mediating effect, with 95% CI did not contain 0 indicating a significant mediating effect. The data analyses were conducted using SPSS version 22 and HLM version 6.0. Also, $p < 0.05$ was considered as statistically significant.

Control and Test of Common Method Deviation

The self-reporting information may cause deviations in the common method. Therefore, the procedural control was focused since the beginning, including applying mature scales with good reliability and validity, protecting the anonymity of participants and the reverse scoring of some items. Second, after the data collection, the common method deviation was tested with the one-factor test of Haman (39). The final results showed that during the five measures, the total numbers of factor with eigenvalues >1 were 15, 16, 15, 14, and 15, respectively, and the variances explained by the first factor were 20.10, 21.66, 23.54, 23.54, and 23.93%, and all were <40% for the critical standard (40). The results fully manifested that the deviations of the common method among five investigations were not significant.

RESULTS

Descriptive Statistics

The demographic differences on the scores of alienation toward parents, life-events, and depression at baseline were summarized in **Table 1**. The scores of depression, alienation toward parents, and life-events did not differ significantly on gender, grade, or parents' marital status. However, they significantly differed in age, family atmosphere, and parenting style ($p < 0.05$). Specifically, the children aged 9 years experienced higher depression than the children with different age. The children from the family with frequent quarrels reported higher scores of alienation toward parents, life-events, and depression compared with those with occasional quarrel or harmonious family atmosphere ($p < 0.001$). Similarly, LBC with compulsive parenting style reported higher scores of alienation toward parents, life-events, and depression compared with those with other parenting styles ($p < 0.001$).

As expected, the Spearman correlation analysis demonstrated that alienation toward parents, life-events, and depression were positively and moderately correlated with each other at the same or different time-points ($r = 0.14 \sim 0.64$, $p < 0.001$). See **Table 2** for details.

Prediction of T0 Alienation Toward Parents and Life-Events on Developmental Trajectory of Depression

Null Model

The results of the Hierarchical Linear Model demonstrated that fixed effect and random effect of the model passed the significance test, and the intra- and inter-group variance were 41.57 and 29.52, respectively. Afterward, the inter-class correlation (ICC) was found to be 0.42. According to the former research (41), when ICC is <0.059, the hierarchy effects cannot be ignored between different levels, and a hierarchical linear analysis is of emphasis and necessity (37).

Unconditional Model

As listed in **Table 3**, the intercept of depression ($B_0 = 39.13$, $t = 138.76$, $p < 0.001$), alienation toward parents ($B_{01} = 31.73$, $t = 70.79$, $p < 0.001$), life-events ($B_{02} = 29.94$, $t = 40.96$, $p < 0.001$), and the slope of depression ($B_1 = -0.23$, $t = -3.12$, $p < 0.01$), alienation toward parents ($B_{11} = -0.24$, $t = -2.04$, $p < 0.05$), life-events ($B_{12} = -0.86$, $t = -4.96$, $p < 0.001$), were all significant. The results indicated that there was a linear downward trend for depression, alienation toward parents, and life-events over time. Moreover, the random effect indicated that

TABLE 1 | Demographic characteristics of alienation toward parents, life-events, and depression at baseline [M(P_{25}, P_{45})].

Characteristic (877) [*n*(%)]	Alienation toward parents T0	Z	Life-events T0	Z	Depression T0	Z
Gender						
Male [466 (53.14%)]	28 (23, 39)	−0.21	27 (15, 45)	−0.16	37 (33, 45)	−0.78
Female [411 (46.86%)]	29 (24, 37)		25 (14, 41)		38 (33, 43)	
Grade						
Four grade [344 (39.22%)]	28 (23, 38.75)	0.39	26 (15, 41)	0.62	38 (33.25, 44)	1.78
Five grade [280 (31.93%)]	29 (24, 37)		25 (13.25, 43)		37 (32, 43.75)	
Six grade [253 (28.85%)]	29 (23, 38)		27 (15.5, 43)		37 (33, 43)	
Age						
Nine years old [132 (15.05%)]	29.5 (24, 34)	6.66	28 (16, 41.50)	5.33	39 (34.25, 45.75)	9.26*
Ten years old [308 (35.12%)]	27 (22, 36)		24 (13, 41)		37 (32, 42)	
Eleven years old [262 (29.88%)]	29 (24, 40)		27.5 (16, 46)		38 (33.75, 44)	
Twelve years old [175 (19.95%)]	30 (23, 38)		27 (14, 41)		37 (33, 43)	
Family atmosphere						
Harmony [262 (29.88%)]	26 (22, 32)	58.25***	18.5 (9, 32)	83.99***	35 (31, 40)	83.77***
Occasional quarrel [567 (64.65%)]	29 (24, 39)		29 (17, 45)		38 (34, 44)	
Frequent quarrel [48 (5.47%)]	43 (31.5, 54)		51.5 (33.25, 65)		49 (43.25, 55)	
Parenting style						
Compulsive [200 (22.81%)]	32.5 (24, 45)	22.13***	31 (17, 49.75)	18.11***	41 (35, 48)	49.79***
Indulged [125 (14.25%)]	29 (23.5, 41.5)		30 (16.5, 47)		39 (34, 44.5)	
Spoiled [83 (9.46%)]	29 (22, 36)		25 (14, 40)		38 (35, 47)	
Democratic [469 (53.48%)]	27 (23, 36)		24 (13, 39)		36 (32, 41)	
Parents' marital status						
Un-divorced [663 (75.60%)]	28 (23, 37)	5.43	26 (14, 41)	2.00	38 (33, 44)	3.43
Divorced [114 (13.00%)]	30 (22.75, 39.25)		26 (14.75, 43)		38 (33, 43.25)	
Father remarried [27 (3.08%)]	34 (24, 49)		24 (15, 45)		37 (33, 43)	
Mother remarried [32 (3.65%)]	29 (25, 45.5)		25 (15.25, 56.75)		36 (32, 45.25)	
Both remarried [41 (4.67%)]	29 (22, 44.5)		29 (16, 48)		39 (36, 46.5)	

*$p < 0.05$, ***$p < 0.001$.

there was a significant individual difference at the initial level of depression ($\chi^2 = 1410.24$, $p < 0.001$), alienation toward parents ($\chi^2 = 1391.44$, $p < 0.001$), and life-events ($\chi^2 = 1556.61$, $p < 0.001$), while the descendant rate also showed significant individual differences in depression ($\chi^2 = 1060.48$, $p < 0.001$), alienation toward parents ($\chi^2 = 1053.58$ $p < 0.001$), and life-events ($\chi^2 = 955.26$, $p < 0.05$). Thus, other potential influential variables could be introduced into the following full model.

Full Model

It can be seen in **Table 4**, the coefficients of $\gamma_{04} = 1.85$ ($p < 0.001$), and $\gamma_{05} = 1.78$ ($p < 0.001$) revealed that alienation toward parents and life-events at baseline positively associated with the intercept of depression. Furthermore, T0 life-events ($\gamma_{15} = 0.20$, $p < 0.05$) positively predicted the descendant rate of depression, while the baseline alienation ($\gamma_{14} = 0.09$, $p > 0.05$) did not predict the decline of depression significantly. According to the random effect, the interaction between family atmosphere, parenting style, alienation toward parents, and life-events explained 9.64% [(0.83 – 0.75)/0.83] (42) of the total variation of the depression. The descendant trend of depression was explained 52.73% [(26.42 – 12.49)/26.42] by age and life-events.

Mediation of Life-Events Between Alienation Toward Parents and Depression

To further explore the causal relationship between alienation toward parents, life-events, and depression, Hayes's PROCESS was carried out. With T0 depression as controlled variable, T0 alienation toward parents as predictive variable, T1, T2, and T3 life-events as mediator separately, and T4 depression as dependent variable, the results showed that none of the mediation effects was significant. A further analysis was carried out to explore the potential mediation of life-events between alienation and later depression, with T1 and T2 alienation toward parents as predictive variable separately (T1 and T2 depression as controlled variable), T2 and T3 life-events as mediator separately, and T4 depression as dependent variable, the results showed that only T3 life-events totally mediated the prediction of T2 alienation toward parents on T4 depression (indirect effect = 0.03, 95% CI 0.01 – 0.05). With life-events at baseline as controlled variable, T0 alienation toward parents as predictive variable, T1, T2,

TABLE 2 | Correlations between depression, alienation toward parents, and life-events between five investigations.

	M(P_{25}, P_{45})	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1T0 Alienation toward parents	29 (23, 38)	1													
2T1 Alienation toward parents	26 (22, 35)	0.38***	1												
3T2 Alienation toward parents	26 (22, 36)	0.23***	0.31***	1											
4T3 Alienation toward parents	27 (22, 36)	0.40***	0.34***	0.26***	1										
5T4 Alienation toward parents	27 (22, 34)	0.34***	0.27***	0.22***	0.46***	1									
6T0 Life-events	26 (15, 42)	0.40***	0.28***	0.16***	0.31***	0.27***	1								
7T1 Life-events	22 (11, 39)	0.24***	0.42***	0.23***	0.25***	0.23***	0.54***	1							
8T2 Life-events	21 (10, 37)	0.17***	0.23***	0.44***	0.19***	0.18***	0.30***	0.47***	1						
9T3 Life-events	21 (10, 37)	0.30***	0.25***	0.21***	0.41***	0.28***	0.58***	0.48***	0.38***	1					
10T4 Life-events	21 (10, 38)	0.26***	0.21***	0.20***	0.31***	0.38***	0.53***	0.42***	0.34***	0.64***	1				
11T0 Depression	37 (33, 44)	0.43***	0.32***	0.17***	0.31***	0.25***	0.50***	0.32***	0.18***	0.36***	0.31***	1			
12T1 Depression	36 (32, 43)	0.25***	0.43***	0.25***	0.27***	0.20***	0.30***	0.50***	0.25***	0.32***	0.27***	0.51***	1		
13T2 Depression	36 (32, 43)	0.14***	0.27***	0.40***	0.18***	0.17***	0.19***	0.29***	0.49***	0.25***	0.23***	0.29***	0.42***	1	
14T3 Depression	36 (32, 44)	0.29***	0.25***	0.22***	0.43***	0.30***	0.42***	0.33***	0.19***	0.50***	0.42***	0.58***	0.46***	0.34***	
15T4 Depression	36 (31, 44)	0.26***	0.23***	0.21***	0.33***	0.44***	0.35***	0.34***	0.21***	0.39***	0.51***	0.48***	0.44***	0.30***	0.63***

*T0, T1, T2, T3, and T4 represent baseline, 1-month, 3-months, 6-months, and 12-months investigation, respectively; ***$p < 0.001$.*

and T3 life-events as mediator separately, and T4 depression as dependent variable, the results showed that T0 alienation toward parents had a direct effect on T4 depression (direct effect = 0.09, $p < 0.01$). Meanwhile, only T3 life-events partially medicated the prediction of T0 alienation toward parents on T4 depression (indirect effect = 0.07, 95% CI 0.01 – 0.02, $p < 0.01$) (**Figure 1**).

DISCUSSIONS

Depression is quite prevalent and becomes a significant issue among LBC (10). The present longitudinal study seems the first report of its kind, as far as we know, to explore the developmental trend of depression and the prediction of alienation toward parents on the developmental trajectory of depression in China's LBC and potential mediation of life-events. There were four essential findings in this study. First, alienation toward parents, life-events, and depression were positively and moderately related to each other at the same or different time-points. Second, there was a downward trend in depression, alienation toward parents, and life-events in LBC over time. Third, T0 alienation toward parents and T0 life-events positively predicted the developmental trajectory of depression over time. Fourth, T3 life-events mediated the prediction of baseline alienation toward parents on T4 depression in LBC.

The demographic information analysis showed that the age of LBC, family atmosphere, and parenting style influenced the scores of depression in LBC significantly. Specifically, the LBC aged 9 years tasted stronger depression than the children with other ages, which suggests that younger children may experience higher depression when their parents are leaving home. It was consistent with previous findings, which reported higher rates of depression in younger LBC (43). It could be explained by their irreplaceable role of parents in the development of younger children (14). Importantly, the children with family atmosphere of frequent quarrels and compulsive parenting style reported higher levels of alienation toward parents and depression, which proved consistent with the previous studies (17, 44, 45). Notably, inadequate parenting styles would lead to childhood abuse (46), which hurt parent–child relationship and increase alienation toward parents consequently (44). In daily life, almost all couples have sorts of conflicts, but only the children who really perceive family conflicts endanger their mental health (47). The children whose parents experienced divorce or involved in highly conflicting disputes (including ongoing conflicts) reported more alienation toward their parents (19). Furthermore, the current results revealed that frequent quarrel and compulsive parenting style increased the reports of life-events in LBC. The possible explanation may be that children with continual parental conflicts and compulsive parenting styles tend to adopt inadequate coping strategies when facing with life-events (48). Indeed, without a timely guidance and support from their parents, the LBC are susceptible to the effects of life-events. Together, the results suggest that elder age, harmonious family atmosphere, and democratic parenting style are vital protective factors for parent–child bond and children's mental health.

The Hierarchical Linear Model illustrated a downward trend of depression, alienation, and life-events in LBC, which was inconsistent with previous research which pointed out that the rate of youth depression was increasing year by year (49). The reason might be that, with the extension of left-behind duration,

TABLE 3 | Estimated results of the unconditional model.

Variables	Fixed effect	Coefficient	Standard error	T
Depression	Intercept B_0	39.13	0.28	138.76***
	Slope B_1	−0.23	0.07	−3.12**
	Random effect	Variance	d83	X^2
	Intercept γ_{00}	26.42	876	1410.24***
	Slope γ_{10}	0.83	876	1060.48***
Alienation toward parents	Fixed effect	Coefficient	Standard error	t
	Intercept B_{01}	31.73	0.45	70.79***
	Slope B_{11}	−0.24	0.12	−2.04*
	Random effect	Variance	d83	X^2
	Interceptγ_{01}	63.35	876	1391.44***
	Slope γ_{11}	2.05	876	1053.58***
Life–events	Fixed effect	Coefficient	Standard error	t
	Intercept B_{02}	29.94	0.73	40.96***
	Slope B_{12}	−0.86	0.17	−4.96***
	Random effect	Variance	d83	X^2
	Intercept γ_{02}	205.19	876	1556.61***
	Slope γ_{12}	2.17	876	955.26*

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

TABLE 4 | Estimated results of the full model.

Fixed effect	Coefficient	Standard error	t
Intertest Effect			
Intercept γ_{00}	39.25	1.32	29.72***
T0 Age γ_{01}	−0.43	0.25	−1.77
T0 Family atmosphere γ_{02}	1.69	0.52	3.27**
T0 Parenting styleγ_{03}	−0.67	0.21	−3.29**
T0 Alienation toward parents γ_{04}	1.85	0.33	5.58***
T0 Life–events γ_{05}	1.78	0.30	6.01***
Slope			
Time γ_{10}	−0.38	0.37	−1.02
T0 Age γ_{11}	0.15	0.07	2.13*
T0 Family atmosphere γ_{12}	−0.28	0.15	−1.87
T0 Parenting styleγ_{13}	0.09	0.06	1.52
T0 Alienation toward parents γ_{14}	0.09	0.09	1.00
T0 Life–events γ_{15}	0.20	0.09	2.29*
Random effect	Variance	d83	R^2
Intercept γ_{00}	12.49	871	1122.16***
Slope γ_{10}	0.75	871	1036.37***

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

the proportion of LBC who understand the hard work and dedication of migrated parents increases (50), which stimulates their motivation to repay their parents through positive efforts in turn (51). In addition, as the children grow up, peers play an increasingly important role for them. To some extent, friendship can fill in the emotional vacancy gap for left-behind children to meet their needs for warmth and support (52), and results in a decrease in alienation toward parents, life-event, and depression. Moreover, our results indicated that life-events positively and independently predicted the descendant rate of depression, which indicated that the more the life-events, the faster the decline in depression declines (42). The reason maybe those adolescents who are experiencing more life-events may improve their coping abilities faster, thereby enhancing their psychological resilience effectively (53), and result in faster decline in depression (54). Besides, the baseline alienation did not predict the decline of depression significantly. There may be some factors protecting against the effect of alienation toward parents on the development of depression in high-risk LBC, such as friendship (52). Thus, in preventing and lowering the occurrence of depression in LBC, the knowledge helps to shape a better understanding about the depression in a more comprehensive and objective way (55).

The correlation analysis showed that alienation toward parents, life-events, and depression were positively correlated with each other. Moreover, the HLM showed that there was a positive prediction of alienation toward parents and life-events at baseline on the developmental trajectory of later depression in LBC, consistent with our hypothesis. It has been well reported that the children exposed to high alienation toward parents were related to higher likelihood of depressive symptoms and diminished health-related quality of life (19, 22). Our previous investigations also confirmed the connection between alienation, life-events, and depression in LBC (17, 18). The current longitudinal investigation further revealed the prediction of alienation and life-events on the developmental trajectory of later depression in LBC. This knowledge helps to better prevent the development of depression in LBC by paying attention to parent-child relationship (especially alienation toward parents) and children's life-events.

Importantly, this study further confirmed that T3 life-events partially mediated the prediction of baseline alienation toward parents on T4 depression in LBC, which manifested that

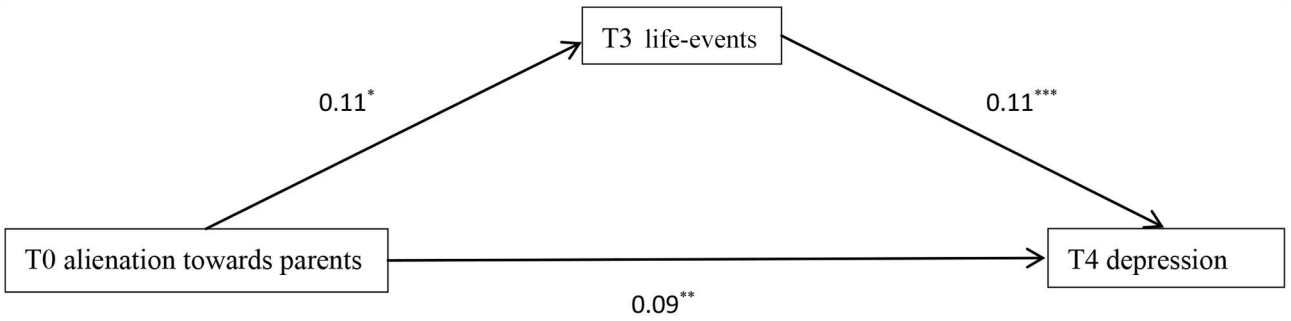

FIGURE 1 | Mediation of T3 life-events in the prediction of T0 alienation toward parents on T4 depression. $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

life-events were important "bridge" linking alienation toward parents to depression. As a well-reported vulnerability for depression (56), this study confirmed the role of negative life-events in the mediation between alienation toward parents and depression. The indirect effect of life-events also implied that high levels of alienation toward parents during the childhood might make people difficulty to cope with negative life-events well, which aggravated the development of depression. Depression is a common negative emotion which occurs when people feel unable to cope with persistent external pressure (7). The children with high levels of alienation toward parents exhibited high levels of depression in the context of negative life-events (29, 57). Due to the limited emotional communication and support from parents, the LBC might taste more negative feelings when they encountered negative life-events, which put them at higher risks for depression (12). Based on the previous correlation findings from a cross-sectional study (6), the current results added to the growing body of knowledge about the predictive effect of alienation toward parents on depression in LBC when exposed to life-events. One point that deserves to point out is that, when controlled for baseline depression, the mediation of life-events between alienation toward parents and later depression was only significant for T3 life-events between the effect of T2 alienation on T4 depression. The findings indicate a close relationship or a sort of co-variation between alienation and depression in LBC, the mediation of life-events only exists when alienation has a weaker effect on depression and other variables, such as life-events, have stronger impact. The results suggest that to prevent the development of depression of LBC effectively, children with high alienation toward parents should be attended, especially when they experienced negative life-events, as well as the necessity to improve the capacity of coping with life-events well in LBC.

LIMITATIONS

First, this study only used self-rating scales to evaluate the level of alienation toward parents, life-events, and depression, which may be subjected to self-report bias. Second, the participants came from three rural primary schools in Chongqing, China, so we should be very cautious to generate the results to other population. Third, some variables, such as friendship, may influence the development of depression in LBC, which was not included in this study, which might refrain the explaining power of our results. Fourth, when controlled for baseline depression, the mediation of life-events between alienation and depression only existed when alienation had a weaker effect on depression and other variables, such as life-events, had stronger impact, thus we should not assume that life-events mediate the prediction of alienation on depression all the time. However, the previous study only observed a connection between alienation toward parents and depression in LBC with cross-sectional design. With this longitudinal investigation, this study allowed us to explore the prediction of alienation on later depression, with a potential mediation of life-event.

In sum, this study is the first to suggest that alienation toward parents, although relatively overlooked in the existing literature, predicts the developmental trajectory of depression in LBC. Life-events partially mediate the prediction of alienation toward parents on later depression. These findings suggest that family and school may enhance the mental health of LBC by improving their parent–child relationship and offering more guidance to deal with life-events effectively. The government may reduce the numbers of LBC gradually by encouraging and guiding rural labors to make a successful living at hometown. In brief, the current findings provide reliable evidence for the prevention and intervention of depression in LBC.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article could be obtained from the corresponding author upon adequate requirement.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Human Research Ethics Committee, Army Medical University. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

XQ mainly wrote and revised the manuscript. XS revised the manuscript mainly for analysis. MZ, BC, FX, ZC, SS, CW, and XR collected the data together. QD designed the study. All authors contributed to the article and approved the submitted version.

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Event-Related Brain Potential Correlates of Event-Based Prospective Memory in Children With Learning Disability

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Prospective memory (PM) has been reported to be impaired in children with learning disabilities (LD), but few studies have examined the underlying neural mechanism of this impairment. To address this issue, the present study applied ERP technique to explore the difference of event-based prospective memory (EBPM) in 21 children with LD and 20 non-LD children with double task paradigm. Results from behavioral data showed that LD children exhibited lower accuracy than non-LD children. The ERP results showed that the two groups displayed significant difference in the ERP components, with longer N300 latency in LD group, but there was no obvious difference found in the prospective positivity component. The present findings seem to indicate that the poor performance of LD children on PM task might be result from deficits in PM cues detection. These results provided evidence for the existence of altered PM processing in LD children, which was characterized by a selective deficit in cues detection of PM. Therefore, these findings shed new light on the neurophysiological processes underlying PM in children with LD.

Keywords: children with learning disability, event-based prospective memory, event-related potentials, N300, prospective positivity

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INTRODUCTION

Many children have suffered problems in learning, with 17.9% of them including combined reading and mathematical disabilities (1). Learning disability (LD) is usually characterized by multiple cognitive weaknesses, probably resulting from neurobiological etiology and variations in brain development (2, 3). Specifically, previous studies have indicated that LD children showed deficits in some sorts of cognitive domains, involvement memory, attention, executive function and so on (4, 5). As an important aspect of episodic memory, prospective memory (PM) plays crucial role in the learning and daily life of LD children, but it is also reported being impaired among these children (6–8).

PM refers to the memory of carrying out preplanned events and activities at the appropriate situation or some future point in time (9, 10). For example, remembering to bring a pass before taking a school exam (event-based prospective memory, EBPM) or going to the hospital for making an appointment with the doctor at 5 pm (time-based prospective memory, TBPM). It's believed that the cognitive process of underlying PM performance includes four stages, namely

intention formation, intention maintenance, intention initiation and intention execution (11, 12). Cue identification and intention retrieval are two important components underlying the intention initiation stage of PM (13). Cue identification refers to the detection of clues needed to perform certain activities. Intention retrieval involves the recalling of what kind of intentional behavior should be implemented (13, 14). Modern cognitive neuroscience and clinical research had provided growing and important evidence for the study of the neural mechanism of PM, especially EBPM. Moreover, researches using event-related potentials (ERPs) have displayed that two ERP components, N300 and prospective positivity (PP), were differentially related to the cue identification and intention retrieval of PM in humans (15–17). N300 is a negative wave in the occipital-parietal region at 300–500 ms after the presentation of PM target cues, which reflects the individual's detection of PM target cues (18–21). N300 is very similar to N2 in duration and morphology. West (15) discussed the similarities and differences between N300 and N2 in study (15). They found that N300 only appears in prospective memory task and reflects the awareness of target cue in PM task. PP is widely distributed in the central, parietal and occipital regions at 400–1,200 ms after the appearance of PM target cues, associated with the process of intentional retrieval of PM (18, 19, 21, 22). PP are often confused with two other temporally distinct components of the ERPs. One is the detection of low probability targets (P3), the other is the recognition of PM cues (parietal old-new effect). Similarities of distribution and morphology in brain regions among the PP, P3 and recognition old-new effect lead one to wonder whether these are in fact the same components observed in different paradigms. However, evidence from a number of studies suggests that the P3 and parietal old-new effect can be distinguished from the PP (23–25). West and Krompinger (23) investigated the neural basis of PM, and found that the PP was only induced in the PM task, but not in the recognition task and the cue recall task. These evidences further confirmed that N300 and PP were two specific wave components of PM (26).

Some scholars have also carried out cognitive neuroscience and clinical research for special groups such as Schizophrenia patients, Attention Deficit children, Alzheimer's patients, Alcohol Dependency Syndrome patients, and Medial Temporal Lobe Epilepsy patients. These studies found that different PM impairment may be caused by different brain function damage and neurological deficits (27, 28). PM deficits in LD children have also been drawing rising attention over the past decade. A large number of studies have indicated that executive functions are assumed to be involved in PM (29–33). Usually, PM requires the integration of several complex processes, and successful PM requires a certain level of executive functioning ability, including updating, inhibition, shifting. Updating abilities maintain the intention of PM (34, 35). Shifting is mainly reflected in the ability to involve shifting between two tasks (ongoing and PM tasks) when PM cues appeared to be a key factor in the successful implementation of PM (35). Similarly, inhibition is necessary when a habitual dominant action must be inhibited and replaced by a new one (36). Therefore, impairments in these aspects of executive functioning may be relevant for failure of PM performance (37). Unfortunately, a substantial number of studies showed students with LDs have problems in executive function (38–42). Moreover, some studies have shown that PM is significantly related to LD. Compared to non-LD children, LD children may report more PM problems, or at least in some cases, the PM performance of LD children was far worse (6–8, 43). But up to now, only a few behavioral studies are focused on PM performance of LD children and some of them still have inconsistent results, including underlying factors of PM weak ability. Dong et al. (43) showed that the performance of LD children was as good as that of typical students in EBPM tasks but not as good as that of typical students in time-based PM tasks without reminders. Chen et al. (7, 8) found that high achieving students outperformed low achieving students in EBPM tasks. Zhang et al. (6) adopted a multinomial modeling approach to study the EBPM in LD children, indicating that prospective components in LD children were lower than control group, while no significant difference was observed in retrospective components.

Then, it can be seen that the characteristics of PM deficits in LD children is still unclear. Moreover, most of existing studies on LD children are explored from behavioral perspectives and little is known about the underlying cognitive and neural mechanisms of PM in LD children with ERP. Considering PM playing an important role in LD children's learning and normal life as well as addressing the knowledge gaps, in the current study we applied an event-based PM paradigm with ERPs to investigate PM abilities in LD children. Based on previous studies, we not only paid attention to behavioral measures, but also adopted ERP technique to study whether LD children would show different patterns during EBPM compared to non-LD controls and whether both PM cue detection (N300) and PM intention retrieval (PP) components may be impaired.

MATERIALS AND METHODS

Participants

The 21 children with LD (13 boys, age: 12.38 $\pm$ 0.56 years) and the 20 age-matched non-LD children (11 boys, age: 12.16 $\pm$ 0.62 years) were selected from one middle school (Grades 7–9) in Kaifeng, Henan province, China.

In the current study, we applied a rigorous method to screen the prospective participants. First, all the 538 students in the school were tested with Learning Adaptability Test (AAT) (44). The 68 students receiving level 2 or below on AAT scores were selected. Second, we invited the head teachers to fill in an adapted Chinese version of Pupil Rating Scale (PRS) for 68 students and screened the 53 students who received scores $<$65 as suspected LD children. Third, we collected students' mathematical and linguistical scores on their latest mid-term and final examinations. Based on the recommendations in the existing studies (45–47), the 22 students who scored $<$25th percentile in their grade level on these two disciplines were considered as LD children. Finally, one student with low IQ test result based on the Raven Standard Intelligence Test (SPM) (48) were excluded and 21 students were confirmed as the LD group.

All participants ($n = 21$) in the control group met the following eligibility criteria: (1) the SPM score was at the normal level; (2) the score of AAT was above the middle level; (3) the mathematical and linguistical scores in both the latest mid-term and final examinations were >25th percentile in their grade level; (4) matched on intelligence. The EEG data of one subject were deleted due to excessive artifacts, and eventually 20 students were confirmed as the control group.

Before enrolling in the study, all of the children were ensured with right-handed, no color-blindness, and with no previous psychiatric and neurological diseases or emotional disorders. All participants' parents signed written informed consents after they acquainted the procedures thoroughly.

Study Design

The experiment employed a mixed factorial design with between subjects factor of condition (LD vs. control group) and within-subjects factor of trial (PM vs. ongoing task).

Stimuli and Event-Based PM Paradigm

We adopted dual task paradigm used in the study of West et al. (49), the ongoing task involved a color discrimination task of phrases. On ongoing activity trials, two colored phrases were presented in the center of a computer screen. The participants' task was to decide whether two phrases were the same color. In the PM task, the participants were required to pause the ongoing task and switch to the PM task by pressing the appropriate button when the same two phrases in coding stages PM target cues which were appeared on the screen again.

The phrases were obtained on the basis of category naming experiments. In the category naming experiment, 27 categories familiar to the subjects were selected (50), and the subjects were asked to list 8 examples for each given category. The samples listed in the first 12 digits of the cumulative frequency were randomly selected from each category to form 648 pairs, which were divided into two groups of 324 pairs each. Half of the phrases were the same color, for example "Word1–Word2 (both words presented in blue)", the other half were of different colors, for example "Word1 (presented in orange)—Word2 (presented in purple). We used e-prime2.0 programming to ensure a rigorous experimental procedure.

There were 27 blocks each of which consisted of three stages (**Figure 1**). In the coding stage: two PM cue trails (each trial consisting of two phrases with the same semantics and color) were presented randomly for 2,000 ms followed by 1,000 ms of blank screen. Participants were asked to remember the two phrases, including their semantics and colors. In the distraction task stage: a three-digit number on the screen after the coding stage lasting 3,000 ms, participants were required to perform "minus three" task for a minute to avoid repeating items they had just learned. In the ongoing task stage each block contained 24 trials which were divided into 22 ongoing activity trails and 2 PM cues trails. Participants would press the "1" key if they judged that the colors of the two words were same and the "2" key if the colors of the two words were different without considering the semantics. However, participants were instructed to press the "0" key if they saw the previous PM target cues again as presented in coding stages on the screen. In each block, PM target cues occurred once in the first 11 trails and once in the last 11 trails. Before the formal experiment, participants are allowed to complete a practice block to ensure that they fully understood the whole experimental procedure. The present study was carried out in according with the guidelines approved by the Institutional Review Board of Henan Provincial Key Laboratory of Psychology and Behavior. All participants in this study gave written informed consent to participate in the experiment.

ERP Data Recording and Analysis

The ERP data were recorded from a 32-channel Ag/AgCI electrodes cap (Brain Products, Munich, Germany). The electrodes placed at standard locations were arranged according to the extended international 10–20 system. Brain Vision Analyzer 2.0 software (Brain Products, Munich, Germany) was used for off-line analysis. The mastoid of the left ear was used as the reference electrode. The ground electrode was the midpoint on the line connecting FCz and Fz. Electrodes were placed besides the eyes to record the HEOG, and above and below the right eye to record the VEOG. All inter-electrode impedance was maintained below 5 kΩ. The ERP data were recorded using a 0.01–100 Hz bandpass filter and continuously sampled at 500 Hz/channel for offline analysis. Data were first re-referenced to link the left and right mastoids for offline analysis. The low-pass offline filter was 50 Hz. Amplitudes over $\pm$ 100 μV were regarded as artifacts and were excluded. The ERP observation window were extracted between the 200 ms pre-stimulus and 1,000 ms post-stimulus time points. The baseline correction was performed in 200 ms pre-stimulus interval. Specifically, data accompanied by artifacts such as bad channels, eye blinks, and eye movements were excluded. The ERPs evoked by PM cue trials and ongoing activity trials were calculated by averaging individual artifact free trials in each participant. Finally, the grand-averaged ERPs were computed and averaged for correctly performed PM cue trials and correctly performed ongoing activity trials in each group.

Statistical Analysis

For behavioral data, mean accuracy and mean response time (RT) were analyzed for in each task type for PM and ongoing task of two groups. Measurement data were presented as (mean $\pm$ standard deviation), and the results showed that the data were normally distributed. Trials with incorrect response or response time faster than 100 ms or slower than 2,000 ms were eliminated. Repeated-measures ANOVAs with task type (PM vs. ongoing task) as a within-subject factor and group (LD vs. control group) as a between-subject factor were performed separately for the accuracy and RT.

With respect to the ERP data, only correct responses and RT in normal range to the stimuli were included in ERP analyses. Based on the previous ERP studies (16, 17), we analyzed mean amplitude of two ERP components related to PM, namely, N300 and PP, in different task conditions. Specifically, according to the relevant literature (51, 52), the peak amplitude and latency of N300 component (300–500 ms) over occipital region (electrodes:

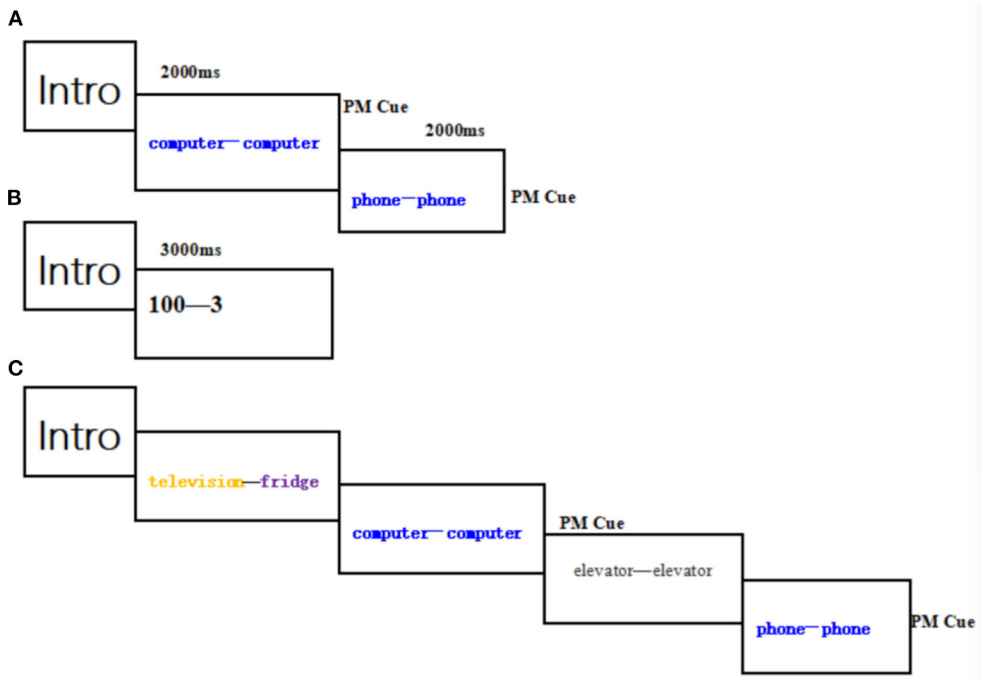

FIGURE 1 | Example block. each block consists of three stage: **(A)** coding stage; **(B)** distraction task stage; **(C)** ongoing task stage.

TABLE 1 | Mean accuracy and RT (M ± SD) of LD group and controls group.

	N	Ongoing task	PM	F_{GROUP} (*p*)	F_{TASK} (*p*)	$F_{TASK*GROUP}$ (*p*)
Accuracy						
LD Group	21	0.883 ± 0.104	0.625 ± 0.241	25.669 (0.000***)	19.112 (0.000***)	14.255 (0.007**)
Control Group	20	0.926 ± 0.072	0.888 ± 0.072			
Reaction time (ms)						
LD Group	21	1,092.002 ± 211.163	1,375.203 ± 212.265	8.872 (0.007**)	33.539 (0.000***)	0.631 (0.537)
Control Group	20	966.051 ± 192.815	1,165.054 ± 230.006			

$^{**}p < 0.01$, $^{***}p < 0.001$.

O1/Oz/O2) was quantified. The mean amplitude of PP (400–1,000 ms) was quantified at F3, F4, Fz, C3, Cz, C4, P3, Pz, P4. The peak amplitude and latency of N300 and mean amplitude of PP were conducted by using a two-way mixed ANOVA with task type (PM vs. ongoing task) as within-subject factor and group (LD group vs. control group) as the between-subject factor, respectively. For all the analyses in this study, $p < 0.05$ was considered to be statistically significant, and the *p*-values were adjusted using the Greenhouse-Geisser correction when appropriate.

RESULTS

Behavioral Performance

Accuracy

For the mean accuracy (see **Table 1**), there was a significant main effect of task type [$F_{(1,39)} = 19.112$, $p = 0.000$, $\eta_p^2 = 0.397$] with accuracy being significantly higher for ongoing activity trials than for PM cue trials. Meanwhile, there was a significant main effect of group [$F_{(1,39)} = 25.669$, $p = 0.000$, $\eta_p^2 = 0.338$], with the lower accuracy of LD group than that of control group. More importantly, we found a robust interaction between group and task type [$F_{(1,39)} = 14.255$, $p = 0.007$, $\eta_p^2 = 0.268$]. An analysis of simple effects showed that this interaction was driven by lower accuracy on PM cue trials in LD group compared with control group and lower accuracy ($p < 0.001$) for PM cue trials than ongoing activity trials in LD group ($p < 0.001$).

Reaction Time

For the mean RT (see **Table 1**), there was a significant main effect of group [$F_{(1,39)} = 8.872$, $p = 0.007$, $\eta_p^2 = 0.167$], indicating that LD children performed more slowly than control group. Moreover, there was also a significant main effect of task type [$F_{(1,39)} = 33.539$, $p = 0.000$, $\eta_p^2 = 0.475$], with response times being longer for PM cue trials than for ongoing activity trials.

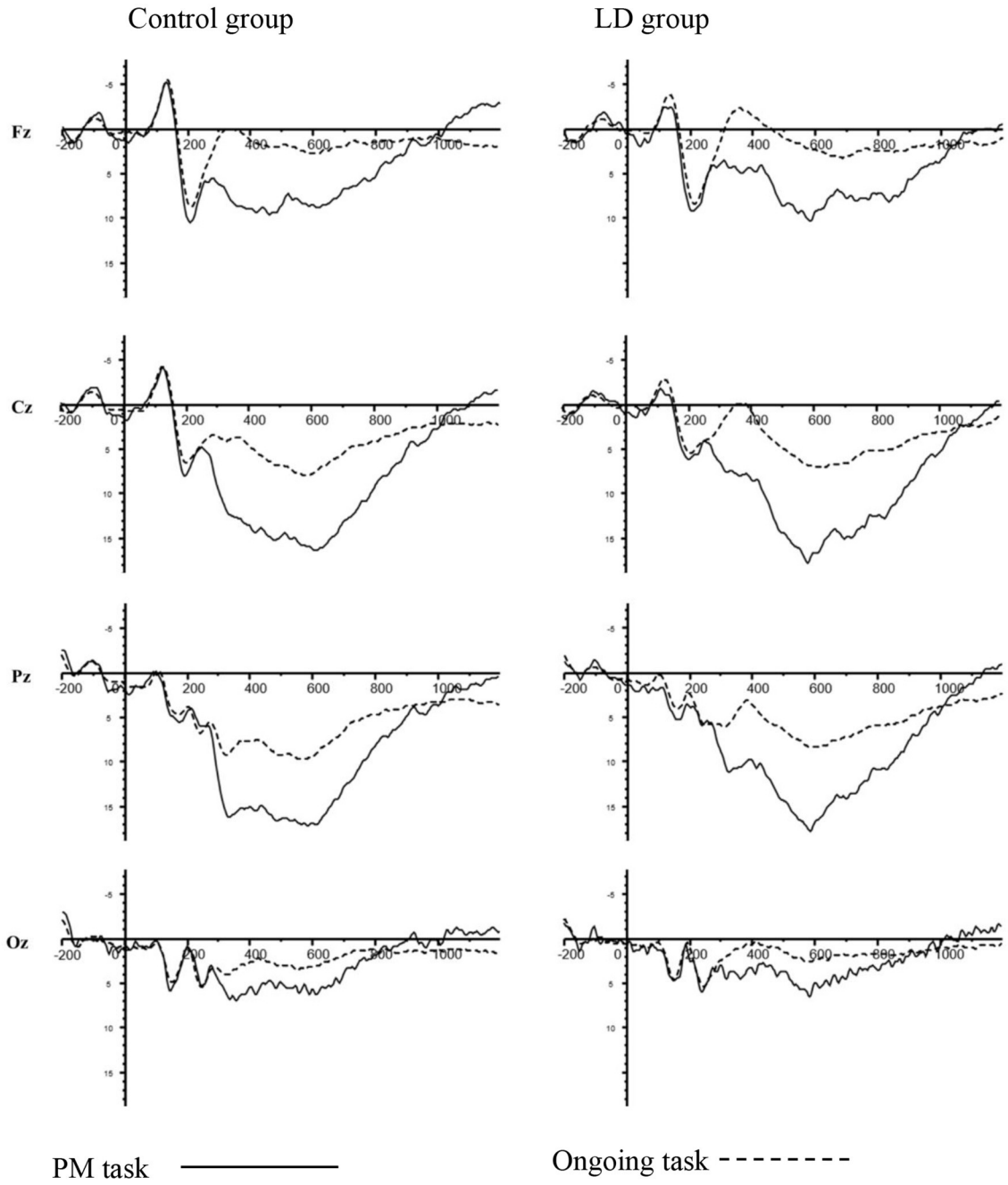

FIGURE 2 | N300 and PP for PM cue trials and ongoing activity trials in LD group and control group at Fz, Cz, Pz, and Oz electrodes.

However, the interaction between group and task type was not significant ($p > 0.05$).

ERP Results

Figure 2 showed the grand-averaged waveforms of children with LD group and control group. The mean (M) and standard deviation (SD) for each component were displayed in **Table 2**.

N300

For the peak amplitude of N300, there were no significant main effect of group ($p > 0.05$). Meanwhile, the interaction between group and task type was also not significant ($p > 0.05$).

For the latency of N300, there was a significant main effect of group [$F_{(1,39)} = 5.840$, $p < 0.05$, $\eta_p^2 = 0.130$], with the latency of N300 being longer in LD group than control group. More importantly, group × task type × electrodes interaction was

TABLE 2 | ERP components (M ± SD) for LD group and control group.

	N	Ongoing task	PM	F_{GROUP} (*p*)	F_{TASK}(*p*)	
N300 latency						$F_{TASK*GROUP*ELECTRODES}$ (*p*)
Total	41	244.433 ± 7.957	282.889 ± 11.114	5.840 (0.020*)	0.005 (0.094)	3.452 (0.04*)
LD group	21	279.873 ± 11.389	285.905 ± 10.616			
Control group	20	248.100 ± 14.954	240.767 ± 10.878			
PP amplitude						$F_{TASK*GROUP}$(*p*)
Total	41	7.963 ± 0.497	15.641 ± 0.630	3.150 (0.001**)	170.859 (0.000***)	8.000 (0.084)
LD group	21	7.933 ± 0.694	17.334 ± 0.902			
Control group	20	7.944 ± 0.711	13.949 ± 0.880			

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

significant [$F_{(1,39)} = 3.452$, $p < 0.05$, $\eta_p^2 = 0.081$]. An analysis of simple effects revealed that this interaction was due to the longer latency of the N300 for PM cue trials in LD group than control group at Oz ($p < 0.001$).

PP

Regarding the amplitude of PP, there was a significant main effect of group [$F_{(1,51)} = 3.150$, $p < 0.01$, $\eta_p^2 = 0.075$], with eliciting larger amplitude of PP in LD group than control. There was also a significant main effect of task type [$F_{(1,39)} = 170.859$, $p < 0.01$, $\eta_p^2 = 0.814$], with an enhanced PP for the PM cue trials than for ongoing activity trials. However, the interaction between group and task type was not significant ($p > 0.05$).

DISCUSSION

The present study investigated the ability to perform the EBPM task and the neural underpinning in LD children. At the behavioral level, LD children had significant lower accuracy on PM cue trials compared to the control group, indicating that LD group's poor performance may be associated with PM deficits, which replicated results from prior studies (6–8). From the perspective of PM, Chen (8) believed that in most cases LD children performed worse in PM owning to their weaker switching ability between two tasks (53). The completion of PM tasks required attention allocation, transfer and inhibition control (54), but LD children were significantly worse than control group in the aspects of central executive function (55, 56). Therefore, LD children indeed needed to distribute more attentional resources to accomplish PM task. Despite such evidence, the specific neural and cognitive mechanisms of EBPM in LD remain unclear. The ERP data may shed specific insights on it.

As to the ERP results of N300 related to the detection of PM cues, this study found longer N300 latency for PM cue trails in LD group. A number of existing studies suggest that the N300 is sensitive to cue detection of PM cue (15–17, 52). The findings might reflect the impairment in PM cue detection in LD group, indicating more cognitive resources were needed to identify an PM cue from tasks. This result is consistent with previous studies in EBPM of children with LD (6, 57, 58). The significant difference of prospective memory performance between special group and general group was mainly due to preparatory attention processing (prospective component), including LD Children, older people, moderate-to-severe traumatic brain injury and other groups with attention disorders. As mentioned in Mattli et al.'s (59) study, the unsuccessful of attentional strategy monitoring linked to frontally mediated processes of executive attention may lead to the failure of cue identification in PM of students. The physiological basis of prospective memory was related to the prefrontal lobe function, which was mainly responsible for intention-maintenance target monitoring in prospective memory tasks (60). However, LD children may have deficits in attention function of prefrontal lobe function (61–63). It was difficult for LD children to have enough attention resources to complete the preparatory attention processing. Therefore, LD children could not identify distinguish PM cues in time from the ongoing task.

Based on the evidence of the significantly larger activity for the PM cue trials than for ongoing activity trials across two groups, but the non-significant interaction between task type and group on the amplitude of PP, Meanwhile, for the amplitude of PP, we didn't find significant difference across groups in PM cues trails. This might indicate when LD children were able to pay attention to PM cue, and judge the current words as a prospective target, LD children seemed to have the ability to switch tasks between two tasks and retrieve a PM intention from memory. It seemed that LD children with poorer PM performance may not be caused by weak PM intention retrieval ability. Nevertheless, although other studies also had found the similar phenomenon (6, 58), successful PM intention retrievement requires a certain level of executive functioning ability, including shifting, inhibition (64–66). However, a substantial number of studies showed students with LDs had problems in executive function (38–42). Therefore, whether LD children were damaged in the PM intention retrieval was still a key aspect deserving further research. Additionally, PP in LD children showed dramatically larger in the whole tasks than that of control group, indicating that LD children need more cognitive resource in process of PM task and ongoing task and demonstrating cognitive deficit for LD children (67, 68). Taken together, these findings suggested that LD children had the impairment in processes associated with PM cues detection.

Furthermore, ERP results from PP showed larger activation for PM cue trials than ongoing activity trials in both two groups,

which was consistent with previous PM studies (15–17). The PP components demonstrated enhanced amplitudes in response to PM cue stimuli, which required a greater recruitment of cognitive resources (69, 70). To some extent, this observed results seemed to support and verified the theory of preparatory attentional processes, which suggested that PM task was a non-spontaneous process, and the monitoring and identification of target cues need to consume more attentional resources. Even if the target cue had not yet appeared, the participants still kept in a promptness state in order to retrieve the PM intention (57, 71).

PM control processing theory supported that in the process of PM, from intention formation to cue detection and intention extraction, it would occupy a large number of cognitive resources and required working memory, especially the participation of central executive system (72). Existing literatures have proved that executive function and PM have similar physiological mechanisms (34, 73, 74). Executive function at different level has different effects on PM (75–77). LD children who always fail to complete the PM task may be due to the deficiency of the central executive function, ultimately leading to poorer PM performance. At present, the predictive effects of executive function components on PM are still inconsistent, and the effects of executive function components on PM differ in term of age (73). Then, for LD children as a special group, which component of central executive function can better predict PM deserves further research.

CONCLUSION

The current study revealed that the major deficits in LD children during PM, with overall worse behavioral performance and longer latency of ERP component (N300). These findings might suggest the PM deficits in LD children characterized by a selective deficit in PM cues detection, not the absent of PM intention retrieval. Future research is needed to further confirm these results and to explore the biochemical mechanisms underlying these results.

DATA AVAILABILITY STATEMENT

The datasets presented in this article are not readily available because the data involving special minority participants must be kept confidential. Requests to access the datasets should be directed to JZ, jfzhao63@hotmail.com.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Institutional Review Board at the Henan University in China (IRB 00007212). Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

LJ and JZ designed the study and drafted the manuscript. LJ, YZ, and JW performed the study. JZ, QZ, and YY analyzed the data and editing of the paper. JZ revised the paper. All authors contributed to the article and approved the submitted version.

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Does HIV-Related Stigma Depress Social Well-Being of Youths Affected by Parental HIV/AIDS?

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Parental illness or death due to HIV/AIDS has long-term impacts on children's social well-being, potentially challenging the children's basic developmental needs and future. Based on the theoretical model of social well-being, the present study tested a moderated mediation model that HIV-related stigma moderated the mediating role of social trust on the relationship between perceived social support (PSS) and social well-being. A sample of 297 youths aged 20–30 years affected by parental HIV/AIDS (57.2% male), including 129 (43.40%) AIDS orphans and 168 vulnerable youths (56.60%) completed questionnaires of perceived social support, social well-being, social trust, and HIV-related stigma. IBM SPSS 25.0 was used to conduct descriptive statistics and multiple regressions. Results showed that the mean score of PSS was 61.34 (SD = 13.99), social well-being was 57.33 (SD = 10.15), social trust was 56.21 (SD = 11.55), perceived stigma was 64.44 (SD = 16.72), and enacted stigma was 21.91 (SD = 9.73) among youths affected by parental HIV/AIDS and the PSS could predict increasing social well-being via increasing social trust. Moreover, the positive influence of PSS on social trust was moderated by the enacted stigma (p = 0.03), in which the positive influence was stronger among youths affected by parental HIV/AIDS who perceived or experienced low enacted stigma than those who perceived or experienced high enacted stigma. The positive impact of social trust on social well-being was moderated by perceived stigma (p = 0.04), in which the positive impact was more significant among youths affected by parental HIV/AIDS who perceived or experienced high perceived stigma than those who perceived or experienced low perceived stigma. These findings explained how and when the PSS affected social well-being and contributed toward an understanding of the experiences and perceptions of HIV-related stigma among youths affected by parental HIV/AIDS. This understanding may inform future research and policies toward improving the social well-being of youths affected by parental HIV/AIDS. The study also highlighted the importance of strengthening interventions on social relations and reducing HIV-related stigma for them.

Keywords: perceived social support, social trust, social well-being, perceived stigma, enacted stigma, youths affected by parental HIV/AIDS, moderated mediation effect

Abbreviations: PSS, perceived social support; PSSS, perceived social support scale; SWB, social well-being; PLWHA, people living with HIV/AIDS.

INTRODUCTION

HIV/AIDS has been identified as a serious global public health concern. In 2020, around 37.7 million people were living with HIV/AIDS globally, of which China had about 1.053 million people, and 351,000 cumulative reported deaths (1, 2). Despite China has carried out a series of interventions (2), the HIV/AIDS epidemic has had a detrimental effect on people living with HIV/AIDS and their family members, including children and youths. Youths (aged 20–30) affected by parental HIV/AIDS, including youths who lost one or both of their parents to HIV/AIDS ("AIDS orphans") and youths who are living with HIV-infected parents ("Vulnerable children") (3, 4). Previous research has focused on the effects of risk factors on the negative psychosocial adjustment (depressive symptoms, problem behaviors, etc.) of children affected by parental AIDS, including loneliness (5), childhood adversity (6), peer victimization (7), HIV-related stigma (8, 9) and their interactive effects (10), etc. Therefore, based on the Chinese government's policy of caring for vulnerable groups, as well as the support and intervention of previous researchers and social institutions (11), the existing social support and the positive psychology context, how to promote their positive psychosocial adjustment function is the focus of our research. Li et al. (12) reported a developmental psychopathology framework of the psychosocial need of children orphaned by HIV and demonstrated the interaction of risk and protective factors on social well-being and the dynamics of individual and environment interactions over time. Wang et al. (13) discovered that perceived social support (PSS) and trust relationships were the most proximate protective factors, and traumatic events and HIV-related stigma were a double burden for AIDS orphans. Therefore, based on a psychological adjustment development research framework and a positive psychology perspective, this study integrates the effects of risk (HIV-related stigma) and protective factors (PSS and social trust) on the positive psychosocial adjustment of youth affected by parental HIV/AIDS.

Social well-being is the self-judgment and evaluation of the relationship between oneself and others, the collective and society (14). As a "double vulnerable group," youths affected by parental HIV/AIDS face more isolation, poverty, difficult living situations, educational disruption, HIV-related stigma, maltreatment, and hostility from families or communities than the general population (15, 16). PSS has proved to be a "buffer" against these setbacks (17). PSS refers to an individual perceptions of the general availability and quality of social support available to them, and the emotional experience generated by expectation, evaluation, and belief of social support (18, 19). The PSS is a potential protective factor for people to buffer against traumatic events and improve social well-being (10, 20). In rural China, Shan et al. (21) discovered the positive effect of PSS on psychological adjustment among children affected by parental HIV/AIDS. Hong et al. (22) found the level of PSS was significantly and positively associated with psychosocial well-being. PSS and social well-being were found to have a significantly positive relationship in adolescent studies (23, 24). Most evidence data showed that levels of PSS were the most important contributor to one's emotional health (25). Zhao et al. (26) demonstrated a strong association between PSS and psychosocial outcomes, emphasizing the importance of adequate social support in alleviating stressful life events and improving the psychosocial well-being of children affected by HIV/AIDS in China. Based on these researches, the PSS may be an antecedent of well-being, and its availability is thought to be causal to social well-being (27). Consequently, youths affected by parental HIV/AIDS with high levels of PSS may have higher levels of social well-being.

According to the theoretical model of social well-being (14), relationships among individuals, society, and community (Social Integration) may affect social well-being by influencing whether people trust others positively (Social Acceptance). In other words, increasing PSS may increase social well-being by boosting social trust in the social environment's security and the others' credibility. Social trust refers to the connection network between individuals and society and the resulting norms of reciprocity and credibility (28). Wang et al. (13) found PSS impacted the trust relationships with caregivers, which in turn affected social well-being, and the trust relationships appeared to be the most proximate protective factor for social well-being among children affected by HIV/AIDS in rural China. Many studies on relevant variables provide evidence for the relationship between them. Mohanty et al. (29) found that support from the targeted community could help nurses build personal and social connections and enhance trust in the community. Strang et al. (30) found the support of families and communities was conducive to improving the trust of those becoming homeless by the conflict. Therefore, when youths affected by parental HIV/AIDS perceive more social support, they tend to have more social trust (31). The social trust may also positively predict the youths' social well-being (32). Tokuda et al. (33), using a sample of Asian countries, found that residents of countries with a high level of social trust were happier than those with low social trust. The research in China also strongly suggested that social trust positively predicted well-being (34). In addition, "warm glow theories" pointed out that high-trust individuals were more likely to obtain additional happiness through the warm light given, indicating that higher social trust may bring better social well-being (35).

The risk factor of HIV-related stigma refers to the prejudice, discounting, and discrediting directed at people living with HIV/AIDS (PLWHA) and the groups and communities with which they are associated (36). HIV-related stigma may moderate the relationship between PSS and social trust for several reasons. The first is the appraisal and coping to the stress of HIV-related stigma, individuals who perceived or experienced high HIV-related stigma are more likely to be stressed and to have a negative appraisal and coping (37). The second reason is that HIV-related stigma makes youths affected by parental HIV/AIDS frequently feel deprived of their basic rights and social support. The unfavorable discrepancy between "value expectations (wanting)" and "value capabilities (deserving)" may decrease the effect of PSS on their social trust (38). Therefore, compared to youths affected

by parental HIV/AIDS who perceived or experienced high HIV-related stigma, the effect of PSS on social trust may be stronger in those who perceived or experienced low HIV-related stigma.

At the same time, HIV-related stigma may also play a moderate role in the relationship between social trust and social well-being, but the specific moderation effect is debated. For one thing, factors in the microsystem (e.g., the stigma environment of schools and community) and macrosystem (e.g., social environment, social trust) interact to shape the developmental outcomes among youths affected by parental HIV/AIDS (39, 40). Chi et al. (8) discovered that HIV-related stigma negatively predicted healthy outcomes with considerable stability over time. Therefore, the higher HIV-related stigma to which youths affected by parental HIV/AIDS are exposed, the more likely they are to develop unhealthy outcomes, reducing the impact of social trust on social well-being. For another, different levels of social trust have a unique impact on social well-being among youths who perceived or experienced high HIV-related stigma (41). Yamamura's et al. (42) research showed that the impact of social trust on well-being could be enhanced in natural disasters, and the enhancement effect was stronger for residents in disaster-affected areas. Studies also suggested that the uncontrollable impact in life would be alleviated with the positive impact of social trust on well-being (34). In other words, for youths who perceived or experienced high HIV-related stigma, the positive impact of social trust on social well-being may be stronger than those who perceived or experienced low HIV-related stigma. The above two inconsistent views have not been well studied in youths affected by parental HIV/AIDS yet.

To summarize, the current study aimed to explore the relationship between PSS and social well-being of youths affected by parental HIV/AIDS, as well as the mediation effect of social trust and the moderation effect of HIV-related stigma. These aims constructed a moderated mediation model that would address how the PSS affects social well-being through social trust among youths affected by parental HIV/AIDS and when is this association most potent? (**Figure 1**). Based on the theoretical model of social well-being, developmental psychopathology framework of the psychosocial need, and related empirical researches, the following three hypotheses were proposed:

H1: PSS would positively predict the social well-being of youths affected by parental HIV/AIDS.
H2: Social trust would mediate the association between PSS and social well-being among youths affected by parental HIV/AIDS.
H3: HIV-related stigma would moderate the mediation model.

MATERIALS AND METHODS

Participants

The participants were from a larger research project on the psychological adjustment of children affected by HIV, which enrolled a total of 1,625 children and adolescents aged 6–18 years in rural China, where many residents were infected with HIV in the 1990s as a result of unhygienic blood collection practices (43). We re-contacted 331 of the participants (youths affected by parental HIV/AIDS) in the prior study through local schools and the government-funded AIDS orphanages and invited them to participate in the current study. This study focuses on youths (20–30 years old) who were in the critical developmental stage of their lifetime, including those who lost one or both of their parents to HIV/AIDS and those who are living with HIV-infected parents. Youths with HIV infection were eligible to participate.

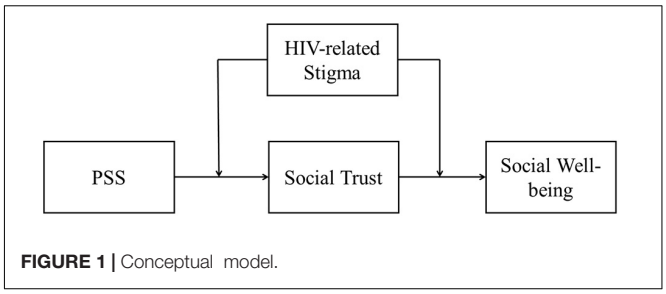

FIGURE 1 | Conceptual model.

Procedures

Data in the current study were collected in 2021 via a questionnaire survey. A mixed-method approach (online and paper-based) was employed in our survey research. We sent an informed consent and online link to the participants who worked or went to school in other places and encouraged them to participate. Because of the popularity of the internet and smartphones in China, most youths are using WeChat and Message to communicate. Therefore, an online questionnaire was distributed through WeChat and Message. After signing the consent form and reading the requirements, participants were asked to complete a comprehensive questionnaire to collect demographic information, perceived social support, perceived stigma, enacted stigma, social trust, and social well-being in order. To avoid missing data, all questions were set as required and there was no option like "not to prefer to respond" or "I do not know." Besides, the paper-based version consistent with the online survey was mainly collected from participants who worked locally and volunteered to participate in the survey. All the participants were free to withdraw from the study at any time. There was a structured data confidentiality process in place to ensure the privacy and confidentiality of the survey. Each participant received a compensation of 50 ¥ after the survey. Among the 331 youths, 274 completed the survey online, and the response time of 12 youths was fewer than 700 s. Additional 57 participants completed a paper questionnaire, and 22 youths failed to complete the survey fully. The final sample included 297 youths (57.2% male) and the response rate was 89.7%. The research protocol, including consenting procedure, was approved by the Institutional Review Board at Henan University in China.

Measures

Demographic Characteristics

Youths were asked to report on individual characteristics during the survey. These characteristics include gender, age, ethnicity,

parental status (i.e., lost one or both of their parents, living with HIV-affected parents, other), work status (i.e., farming, in college, odd jobs, permanent jobs, government employees, public institution employees), current residence (i.e., countryside, town, small-medium cities, big cities), and health status (i.e., very good, good, fair, poor, very poor).

Perceived Social Support Scale

The perceived social support scale (PSSS) was adapted from the Multi-dimensional Scale of Perceived Social Support (MSPSS) (44). The Chinese version of the perceived social support was translated and independently back-translated from English to Chinese by Hong et al. (22). Considering the developmental stages of the participants, the parallel subscale of teacher support was removed. The modified version measures perceived social support (PSS) from three sources: family, friends, and significant others, and consists of 12 items rated on a 7-point Likert scale (from 1 = very strongly disagree to 7 = very strongly agree). The sample questions include "My family really tries to help me," "I can count on my friends when things go wrong," and "I have a special person who is a real source of comfort to me." A total score was employed as a composite score for the PSSS with a higher score indicating a higher level of perceived social support. Zimet et al. (44) reported the scale has good internal and test-retest reliability as well as moderate construct validity, which has been validated in children and adolescents affected by parental HIV/AIDS (10, 22). The Cronbach's alpha of the 12-item scale was 0.94 for this study.

Social Well-Being

The Social Well-being Scale (SWB) was revised by Yuanjiang and Qinghua (45) according to the social well-being scale of the Midlife Development in the United States, MIDUS (46). The modified version measures social well-being from five sources: social actualization, social coherence, social integration, social acceptance, and social contribution, and consists of 15 items rated on a 5-point Likert scale (from 1 = very inconsistent to 5 = very consistent). The sample questions include "The world is becoming a better place for everyone," "I feel close to other people in my community," and "My community is a source of comfort." The total score of the scale was used with a higher score indicating a higher level of social well-being. Yuanjiang and Qinghua (45) and Keyes and Shapiro (46) reported the scale has good internal and test-retest reliability as well as moderate construct validity, which has been validated in China (45, 47). The Cronbach's alpha of the 15-item scale was 0.93 for this study.

Social Trust

The Social Trust Questionnaire (STQ) was developed by Wanqing (48). The STQ measures social trust from four sources: authoritarian trust, interpersonal perception, market trust, and media identification, and consists of 17 items rated on a 5-point Likert scale (from 1 = strongly disagree to 5 = strongly agree). The sample questions include "Supermarkets (or stores) will not sell expired goods" and "More and more people keep their promises in society." The total score of the scale was used with a higher score indicating a higher level of social trust. Wanqing (48) reported the fitting indicators were good and the internal consistency of the official scale is 0.853. All of these indicate that the self-developed social trust scale for adolescents has good reliability and validity and can be used as a tool to measure the social trust of young people. The Cronbach's alpha of the 17-item scale was 0.92 for this study.

HIV-Related Stigma

Perceived Stigma

Perceived stigma was assessed with a 30-item scale (3, 16). This scale included three subscales. The first subscale assessed the youths' perceptions of public stigma against HIV/AIDS patients and their living environment. Youths were asked to indicate that in their opinion how many people in the community/society would have certain stigmatizing attitudes toward HIV/AIDS patients and their families. The sample questions include "People will think someone with HIV is unclean" and "People will look down at someone who has HIV/AIDS." The second subscale assessed the youths' perceptions of public stigma against HIV/AIDS patients. Youths were asked to indicate in their opinion whether they agreed with some attitudes toward HIV/AIDS patients in society. The sample questions include "AIDS patients should be ashamed of themselves" and "AIDS patients should be isolated." The third subscale assessed the youths' perceptions of public stigma against youths affected by parental HIV/AIDS. Youths were asked to indicate that in their opinion how many people in the community/society would have certain stigmatizing attitudes toward them. The sample questions include "People think youths affected by parental HIV/AIDS should leave their villages" and "People think youths affected by parental HIV/AIDS are unclean." All items were reverse-scored when appropriate to have higher total scores suggesting higher levels of perceived stigma. Zhao et al. (16) reported the scale demonstrated good content validity, which has been validated in children and adolescents affected by parental HIV/AIDS (3, 9, 16). The Cronbach's alpha of the 30-item scale was 0.94 for this study.

Enacted Stigma

Enacted stigma consists of 14 items rated on a 5-point Likert scale (from 1 = never happened to 5 = always happened) (16), youths affected by parental HIV/AIDS were asked to indicate whether they had experienced any stigmatized actions after a parental HIV infection. Sample items included "Being beaten by others" and "Being called bad names." The total score of the scales with a higher score indicates a higher level of enacted stigma. Previous studies reported the scale demonstrated good content validity, which has been validated in children and adolescents affected by parental HIV/AIDS (3, 9, 10, 16). The Cronbach's alpha of the 14-item scale was 0.95 for this study.

Statistical Analysis

Data were analyzed with IBM SPSS Statistics (Version 25) in four steps. First, descriptive statistics were employed to display demographic characteristics of the sample. Measurement data were presented as (mean ± standard deviation), and the results showed that the data were normally distributed.

Second, the degree of common method deviations in the data was tested using the Harman one-factor model method. Third, the bivariate correlations among key study variables were measured with Pearson's correlation coefficient. Fourth, the present study conducted multiple regressions using PROCESS Marco (Model 59) to analyze the moderated mediation effect. Before regression analyses, all variables except gender were standardized. In regression Model 1, PSS, enacted stigma, and the interaction of PSS and enacted stigma were predictor variables, social trust was outcome variable; In regression Model 2, PSS, perceived stigma, and the interaction of PSS and perceived stigma were predictor variables, social trust was outcome variable; In regression Model 3, PSS, social trust, enacted stigma, and the interaction of social trust and enacted stigma were predictor variables, social well-being was outcome variable; In regression Model 4, PSS, social trust, perceived stigma, and the interaction of social trust and perceived stigma were predictor variables, social well-being was outcome variable. Gender and age were the control variable in all regression models. A simple slopes analysis was also carried out in the PROCESS Macro to examine the nature of these moderating effects.

RESULTS

Sample Characteristics

Table 1 outlines demographic characteristics of the 297 participants (57.2% male) including group, gender, age, work status, current residence, and health status. The participants included 43.40% (n = 129) orphans and 56.60% (n = 168) vulnerable youths. The mean age of the sample was 25.80 years (SD = 3.14), with a range from 22 to 29 years. About 45.8% of youths lived in the countryside, 46.4% have relatively stable jobs (37.4% permanent jobs, 1.3% government employees, and 7.7% public institution employees) and 84.20% have very good (61.30%) or good (22.9%) good health status.

TABLE 1 | Background characteristics of the HIV-affected youths (N = 297).

Characteristics	*n*	%
Group		
AIDS orphans	129	43.40
Vulnerable youths	168	56.60
Gender		
Male	170	57.20
Female	127	42.80
Age ($M \pm SD$)	25.80 ± 3.14	
Work status		
Farming	48	16.20
In College	43	14.50
Odd jobs	68	22.90
Permanent jobs	111	37.40
Government employees	4	1.30
Public institution employees	23	7.70
Current residence		
Countryside	136	45.80
Town (county seat and below)	50	16.80
Small-medium cities	57	19.20
Big cities	54	18.20
Health status		
Very good	182	61.30
Good	68	22.90
Fair	37	12.50
Poor	9	3.00
Very poor	1	0.30

AIDS orphans, orphans who lost one or both of their parents to AIDS; Vulnerable youths, youths who were living with HIV-infected parents.

Testing of Common Method Deviations

The data collected in this study were collected from the self-reports of the respondents, and thus common method deviations may exist. Statistically, the results showed that there were 15 factors with eigenvalues greater than one, and the first factor explained only 23.85% of the variance, which was much less than the critical value of 40%, indicating that there were no serious homoscedasticity deviations for each variable in this study.

Preliminary Analyses: Correlation

The mean, standard deviation, and Pearson correlation coefficient for each variable were presented in **Table 2**. The results showed that the perceived social support (PSS) was significantly positively correlated with social well-being (r = 0.43, $p < 0.001$) and social trust (r = 0.46, $p < 0.001$), and significantly negatively correlated with perceived stigma (r = −0.37, $p < 0.001$) and enacted stigma (r = −0.29, $p < 0.001$). Social well-being was significantly positively correlated with social trust (r = 0.67, $p < 0.001$), and significantly negatively correlated with perceived stigma (r = −0.28, $p < 0.001$). Social trust was significantly negatively correlated with perceived stigma (r = −0.34, $p < 0.001$) and enacted stigma (r = −0.24, $p < 0.001$). The perceived stigma was significantly positively correlated with enacted stigma (r = 0.30, $p < 0.001$).

Testing for Moderated Mediation Effect

All predictor variables were standardized in each equation, controlling for key demographic variables such as age and gender. As shown in **Table 3**, PSS significantly positively predicted social well-being (β = 0.19, $p < 0.001$) and social trust (β = 0.43, $p < 0.001$). Social trust positively predicted social well-being (β = 0.60, $p < 0.001$). Besides, the interaction terms of PSS and enacted stigma were also significant in predicting social trust (β = −0.11, p = 0.03), but the interaction terms of social trust and enacted stigma were not significant in predicting social well-being (β = 0.03, p = 0.50). To reveal how the interaction terms of PSS and enacted stigma predicted the social trust, we grouped high and low according to the score of enacted stigma and plotted the interaction as shown in **Figure 2**. The simple slope test (simple slope test) showed that when the level of enacted stigma was low (−1 SD), the degree of PSS on social trust showed a more obvious upward trend ($bsimple$ = 0.54, t = 7.12, $p < 0.001$). When the level of enacted stigma was high (+1 SD), the degree of PSS on social trust showed an upward trend with signs of leveling off

TABLE 2 | Means, standard deviations, and correlations of variables (N = 297).

	M	*SD*	1	2	3	4	5	6
1. .Gender[a]	–	–	1					
2. .Age	25.80	3.14	−0.04	1				
3. .PSS[b]	61.34	13.99	0.00	0.11	1			
4. Social well-being	57.33	10.15	−0.01	0.11	0.43***	1		
5. .Social trust	56.21	11.55	−0.06	0.02	0.46***	0.67***	1	
6. .Perceived stigma	64.44	16.72	−0.08	0.04	−0.37***	−0.28***	−0.34***	1
7. .Enacted stigma	21.91	9.73	−0.08	−0.06	−0.29***	−0.08	−0.24***	0.3***

[a]*0, boys; 1, girls.* [b]*PSS, perceived social support.*
****p < 0.001.*

TABLE 3 | Moderated mediation effects test for HIV-related stigma.

Regression equation (n = 297)			Overall fitting index		Significance of regression coefficient		
Outcome variable		Predictor variable	R^2	F	β	t	95% CI
Model 1	Social trust	PSS	0.24	18.49***	0.43	8.03***	[0.33,0.54]
		Enacted stigma			−0.16	−2.93**	[−0.27, −0.05]
		PSS × Enacted stigma			−0.11	−2.17*	[−0.20, −0.01]
		Gender			−0.14	−1.33	[−0.34, 0.07]
		Age			−0.01	−0.58	[−0.04, 0.02]
Model 2	Social trust	PSS	0.25	19.84***	0.38	7.00***	[0.28, 0.49]
		Perceived stigma			−0.21	−3.75***	[−0.31, −0.10]
		PSS × Perceived stigma			−0.08	−1.54	[−0.17, 0.02]
		Gender			−0.16	−1.60	[−0.37, 0.04]
		Age			−0.01	−0.37	[−0.04, 0.03]
Model 3	Social well-being	PSS	0.49	40.06***	0.19	3.83***	[0.09, 0.29]
		Social trust			0.60	12.15***	[0.50, 0.70]
		Enacted stigma			0.10	2.07*	[0.00, 0.19]
		Social trust × Enacted stigma			0.03	0.67	[−0.05, 0.11]
		Gender			0.10	1.22	[−0.06, 0.27]
		Age			0.03	1.98*	[0.00, 0.05]
Model 4	Social well-being	PSS	0.48	38.07***	0.14	2.76**	[0.04, 0.24]
		Social trust			0.58	11.83***	[0.49, 0.68]
		Perceived stigma			−0.06	−1.22	[−0.15, 0.04]
		Social trust × Perceived stigma			0.10	2.04*	[0.00, 0.19]
		Gender			0.06	0.74	[−0.11, 0.23]
		Age			0.03	1.93	[−0.00, 0.05]

**p < 0.05, **p < 0.01, ***p < 0.001. PSS, perceived social support.*

(*bsimple* = 0.33, t = 4.66, $p < 0.001$). Thus, the positive influence of PSS on social trust was moderated by the enacted stigma.

The same procedure was used to test the effect of perceived stigma. As shown in **Table 3**, PSS significantly positively predicted social well-being (β = 0.14, p = 0.01) and social trust (β = 0.38, $p < 0.001$). Social trust positively predicted social well-being (β = 0.58, $p < 0.001$). The interaction terms of social trust and perceived stigma were also significant in predicting social well-being (β = 0.10, p = 0.04), while the interaction terms of PSS and perceived stigma were not significant in predicting social trust (β = −0.08, p = 0.12). To reveal how the interaction terms of social trust and perceived stigma predicted social well-being, we grouped high and low according to the score of perceived stigma and plotted the interaction as shown in **Figure 3**. The simple slope test (simple slope test) showed that when the level of perceived stigma was high (+1 SD), the degree of social trust in social well-being showed a more obvious upward trend (*bsimple* = 0.68, t = 10.12, $p < 0.001$). When the level of perceived stigma was low (–1 SD), the degree of social trust on social well-being showed an upward trend with signs of leveling off (*bsimple* = 0.49, t = 6.97, $p < 0.001$). Thus, perceived stigma could play a moderated role in the positive effect of social trust on social well-being.

DISCUSSION

This study found that perceived social support (PSS) could significantly predict social well-being among youths affected by

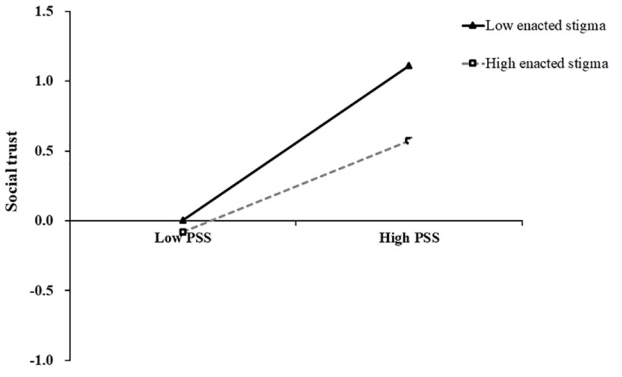

FIGURE 2 | The moderating effect of enacted stigma on the relationship between PSS and social trust.

parental HIV/AIDS, the result was consistent with previous research findings (26, 49) and confirmed the hypothesis of H1. Researchers believed the social support "buffered" (protected) youths affected by parental HIV/AIDS from the potentially pathogenic influence of stressful events and could provide a positive effect, recognition of self-worth, and the ability to integrate social networks (50). Youths who have high levels of PSS are more likely to integrate social networks (51). They may maintain external social support and strengthen protective factors against negative social challenges, implying they may integrate more support from society (51, 52). Nyoni et al. (49) found that PSS and family cohesion protected the psychological well-being of youths affected by parental HIV/AIDS, implying youths who have high levels of PSS may maintain more support from family and relatives. Studies also showed that youths who have more friends' or colleagues' support may develop physical function, social function, and cognitive function well, and improve their social well-being, implying people who have high levels of PSS may maintain more support from friends or colleagues (53, 54). Therefore, the youths affected by parental HIV/AIDS who have high levels of PSS may transform the external social support into the internal resources to deal with life events and have a high level of social well-being.

Consistent with hypothesis H2, the results showed that social trust played a mediating role between PSS and social well-being, which was consistent with the previous research results (35) and verified again that trusting relationships were the most proximate protective factor for social well-being (13). For the first stage, PSS may affect the cognitive evaluation of environmental adaptability of youths affected by parental HIV/AIDS. Individuals with high levels of PSS have a strong sense of belonging, obligation, care, respect, and intimacy (55, 56). The sense of social belonging means being accepted and tolerated by other group members (57) and means having a better relationship with group members. The better the relationship between individuals and society, the higher the level of social trust (46). In the second stage, social trust is related to beneficial interpersonal relationships and social care, which plays a positive role in promoting social well-being (58). Research has found that individuals with high levels of trust will have higher social cohesion and well-being in society (59). Carattini and Roesti (35) also pointed out that people who have high levels of social trust were more likely to feel the warm light given, realize their value, and feel more well-being. As far as this study is concerned, the PSS significantly increases social well-being via increasing social trust among youths affected by parental HIV/AIDS.

In line with our hypothesis H3, the results showed that different types of HIV-related stigma (perceived stigma and enacted stigma) had different moderated effects on the mediatory model, it found new different pathways of perceived stigma and enacted stigma influenced social well-being of youths. Specifically, enacted stigma moderated the relationship between PSS and social trust. This study found that the effects of PSS on social trust were stronger among youths who perceived or experienced low enacted stigma than those who perceived or experienced high enacted stigma. The result was consistent with the developmental psychopathology framework of psychosocial need (12). Individual risk factors (enacted

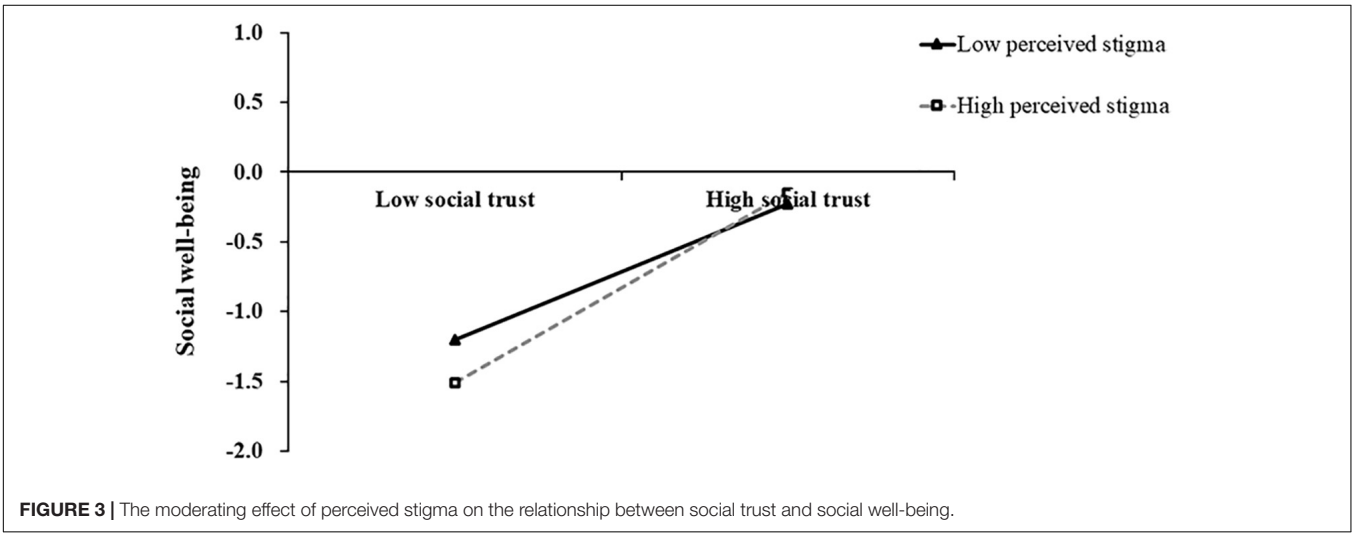

FIGURE 3 | The moderating effect of perceived stigma on the relationship between social trust and social well-being.

stigma) will weaken the beneficial impact of PSS on social trust (60, 61). The more personal risk factors (enacted stigma) happened to youths affected by parental HIV/AIDS, the more they feel that they aren't protected or accepted in interaction with the social environment, and the more difficult for them to establish trusting interpersonal relationships with others. Researchers suggest that the brain expects to establish harmonious social relations including mutual trust and interdependence. If these expectations are not met, the brain will perceive less positive resources and more stress, and increase more negative attitudes toward the external environment (62, 63). Youths who perceived or experienced more enacted stigma are more likely to have a negative attitude toward the external environment. Therefore, when the level of enacted stigma is high, the beneficial impact of PSS on social trust will be significantly reduced.

In addition, perceived stigma moderated the relationship between social trust and social well-being. Our data showed that the positive predictive effect of social trust on social well-being was stronger in youths who perceived more stigma. In specific, the development disadvantages of those who perceived high stigma are more reflected in the situation of low social trust. Increasing social trust may benefit those who perceived high stigma (60), which was inconsistent with the negative impact of perceived stigma among children affected by parental HIV/AIDS (9). The result supported that the children's perceived stigma was linearly decreased with age, the linear age trend of perceived stigma may reflect the relative maturity in cognition and emotion among children as they mature (36). Internal resources (mature cognitive capacity and coping skills) together with relational (trusting relationships) and community resources (supportive environment) were suggested to be associated with better neurobiological and psychosocial outcomes (64). Other studies had shown that in a chaotic environment, social trust would play a greater role, and the relationship between social trust and well-being would become stronger after a disaster (42). Youths who perceived high stigma may suffer more psychological disasters than those who perceived low stigma. They are more likely to be influenced by social trust-related interventions. The moderation effect also shows that youths affected by parental HIV/AIDS need more social warmth and concern to improve their social well-being.

LIMITATIONS

Several study limitations should be noted. First, because the HIV epidemic in the research site included was primarily due to unhygienic blood collection, the sample size of this study is relatively small and may not be representative of all youths affected by parental HIV/AIDS in other settings. Second, an online survey may exist the possibility of a selection bias and cannot control for the effects of some additional variables, which was affected by the participant's cooperation attitude. Furthermore, the data was gathered through self-report, which may be subject to social desirability and self-reporting bias. Third, confounding variables caused by inconsistent environmental variables may affect findings among youth affected by AIDS, and the cross-sectional data in this study can only reveal the correlation among all variables. Thus, future research can include more types of youths affected by parental HIV/AIDS, and combine the evidence of multiple disciplines (psychophysiology, brain science, etc.) and multiple indicators (behavioral experiments, brain imaging, etc.) to reveal the role of perceived social support (PSS) and the occurrence mechanism of HIV-related stigma among vulnerable groups, as well as the causal relationship among variables.

CONCLUSION

This study constructed a moderated mediation model to explore whether HIV-related stigma depresses their social well-being, discovering the risk and protective factors for social well-being, as well as the unique contribution of different types of HIV-related stigma. The findings are crucial for intervention and social well-being enhancement among youths affected by parental HIV/AIDS. First, future health promotion and psychological care efforts for youths affected by parental HIV/AIDS must consider the effect of various forms of HIV-related stigma on these youths' social well-being. Second, as social trust is the most proximate protective factor for social well-being, it should be a focal point and an important goal for future prevention interventions aimed at improving social well-being among youths affected by parental HIV/AIDS. Finally, intervention programs should be developed by the government, society, community, health care settings, and practitioners to mitigate the negative effect of risk factors (HIV-related stigma) and promote protective factors (PSS and social trust).

DATA AVAILABILITY STATEMENT

The datasets presented in this article are not readily available because the data involving special minority participants must be kept confidential. Requests to access the datasets should be directed to JZ, fzhao63@hotmail.com.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Institutional Review Board at the Henan University in China (IRB 00007212). The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

YZ conceptualized the manuscript, performed statistical analyses, and wrote the first draft of the manuscript. LJ, GL, YS, and XL revised the manuscript for important intellectual content. JZ guided and supervised the whole study. All authors reviewed and approved the final version of the manuscript.

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Inhibitory Control of Emotional Interference in Deaf Children: Evidence From Event-Related Potentials and Event-Related Spectral Perturbation Analysis

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Background: Impairment of interference control ability may reflect a more general deficit in executive functioning, and lead to an increase in internal-externalized problems such as impulsivity, which has been reported in deaf children. However, few researches have examined the neural mechanism of this impairment.

Methods: This study applied the electroencephalogram (EEG) technique to investigate the interference control ability in 31 deaf children and 28 hearing controls with emotional face-word stroop task.

Results: Results from behavioral task showed that deaf children exhibited lower accuracy compared to hearing controls. As for EEG analysis, reduced activation of ERP components in N1 and enhanced activation of ERP components in N450 have been found in deaf children. Besides, incongruent condition elicited larger N450 than congruent condition. Furthermore, for brain oscillation, alpha band (600–800 ms) revealed a reduced desynchronization in deaf children, while theta band (200–400 ms) revealed an enhanced synchronization in deaf children and incongruent condition, which were in line with ERP components.

Conclusion: The present findings seem to indicate that the deficit during emotional interference control ability among deaf children might be due to the impaired attention allocation ability and emotional cognitive monitoring function during emotional conflict detection process. Consequently, reduced N1 and enhanced N450 might be due to early attention impairment causing more effort of deaf children later in emotional cognitive monitoring.

Keywords: deaf children, interference control, emotional stroop, event-related potentials, time-frequency analysis

INTRODUCTION

The World Health Organization (WHO) estimates that there are approximately 360 million people with hearing impairment in the world and almost one-tenth of the affected population are children (1). Previous research has shown that hearing loss not only affects the normal development of language skills, but also affects other neurocognitive functions among deaf children, such as interference control ability (2, 3). However, most of these previous studies were done with questionnaires or behavioral experiments (4–6) and focused on the performance of working memory, attention, inhibitory control and other executive functions of deaf children. Few of them ever implied electroencephalogram (EEG) technique to investigate the neural mechanisms of this interference control impairment among deaf children. However, EEG signals, with their millisecond temporal resolution, are excellent at tracking rapid changes in brain function, and techniques to acquire these signals are relatively simple and non-invasive, providing more accurate and detailed information to help estimate inhibitory control. Therefore, this study selected it to identify the inhibitory control of emotional interference in deaf children (7, 8).

In addition to the commonly studied interference control ability, various emotion skills are also believed to be impaired in deaf children. For instance, facial emotion processing, as one of the most studied aspects of social cognitive function, is reported being impaired in deaf children (4, 9, 10). Moreover, dozens of studies also showed that deaf children are more challenged in terms of emotion identification, emotion understanding, and the expression of emotion compared with hearing controls (11–16). Such challenges can be attributed to delayed language acquisition or lack of personal experience opportunities to talk with others, as well as the long-term stress environment in which they are trapped in emotional states such as anxiety, depression and subjective anxiety.

Moreover, Gray (17, 18) believed that cognition and emotion are strongly integrated and inseparable in the process of information processing (19). A meta-analysis of inhibitory control demonstrated that several brain areas have been associated with the mechanisms underlying inhibitory control, with a network involving left and right inferior frontal gyrus (IFG) dorsolateral pre-frontal cortex (dlPFC), anterior cingulate (ACC) (20). Specifically, the role of the anterior cingulate cortex (ACC) and the dorsolateral pre-frontal cortex (DLPFC) regions have been shown to be components of a neural network which plays a critical role in the completion of tasks requiring self-monitoring and inhibition (21, 22). In addition, several meta-analyses of emotion regulation reported activations in the bilateral dorsolateral pre-frontal cortex (dlPFC), ventrolateral pre-frontal cortex (vlPFC), dorsal anterior cingulate cortex (dACC) (23–25), which largely overlaps with the classic frontoparietal cognitive control network (26).

According to the above evidence analysis (2–4, 9, 10, 20, 23–26), we can know that emotional and inhibitory control disorders both exist in deaf children, and the activation brain regions of cognitive and emotional networks are highly overlapped. Therefore, the present study combined two aspects and employed the face-word emotional stroop task to investigate the emotional inhibitory control of deaf children (27–29). In this task, "happy" and "fear" words with red color are superimposed across facial expressions of happy and fear, conflict effects occur when emotional words and facial expressions are incongruent, which has been widely used to examine the inhibitory control of emotional interference (28, 29). Previous studies have observed two important ERP components that were related to emotional interference control processing: N1 and N450 (28, 30–39). The N1 component of the ERP reflect brain activation in the early perceptual stages (38). It was hypothesized that larger amplitudes of the sensory components (N1) to emotional words indicated an increased attention-related cerebral processing during relatively early perceptual stages of information processing (31). The N450 is a popular index of conflict detection in emotional conflict control tasks which shows larger negative amplitude in the incongruent condition compared to congruent condition (34–37).

Furthermore, time-frequency analysis (TFA) can provide complementary information on neural processing dynamics that is distinctive from traditional phase-locked ERP method. Therefore, according to previous studies, theta and alpha band are used for analysis to explore the characteristics of emotional suppression control in deaf children (40–46). The frontal-central distribution of the evoked theta (4–7 Hz) response is suggested to be related with central executive and working memory processes, and reflects initiation of the central executive processes to detect interference and to inhibit the response for task-irrelevant features (40, 42, 43, 47). Alpha desynchronization (8–14 Hz) which reflects attentional processes, processing of sensory–semantic information and the difficulty of the task, that is to say, the more demanding a task, the stronger the amount of event-related alpha desynchronization (40, 44–46).

Taken together, inhibitory control of emotional interference is vital not only for good behavior and cognitive function, but also for adequate emotional control and social interaction (48, 49). In the current study, we applied EEG technique to investigate both emotion and cognitive abilities using face-word emotional stroop task, and further explore the potential neural markers of emotional interference control deficit among deaf children. On the basis of previous research (10, 48, 50–52), our hypothesis was that compared to hearing controls, deaf children would show worse performance in both behavioral and EEG measures during emotional stroop task.

TABLE 1 | Descriptive characteristics of deaf children and hearing controls.

	Deaf children	Hearing controls
No. of children	31	28
Mean age (SD) (years)	11.613 (0.230)	11.321 (0.242)
Range of age (years)	9–13	9–13
Ratio of female/male (%)	48.39/51.61	53.57/46.43
With hearing aids/Without hearing aids (%)	48.39/51.61	//
Communication mode	Sign language	Oral language

MATERIALS AND METHODS

Participants

We performed a sample size calculation on the basis of G*Power 3.1, using an alpha level of 0.05 with 95% power to detect a large effect size (f = 0.4). Results showed that a sample size of 12 would be needed to assure the adequate statistical power. Therefore, a total of 31 deaf children aged 9–13 were recruited from the Kaifeng Special Education School in central China and 28 matched hearing controls were recruited from the same geography area. Parent and teacher reports established that all children were born to hearing parents and had no apparent mental health disorders such as ADHD or autism spectrum disorders. Main demographic characteristics of both deaf children and hearing controls were shown in **Table 1**. Participants were required to complete a computer version of emotional conflict task while recording EEG. Each participant received an age-appropriate gift at the completion of the experiment as token of appreciation. The study protocol was approved by the Institutional Review Board of Henan University, and all participants provided written informed consent prior to data collection.

Stimuli and Procedure

Twenty face pictures were selected from Chinese affective picture system (53), including 10 happy face pictures (5 female, 5 male) and 10 fearful face pictures (5 female, 5 male). Two Chinese characters, "愉快" (which means "happy") or "恐惧" (which means "fear") were superimposed on the faces in red. The words and facial expressions were either congruent (e.g., character meaning fear superimposed onto a fear face picture, see **Figure 1**) or incongruent (e.g., character meaning happy superimposed onto a fear face picture, see **Figure 1**). The stimuli were programmed by E-Prime 2.0 software, and they were presented on a Dell 19 -in monitor.

Participants performed modified face-word stroop task (judging facial expression) while sitting in quiet room with dim light, participants had to identify the facial expression of the target faces while ignoring the meaning of the words. They were instructed to respond by pressing a button, corresponding to "fear" faces (right index finger) or "happy" faces (right middle finger), as quickly and accurately as possible. The order of performing the experimental task was counterbalanced across participants.

The face-word stroop task consisted of 240 trials that were presented over 4 blocks (60 trials per block). Each block in each task consisted of an equal amount of congruent and incongruent trials. Stimuli were presented in random order within each block. Participants performed in a 24-trial practice block prior to the experiment. The timing and order of each trial was the same for each block: a fixation dot was presented for a specific duration (500 ms) followed by a blank screen of variable duration (300–500 ms). Then, the target face appeared for 1000 ms at the center of the screen. Participants had to respond within 1500 ms. The inter-trial interval (ITI) varied randomly between 800 ms and 1200 ms, with a mean of 1000 ms (**Figure 1**).

EEG Recording

The electroencephalogram (EEG) was recorded from a 32 scalp standard channel cap (10/20 system; Brain Products, Munich,

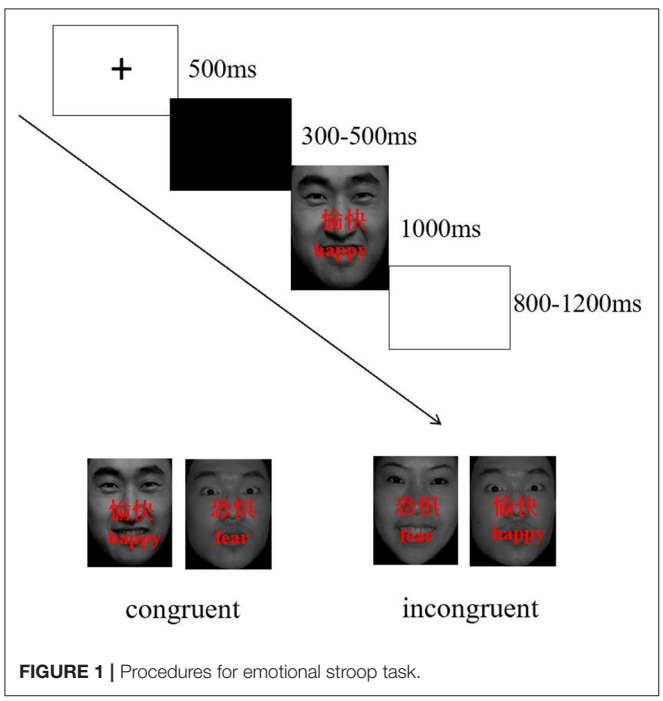

FIGURE 1 | Procedures for emotional stroop task.

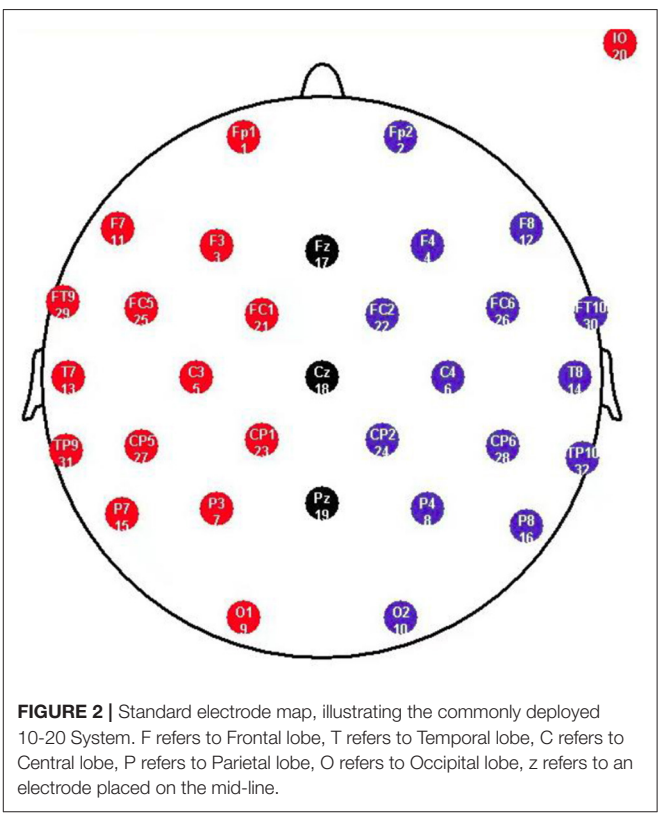

FIGURE 2 | Standard electrode map, illustrating the commonly deployed 10-20 System. F refers to Frontal lobe, T refers to Temporal lobe, C refers to Central lobe, P refers to Parietal lobe, O refers to Occipital lobe, z refers to an electrode placed on the mid-line.

TABLE 2 | Mean accuracy and reaction time (M ± SD) of deaf children and hearing controls, and results of repeated measures ANOVA for conditions.

	Congruent	Incongruent	F_{GROUP} (p)	F_{CON} (p)	$F_{CON*GROUP}$ (p)
ACC					
Total ($n = 59$)	0.927 ± 0.009	0.872 ± 0.010	63.094 (0.000***)	11.075 (0.002***)	1.696 (0.198)
Deaf Children ($n = 31$)	0.893 ± 0.012	0.847 ± 0.014			
Controls ($n = 28$)	0.961 ± 0.013	0.897 ± 0.014			
Reaction Time (ms)					
Total ($n = 59$)	759.818 ± 14.833	816.231 ± 14.481	3.395 (0.071)	135.774 (0.000***)	24.981 (0.000***)
Deaf Children ($n = 31$)	745.278 ± 20.437	777.492 ± 19.952	23.325 (0.000***)		
Controls ($n = 28$)	774.358 ± 21.504	854.969 ± 20.994	131.910 (0.000***)		

***$p < 0.01$.

Germany) (**Figure 2**). Electrooculogram (EOG) was recorded from electrodes placed above the right eye. All electrode recordings were online referenced to FCz. All inter-electrode impedance was maintained below 5 kΩ. The EEG and EOG signals were amplified using a 0.01–100 Hz band pass filter and continuously sampled at 500 Hz/channel for offline analysis.

After data acquisition, EEG data were transferred into the EEGLAB and Letswave toolboxes, which are open-source Matlab toolboxes for neurophysiologic data analysis (54, 55). EEG were re-referenced to the average of the two mastoids and filtered with a band pass of 0.1–30 Hz. Epochs were extracted between the 200 ms pre-stimulus and 1000 ms post-stimulus time points, and the baseline correction was performed in 200 ms pre-stimulus interval. Eye movement artifacts were removed with ICA. Finally, data were inspected and cleansed manually for any obvious remaining artifacts.

ERP Analysis

This study analyzed the potentials of the ERP components N1 and N450. The electrodes for further analysis were chosen according to ERP topographical distribution and previous studies (56, 57). Specifically, the amplitudes of the N1 (100-200 ms) were analyzed at F3, F4, Fz, and the N450 (330–400 ms) at C3, C4, Cz, P3, P4, Pz, and were measured as mean values. The time windows were determined through visual detection in the grand-averaged ERPs.

Time–Frequency Analyses

An estimate of the oscillatory power as a function of time and frequency (time–frequency representation) was obtained from single-trial EEG epochs using the continuous wavelet transform (CWT) (55). The time–frequency representations were explored between 1 Hz and 30 Hz in steps of 0.29 Hz. Epochs were extracted between the 400 ms pre-stimulus and 1000 ms post-stimulus time points. To avoid edge effects when performing CWT, the pre-stimulus time interval (−400 ms to −200 ms) was used as a baseline interval. Based on average condition contrast maps and previous studies (58), 2 clusters were tested in this study: 4–7 Hz at 200–400 ms for theta (F3, F4, Fz, C3, C4, and Cz), 8–14 Hz at 600–800 ms for alpha (P3, P4 and Pz). Each of these oscillatory components was quantified as the mean amplitude within these time windows of each participant.

Statistical Analysis

SPSS 20.0 was used to perform ANOVA or the chi-square test to investigate whether the demographic factors (including age and gender) showed significant differences between groups (deaf children and hearing controls). Furthermore, repeated measures ANOVA was conducted on behavioral and ERP data with group (deaf children vs. hearing controls) as a between-subject factor, while stimulus type (congruent, and incongruent), Hemisphere (Hemi) (only in EEG data: Left, Midline and Right) and antero-posterior distribution (AP) (only in EEG data: Frontal, Central, Parietal and Occipital) were considered as within-subject factors. For all the analyses in this study, the p-values were corrected by Greenhouse-Geisser correction when appropriate.

RESULTS

Behavioral Data

Accuracy

ANOVA showed significant main effect of group on response accuracy ($F_{1,57} = 11.705$, $p = 0.002$, $\eta^2 = 0.163$), with overall lower accuracy in deaf children compared to hearing controls (see **Table 2**), which indicated that deaf children had difficulties in suppressing irrelevant information and suffered from deficient cognitive control mechanisms (4, 5, 50). The main effect of condition was also significant ($F_{1,57} = 63.094$, $p = 0.000$, $\eta^2 = 0.525$), with incongruent condition (0.872 ± 0.010) being significantly lower than congruent condition (0.927 ± 0.009), which indicated that in the presence of a conflict effect, the incongruent condition invested more cognitive resources than the congruent condition (28, 29, 59).

Reaction Time

The significant main effect of condition was found that congruent condition (759.818 ± 14.833) was significantly faster than incongruent condition (816.231 ± 14.481) ($F_{1,57} = 135.774$, $p = 0.000$, $\eta^2 = 0.704$), which is consistent with the response accuracy, indicating that the conflict condition requires more cognitive resources and that participants need longer reaction times to make judgments. The interaction between group and condition was significant ($F_{1,57} = 24.981$, $p = 0.000$, $\eta^2 = 0.305$). Further analysis indicated that a significant interference effect

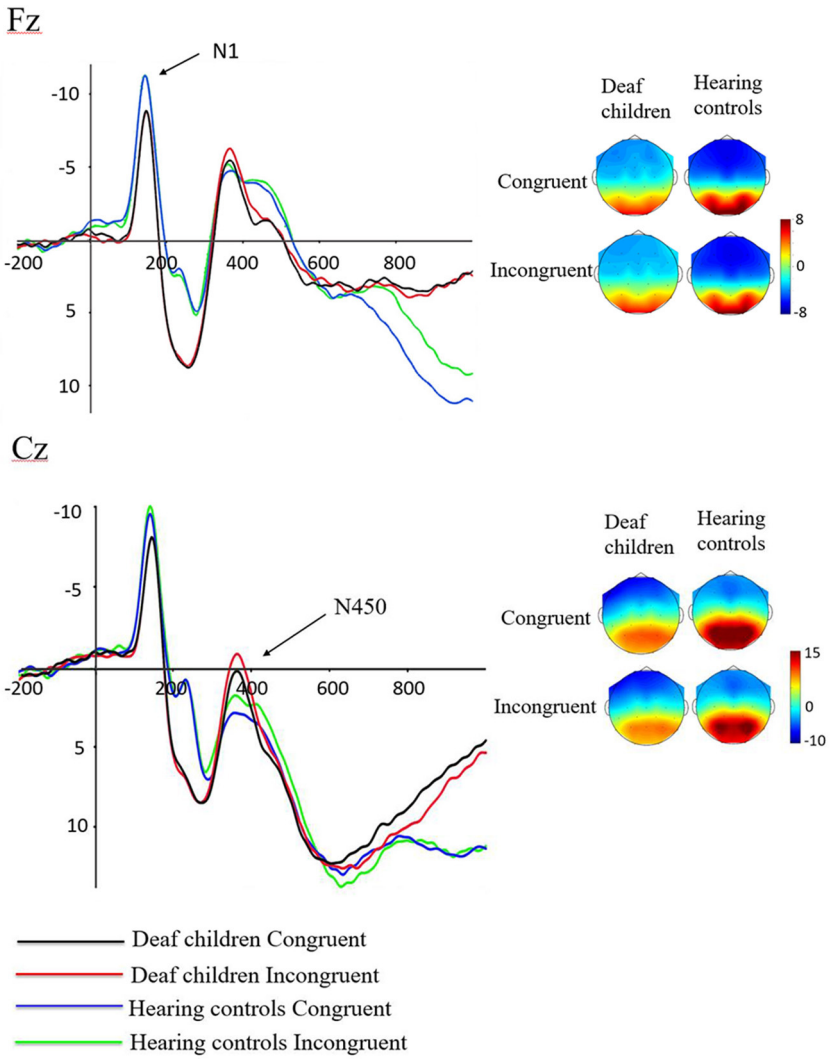

FIGURE 3 | Waveforms of N1 and N450 components in emotional stroop task of deaf children and hearing controls.

with the congruent condition (745.278 ± 20.437) (774.358 ± 21.504) being faster than the incongruent condition (777.492 ± 19.952) (854.969 ± 20.994) in deaf children ($F_{1,57} = 23.325$, $p = 0.000$, $\eta^2 = 0.290$) and hearing controls ($F_{1,57} = 131.910$, $p = 0.000$, $\eta^2 = 0.698$).

ERP Amplitude Analysis

For the consideration of space, we only included significant results in this part. **Figure 3** showed the grand-averaged waveforms of deaf children and hearing controls. The Means and SEs for each component were displayed in **Table 3**, and the Means and SDs of amplitudes of each electrode N1 and N450 were displayed in **Table 4**.

N1

A repeated-measures analysis of variance (ANOVA) was applied in this procedure with N1 amplitude as dependent variable, with stimulus type (congruent, and incongruent), Hemisphere (Hemi: Left, Midline and Right) and AP [frontal(F) (electrodes: F3, Fz, F4), central (C) (electrodes: C3, Cz, C4), and parietal (P) (electrodes: P3, Pz, P4)] as within-subject factors, and group (deaf children vs. hearing controls) as a between-subject factor. Results showed significant main effect of group on N1 amplitude ($F_{1,57} = 4.517$, $p = 0.038$, $\eta^2 = 0.073$), with hearing controls (−7.913 ± 0.734 μV) eliciting overall larger N1 compared to deaf children (−5.761 ± 0.697 μV), which suggested that the smaller N1 amplitudes were neurophysiological reflex of deficient inhibition for emotional stroop task in deaf children (60). The interaction effect of Group × Hemisphere was also significant for N1 amplitude ($F_{2,56} = 3.197$, $p = 0.046$, $\eta^2 = 0.053$). Further analysis indicated that midline region (Fz) elicited larger N1 activation in hearing controls (−8.360 ± 0.75 6μV) compared to deaf children (−5.692 ± 0.718 μV), while there was no

TABLE 3 | ERP amplitudes (M ± SD) of deaf children and hearing controls, and results of repeated measures ANOVA for conditions.

	Congruent	Incongruent	F_{CON} (p)	F_{GROUP}(p)	$F_{CON*GROUP}$ (p)
N1 amplitude					
Total ($n = 59$)	−6.898 ± 0.574	−6.776 ± 0.496	0.118 (0.732)	4.517 (0.038*)	0.171 (0.681)
Deaf Children ($n = 31$)	−5.896 ± 0.791	−5.627 ± 0.683			
Controls ($n = 28$)	−7.900 ± 0.832	−7.925 ± 0.719			
N450 amplitude					
Total ($n = 59$)	7.285 ± 0.938	6.319 ± 0.945	5.090 (0.028*)	5.883 (0.018*)	0.237 (0.629)
Deaf Children ($n = 31$)	4.957 ± 1.293	4.199 ± 1.302			
Controls (n=28)	9.613 ±1.360	8.439 ±1.370			

*$p < 0.05$.

TABLE 4 | The average amplitudes (μV) of the ERP components (M ± SD) between deaf children and hearing controls.

ERP components	Stimulus type	Electrode point	Average amplitudes (μV)	
			Deaf children	Hearing controls
N1	congruent	F3	−6.066 ± 4.142	−7.687 ± 4.475
		Fz	−5.703 ± 4.479	−8.360 ± 4.716
		F4	−5.919 ± 4.569	−7.654 ± 4.570
	incongruent	F3	−5.710 ± 3.381	−7.682 ± 3.868
		Fz	−5.681 ± 3.492	−8.360 ± 4.257
		F4	−5.489 ± 4.195	−7.733 ± 4.257
N450	congruent	C3	−0.395 ± 7.057	3.522 ± 7.800
		Cz	1.233 ± 7.891	3.107 ± 10.568
		C4	1.171 ± 8.083	3.162 ± 8.849
		P3	8.555 ± 7.166	15.931 ± 8.604
		Pz	9.506 ± 6.065	15.075 ± 9.569
		P4	9.670 ± 7.649	16.884 ± 9.240
	incongruent	C3	−0.818 ± 7.630	2.660 ± 7.194
		Cz	0.182 ± 8.320	2.191 ± 10.376
		C4	0.466 ± 8.285	2.414 ± 8.185
		P3	8.075 ± 7.098	14.529 ± 7.968
		Pz	8.449 ± 7.165	13.514 ± 9.028
		P4	8.840 ± 7.791	15.327 ± 8.594

significant group difference in response to right (F4) and left hemispheres (F3).

N450

Analysis of N450 amplitude showed a significant main effect of group ($F_{1,57} = 5.883$, $p = 0.018$, $\eta^2 = 0.094$), with deaf children (4.578 ± 1.263 μV) eliciting overall larger N450 compared to hearing controls (9.026 ± 1.329 μV). There also was a significant main effect of condition ($F_{1,57} = 5.090$, $p = 0.028$, $\eta^2 = 0.082$), incongruent condition (6.319 ± 0.945 μV) eliciting larger N450 than congruent condition (7.285 ± 0.938μV). The results of the N450 amplitudes were consistent with behavioral outcomes, reflecting deficits in inhibitory control in deaf children and inconsistent conditions requiring more effort to complete. The results showed a significant main effect of AP ($F_{1,57} = 203.155$, $p = 0.000$, $\eta^2 = 0.781$), with central area (1.574 ± 1.031 μV) eliciting larger N450 than parietal area (12.030 ± 0.942 μV). There was also a significant Group × AP interaction effect ($F_{1,57} = 6.798$, $p = 0.012$, $\eta^2 = 0.107$). According to further analysis, this interaction indicated that the central area (0.306 ± 1.420 μV) (2.842 ± 1.495 μV) elicited larger N450 than parietal area (8.849 ± 1.298 μV) (15.210 ± 1.366 μV) in both deaf children ($F_{1,57} = 71.447$, $p = 0.000$, $\eta^2 = 0.556$) and hearing controls ($F_{1,57} = 135.262$, $p = 0.000$, $\eta^2 = 0.704$).

Time-Frequency Results

Theta Activity

Figure 4 presented the Time-frequency (TF) analysis results. Theta synchronization (200–400 ms) showed significant main effect of condition ($F_{1,57} = 5.022$, $p = 0.029$, $\eta^2 = 0.081$), with incongruent condition (7.135 ± 0.467) eliciting larger theta synchronization than congruent condition (6.624 ± 0.460). Theta synchronization also showed significant main effect of group ($F_{1,57} = 5.348$, $p = 0.024$, $\eta^2 = 0.086$), with deaf children (7.920 ± 0.620) eliciting larger theta synchronization than hearing controls (5.840 ± 0.652), which were consistent with the results of N450. There also was a significant main effect of emotional background ($F_{1,57} = 7.659$, $p = 0.008$, $\eta^2 = 0.118$), with fear background (7.189 ± 0.458) eliciting larger theta synchronization than happy background (6.571 ± 0.469). The results also showed significant main effect of AP ($F_{1,57} = 44.420$, $p = 0.000$, $\eta^2 = 0.438$) and hemisphere ($F_{2,56} = 12.970$, $p = 0.000$, $\eta^2 = 0.185$), with frontal area (7.674 ± 0.490) eliciting larger theta synchronization than central area (6.085 ± 0.439), midline region (Fz, Cz) (7.408 ± 0.494) eliciting larger theta synchronization than left hemispheres (F3, C3) (6.857 ± 0.476) and right hemispheres (F4, C4) (5.840 ± 0.652). A significant interaction was found between the emotional background and group ($F_{1,57} = 7.832$, $p = 0.007$, $\eta^2 = 0.121$), further analysis indicated that deaf children (8.541 ± 0.631) elicited larger theta synchronization in fear background compared to hearing controls (5.836 ± 0.663), while there was no significant group difference in response to happy background.

Alpha Activity

Alpha desynchronization (600–800 ms) showed significant main effect of group ($F_{1,57} = 6.868$, $p = 0.011$, $\eta^2 = 0.108$), with hearing controls (−6.376 ± 1.003) eliciting larger alpha

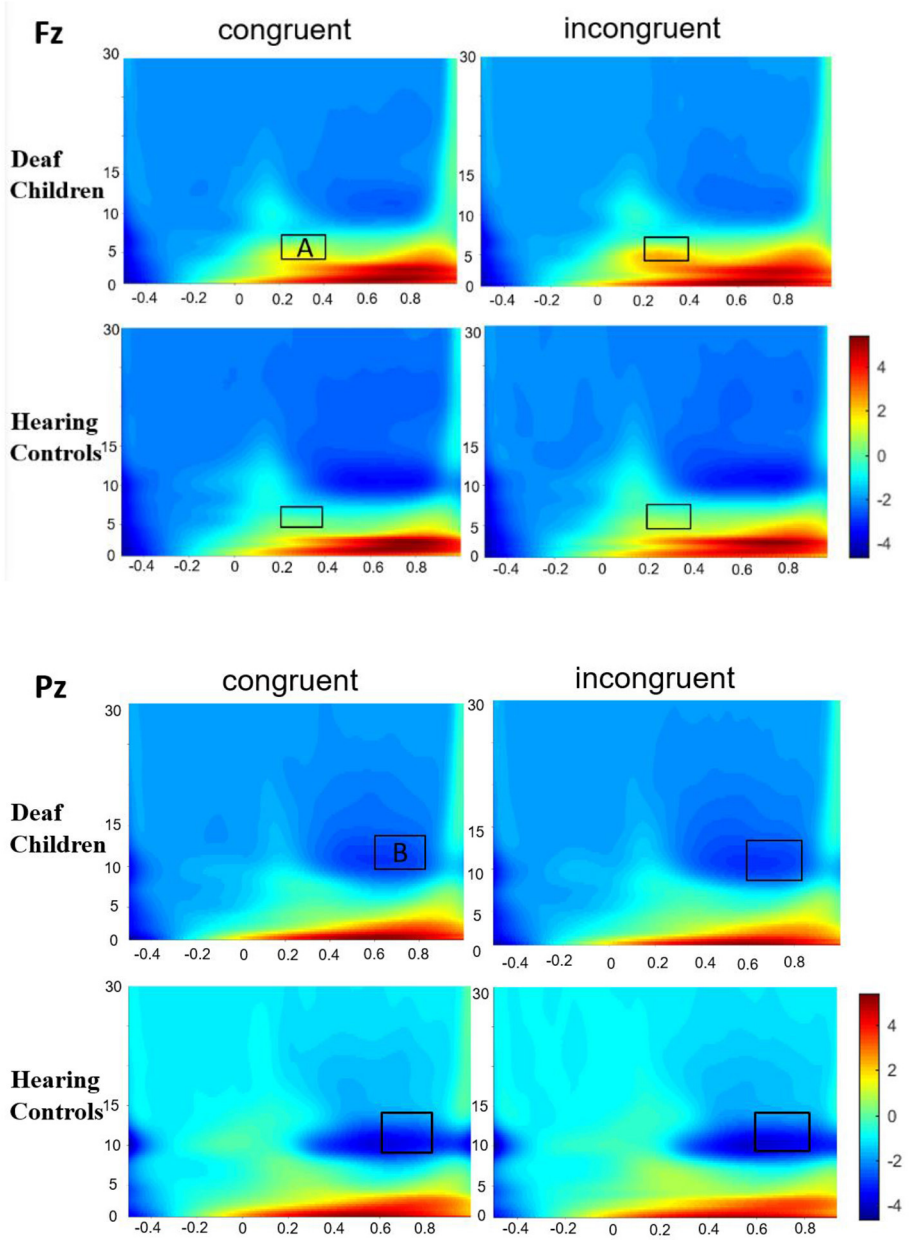

FIGURE 4 | Group-averaged time-frequency spectrogram during facial emotion recognition. Time (in ms) is denoted on the x-axis, with 0 ms defined as the onset of the stimuli. Frequency (in Hz) is shown on the y-axis. A represent the theta band (200–400 ms), and B represent the alpha band (600–800 ms).

desynchronization than deaf children (−2.750 ± 0.953), which were in line with the results of N1. Alpha desynchronization also showed significant main effect of emotional background ($F_{1,57}$ = 6.939, p = 0.011, η^2 = 0.109), with fear background (−4.882 ± 0.773) eliciting larger alpha desynchronization than happy background (−4.244 ± 0.624). There also was a significant main effect of hemisphere ($F_{2,56}$ = 10.817, p = 0.000, η^2 = 0.160), with midline region (Pz) (−3.665 ± 0.540) eliciting smaller alpha desynchronization than left hemispheres (P3) (−4.823 ± 0.798) and right hemispheres (P4) (−5.190 ± 0.790).

DISCUSSION

The present study explored the emotional interference effect among deaf children. Behavioral results showed that the main effect of condition was significant not only for the accuracy data but also for the reaction time data, which indicated that in the presence of a conflict effect, the incongruent condition invested more cognitive resources than the congruent condition (28, 29, 59). In addition, it was also found that deaf children demonstrated significantly lower accuracy rate in

emotional stroop task than hearing controls, which is consistent with previous findings that deaf children had difficulties in suppressing irrelevant information and suffered from deficient cognitive control mechanisms (4, 5, 50).

These behavioral results were further explored by ERP analysis. Deaf children showed diminished activation in the emotional interference processing components compared to hearing controls. Given that the N1 components reflect the attentional focus on the target and a discrimination process within the focus of attention (31, 60), the smaller N1 amplitudes suggest two important points. First, although the emotional stroop task needed participants to concentrate on the facial expression of the picture, the deaf children paid less attention on the task-relevant information (the words of the picture) because of the interference of the meaning of the words. Therefore, a weaker allocation for target information was obtained. Second, for task-irrelevant information (the words of the picture), the deaf children also automatically put attentional resources on it; consequently, the attentional resources for task completing were deficient, and the time needed to complete the task was prolonged or the task was poorly performed. So the smaller N1 amplitudes might be correlated with a slower response to emotional interference stimuli, which suggested that the smaller N1 amplitudes were neurophysiological reflex of deficient inhibition for emotional stroop task (61). This finding is in accordance with the evidence of similar alterations during stroop task in individuals with schizophrenia, amblyopic, obsessive compulsive disorder, or depression (31, 38, 62, 63).

In contrast to N1, deaf children showed enhanced activation in N450 compared to hearing controls. According to previous studies, the N450 is a valid index of conflict monitoring in emotional conflict control tasks and shows larger negative amplitude in the incongruent condition compared to congruent condition (34–37, 64). The role of the anterior cingulate cortex (ACC) and the dorsolateral pre-frontal cortex (DLPFC) regions have been shown to be components of a neural network which plays a critical role in the completion of tasks requiring self-monitoring and inhibition (21). The N450 component demonstrated enhanced amplitudes in deaf children, suggesting that deaf children may require a greater recruitment of cognitive resources from the ACC and DLPFC to achieve the performance levels of hearing controls during emotional stroop task (22, 64). In addition, compared to healthy controls, major depressive disorder (MDD) patients showed enhanced N450 amplitude (31, 65). Patients with attention deficit hyperactivity disorder (AHDH), nocturnal enuresis (NE) and developmental coordination disorder (DCD) showed increased activation in the bilateral temporoparietal junctions, bilateral dorsolateral pre-frontal cortex, and bilateral anterior cingulate cortex (66–68). There is a causal relationship between the decreased N1 and the increased N450, which is similar to previous studies of person with depression (31). The correlation may be due to reduced early attention requiring more effort later in emotional stroop task. Combined with the analysis of behavioral results which showed that accuracy rate of deaf children in emotional stroop task was significantly lower than hearing controls, it can be found that although deaf children made more efforts and showed more activation on N450 than hearing controls, they did not reach the same level as hearing controls, which revealed the emotional impairment of cognitive monitoring function of the deaf children, meanwhile indicated that the emotional cognitive resources for monitoring conflict information and inhibition irrelevant information in the inhibition control process of the deaf children are very limited.

Besides ERP analysis, the current study employed time–frequency measures in alpha and theta band which showed significantly more desynchronization in hearing controls and significantly more synchronization in deaf children and incongruent condition. A number of studies have found that alpha oscillation was a reliable marker of attention (69, 70), theta band was related with central executive and working memory processes, and reflected initiation of the central executive processes to detect interference and to inhibit the response for task-irrelevant features (40, 42, 43). Alpha desynchronization was similar to the results from ERP components in N1. Previous studies have showed diminished alpha suppression in the predominantly inattentive (IA) and absent alpha oscillation in ADHD (71, 72). Therefore, the diminished alpha desynchronization might suggest impaired attention distribution ability during emotional interference processing of deaf children. Theta synchronization also showed a conflict effect which was in line with the previous studies (73, 74). In addition, consistent with ERP results, deaf children showed enhanced theta synchronization which might suggest impaired cognitive monitoring function during emotional interference processing of them.

The negative impact poor inhibitory control has on a range of outcomes for deaf children, but considering that after a period of training, children showed great improvements in their inhibition skills (49, 75). Therefore, we can train the inhibitory control of emotional interference ability of deaf children to help them form a healthy personality and better integrate into the society. Specifically, school education can strengthen the training of deaf children's inhibitory control of emotional interference ability through flexible and diverse classroom forms. Based on the fact that deaf children are more inclined to visual images when receiving information, they have stronger perception and memory for actions, expressions or visualized pictures. Teachers can use multimedia animation and small games in teaching to mobilize students to participate in various emotional situations, help them improve the problems in emotional control, let them understand the way of emotional expression, enhance their ability to understand the behavior intention of others, and have a certain ability to predict the behavior consequences, so as to improve their ability of the inhibitory control of emotional interference.

CONTRIBUTIONS, LIMITATIONS, AND FUTURE DIRECTIONS

Combining the ERP and TFA data analysis methods simultaneously can not only enhance the energy of ERP components by using the high temporal resolution ERP

technology, but also greatly reduce the amplitude and noise of the spontaneous EEG, so as to reveal the time process of individuals in the process of inhibitory control of emotional interference (76). Moreover, time-frequency analysis can be used to simultaneously extract the temporal and spectral domains of event-related brain activity, improving the detectability of ERP and allowing characterization of non-phase-locked components that cannot be identified by traditional time-domain averaging in healthy and deaf children (77, 78).

The limitation of this study is that it does not use nuclear magnetic technology with high spatial resolution, but only ERP technology with high temporal resolution. Future research should use the combination of ERP and functional magnetic resonance imaging (fMRI) to measure the neural mechanism of deaf children in emotional stroop task, and use the advantages of the combination of high temporal resolution and high spatial resolution to explore the damage degree of inhibitory control of emotional interference and the corresponding impaired brain regions of deaf children.

CONCLUSION

In conclusion, the current study revealed major deficits in deaf children during emotion-related conflict control, with overall worse behavioral performance and reduced activation of N1 and alpha desynchronization, and enhanced activation of N450 and theta synchronization compared to the hearing controls, which might suggest impaired attention allocation ability and cognitive monitoring function during conflict detection process in deaf children. The Findings enriched the understanding of impaired inhibitory control of emotional interference in deaf children, and helped educators to take timely and appropriate intervention measures to promote the optimal neuropsychological development of deaf children.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Institutional Review Board of Henan University. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

JZ contributed to the conception of the study. HG contributed significantly to analysis and manuscript preparation. QC performed the data analyses and wrote the manuscript. XL helped revise the manuscript. QC contributed to the interpretation and discussion of the results of the analysis. All authors contributed to the article and approved the submitted version.

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EEG Evidence of Altered Functional Connectivity and Microstate in Children Orphaned by HIV/AIDS

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Children orphaned by HIV/AIDS ("AIDS orphans") suffer numerous early-life adverse events which have a long-lasting effect on brain function. Although previous studies found altered electroencephalography (EEG) oscillation during resting state in children orphaned by HIV/AIDS, data are limited regarding the alterations in connectivity and microstate. The current study aimed to investigate the functional connectivity (FC) and microstate in children orphaned by HIV/AIDS with resting-state EEG data. Data were recorded from 63 children orphaned by HIV/AIDS and 65 non-orphan controls during a close-eyes resting state. The differences in phase-locking value (PLV) of global average FC and temporal dynamics of microstate were compared between groups. For functional connectivity, children orphaned by HIV/AIDS showed decreased connectivity in alpha, beta, theta, and delta band compared with non-orphan controls. For microstate, EEG results demonstrated that children orphaned by HIV/AIDS show increased duration and coverage of microstate C, decreased occurrence and coverage of microstate B, and decreased occurrence of microstate D than non-orphan controls. These findings suggest that the microstate and functional connectivity has altered in children orphaned by HIV/AIDS compared with non-orphan controls and provide additional evidence that early life stress (ELS) would alter the structure and function of the brain and increase the risk of psychiatric disorders.

Keywords: children orphaned by HIV/AIDS, early life stress, resting-state, microstate, functional connectivity

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INTRODUCTION

Children orphaned by HIV/AIDS ("AIDS orphans") were defined as children under the age of 18 years who had lost one or both parents to HIV-related illnesses (1). The United Nations International Children's Emergency Fund estimated that there were 15.4 million AIDS orphans worldwide by 2021 (2). The number of AIDS orphans could have reached 260,000–400,000 in China (3) with an increasing trend. When they grow up, AIDS orphans may suffer numerous early life stress (ELS) events, such as parental death, poverty, disrupted school attendance, and stigma. According to previous studies, these ELS events have been associated with changes in brain structure and function (4–8). Understanding these changes promises fundamental insights into the underlying pathophysiology and may eventually help establish a much sought-after biomarker of ELS.

Brain function development after ELS has mostly been assessed using functional magnetic resonance imaging (fMRI). By assessing brain activity and connectivity, recent fMRI studies have

found a reduction in the volume of the hippocampus, prefrontal cortex (PFC), and corpus callosum in children with ELS (9, 10). Besides the brain structure, the alterations in brain functional connectivity (FC) have also been found, such as increased connectivity between the ventral striatum and lateral PFC (11, 12), and decreased amygdala-PFC connectivity (13, 14), or reduced ventral tegmental area-hippocampal connectivity (15). While findings from fMRI studies are all in low frequencies, there is still a lack of knowledge about brain function in a resting state at higher frequencies. To address this, electroencephalography (EEG) can provide a new perspective because of its higher temporal resolution. Mounting evidence indicates that resting-state EEG activity is related to brain functions (16–18). For example, in the attentional function, alpha oscillations were considered to clear sensory information from distractors (19). The theta/beta ratio had a negative correlation with information processing speed and attention performance (20). Therefore, analysis of resting-state EEG characteristics may reveal the alteration of brain functions in AIDS orphans.

In the commonly resting EEG analysis, a promising approach is a microstate. EEG microstates are defined as global patterns of scalp potential topographies which remain stable for a certain period of time (50–100 ms) before rapidly transitioning to different microstates (21). Most studies demonstrate that the same four classes of archetypal microstates which were labeled as A, B, C, and D can explain most of the global topographic variance (22). According to fMRI-EEG studies, different microstates correspond to certain specific resting-state functional networks. Specifically, microstate class A was associated with the auditory processing, microstate class B with the visual network, microstate class C with the salience network (SN), and microstate class D with the attention (23, 24). According to previous studies, the temporal parameters, such as duration (the mean duration of a microstate class in milliseconds), occurrence (the mean frequency of observation of a microstate class per second), and coverage (the proportion of the total time spent in a microstate class) could reflect the function of brain networks and these parameters could be altered by age, pressure, and diseases (22, 25, 26).

Following what was previously reported, there are many techniques to estimate resting-state EEG FC (27, 28). Among these techniques, The phase locking value (PLV) is especially suitable for connectivity analysis because it quantifies coupling between pairs of electrodes and measures the synchronization of temporal relationships of neural signals independent of their signal amplitude (29, 30). PLV has been used in previous studies to examine FC (31). For instance, a study that measures FC between default mode networks regions of interest and the medial prefrontal regions using PLV found decreased connectivity in the alpha band in older people (32). Rogala et al. found a positive correlation between resting-state PLV and the power of the beta-2 band (22–29 Hz), demonstrating that beta band activity plays an important role in the attentional process (16). In addition, recent studies investigated the correlation between EEG FC and fMRI FC by using different techniques and found that PLV is significantly correlated with fMRI networks compared with other FC methods (33).

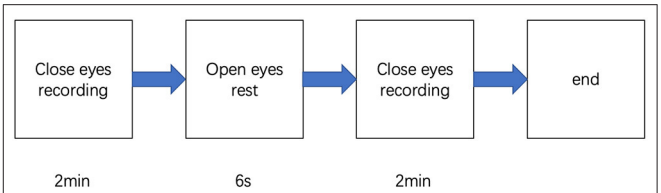

FIGURE 1 | Procedures of the experiment.

This study aimed to investigate the large-scale network across the whole brain in AIDS orphans and compared it to non-orphan controls. To achieve this, the present research will use FC and the microstate approach to analyze the EEG data. The temporal parameters (duration, occurrence, and coverage) will be assessed for the microstate. For FC, the PLV will be used to calculate the functional connection.

METHOD

Participants

Data were derived from a larger neurodevelopmental study in which a total of 91 AIDS orphans and 66 non-orphan children (controls) were recruited from the local communities and school systems in central rural China. The study was open to children at 8–18 years of age who did not have HIV/AIDS-related illnesses. Age eligibility was verified through the local community leaders, school records, or caregivers. Among these participants, 65 AIDS orphans and 66 controls completed the EEG experiment. All the subjects had a normal or adequately corrected vision, were right-handed, and reported no history of mental, medical, or neurological disorders. At the end of the experiment, they received an age-appropriate gift as a token of appreciation. Written informed consent was obtained for the study. Two AIDS orphans and one control child were excluded from further analysis due to an unfinished EEG experiment. The study protocol was approved by the Institutional Review Boards at the University of South Carolina in the United States and Henan University in China (IRB 00007212).

Measures and Procedures

EEG Recording and Preprocessing

Participants were in the eyes-closed resting state when 4-min spontaneous EEG data were collected (**Figure 1**). The EEG was recorded from a 32-scalp standard channel cap (10/20 system; Brain Products, Munich, Germany) (**Figure 2**). An electrooculogram (EOG) was recorded from electrodes placed at the outer canthi of the right eye. All electrode recordings were online referenced to FCz. All inter-electrode impedances were maintained below 5 kΩ. The EEG and EOG signals were amplified using a 0.01–100 Hz bandpass filter and continuously sampled at 500 Hz/channel for offline analysis.

After data acquisition, offline preprocessing was performed with EEGLAB (34). The EEG data were re-referenced to the common average reference. Then, the data were corrected for artifacts using Independent Component Analysis (ICA).

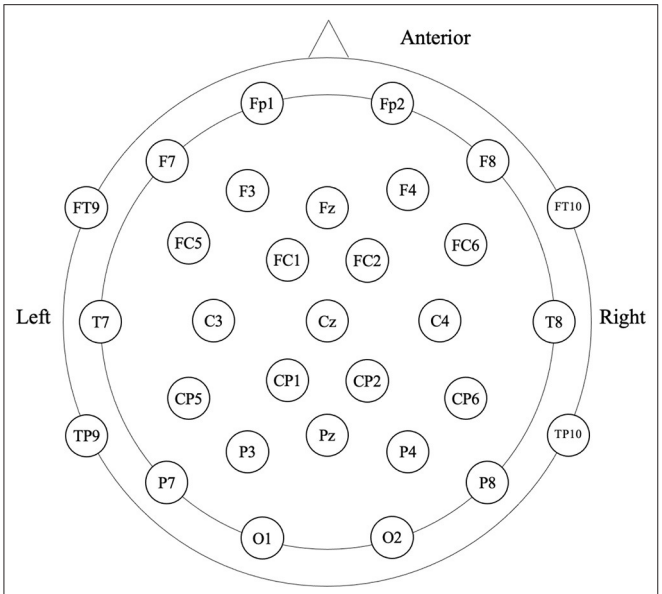

FIGURE 2 | Electroencephalography (EEG) cap configuration with international 10–20 system.

Subsequently, all data were bandpass filtered at 2–20 Hz and segmented in 2 s epochs. Segments were rejected from further analyses if amplitudes exceeded ±100 uV.

EEG Connectivity Analysis

As a measure of synchrony, PLV is used as an indicator of FC between different brain regions. Compared with other indicators of FC, PLV does not depend on the spectral power of recorded signals and is more sensitive for measuring FC (16). In addition, it has good reliability for all frequency bands.

The current source density (CSD) method was used to transform EEG data from scalp electrode space into a reference-free montage (35). The EEG signals of all electrodes from CSD-converted montage are band-pass filtered into four frequency bands [delta (2–4 Hz), theta (4–8 Hz), alpha (8–13 Hz), and beta (13–20 Hz)] and transformed into analytical EEG signals using Hilbert transform (29). For each frequency band, the PLVs were calculated for all pairs of electrodes and generated an $N \times N$ synchronization matrix with N equal to 29, in which each entry $N_{i,j}$ contains the value of the PLV for the channels i and j. The global mean PLV of each subject was calculated based on the $N \times N$ matrix.

Microstate Analysis

As a method of studying EEG, microstate analysis regards the EEG signal as a series of quasi-stable microstates and access the global functional state of the brain by comparing the characteristic of microstate time series (23).

Microstate analysis was performed with the microstate analysis plugin (Version 1.2; http://www.thomaskoenig.ch/Download/EEGLAB_Microstates/) for EEGLAB in Matlab 2018b. The steps were as follows. First, 1,000 global field power (GFP) peaks were selected randomly and were submitted to Atomize-Agglomerate Hierarchical Clustering (AAHC) analysis. Next for each cluster number of microstate maps from 3 to 6 was determined. According to the cross-validation criterion, we found four microstates could explain the variance of 76.26 and 71.75% for two groups. Then, a similar clustering analysis was performed at the group level based on the microstate template maps of all the participants. For the statistical analysis, the three temporal features of the microstates were extracted (duration, occurrence, and, coverage).

Statistical Analysis

In this study, the *t*-test was used to compare the demographic variables between two groups. All the variables with a significant difference will be used as covariates in all the subsequent analyses.

The group differences of EEG connectivity analysis were evaluated separately on each frequency band. A comparison of the group mean PLVs was conducted using one-way analysis of variance (ANOVA). For microstate analysis, the repeated-measures ANOVA was applied with microstate class (A, B, C, and D) as a within-subject factor, and group (AIDS orphans and controls) as a between-subject factor. One-way ANOVA was used to compare groups for temporal parameters of each microstate when the main effects or interactions were significant.

A greenhouse-Geisser correction was conducted to adjust *p*-values when appropriate. All analyses were calculated by SPSS 25.0.

RESULTS

In demographic variables, age was found to be a significant difference between the two groups and included as a covariate in subsequent analyses.

Global Connectivity

The group difference in mean global PLV was calculated with one-way ANOVA and age as a covariate. As shown in **Figure 3**, the mean PLV was significantly lower in AIDS orphans (alpha: 0.415 ± 0.064; theta: 0.389 ± 0.014; delta: 0.559 ± 0.013; and beta: 0.263 ± 0.015) than controls (alpha: 0.419 ±0.073; theta: 0.416 ± 0.062; delta: 0.0571 ± 0.410; and beta: 0.293 ± 0.080) in all frequency bands (alpha: $F_{(1,128)} = 8.446$, $p = 0.004$, $\eta^2 = 0.062$; theta: $F_{(1,128)} = 24.337$, $p < 0.001$, $\eta^2 = 0.160$; delta: $F_{(1,128)} = 15.395$, $p < 0.001$, $\eta^2 = 0.107$; and beta: $F_{(1,128)} = 22.989$, $p < 0.001$, $\eta^2 = 0.152$) (**Table 1**).

Microstate Results

The four microstate classes (A, B, C, and D) of orphans and controls obtained in the whole groups had topographies comparable with those previously found in most microstate studies (**Figure 4**). These microstates accounted for an average of 76.26% (SD = 5.4%) and 71.75% (SD = 7.6%) of the global variance in the AIDS orphans and control group, respectively.

We found significant class (A, B, C, and D) × group (AIDS orphans and controls) interactions for coverage ($F_{(3,375)} = 3.492$, $p = 0.020$, $\eta_p^2 = 0.027$), and occurrence ($F_{(3,375)} = 5.756$,

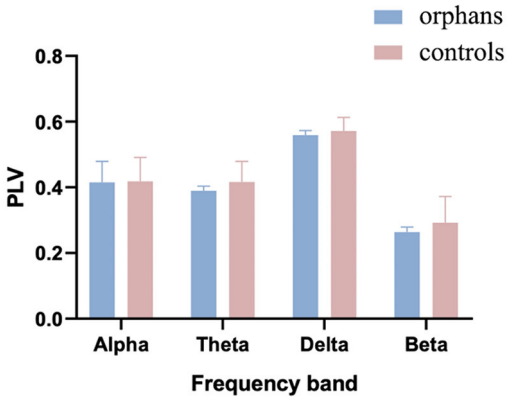

FIGURE 3 | The mean phase-locking value (PLV) averaged over all pairs of EEG channels for AIDS orphans and controls in four frequency bands.

TABLE 1 | The mean phase-locking value (PLV) for AIDS orphans and controls at each frequency.

	Alpha	Theta	Delta	Beta
orphans	0.415 ± 0.064	0.389 ± 0.014	0.559 ± 0.013	0.263 ± 0.015
controls	0.419 ± 0.073	0.416 ± 0.062	0.0571 ± 0.410	0.293 ± 0.080
F	8.446	24.337	15.395	22.989
p	**0.004**	**< 0.001**	**< 0.001**	**< 0.001**

Values are expressed as means ± SD; analysis of variance (ANOVA) test followed by Greenhouse-Geisser correction.
Significant differences are marked in bold.
Orphans, AIDS orphans.

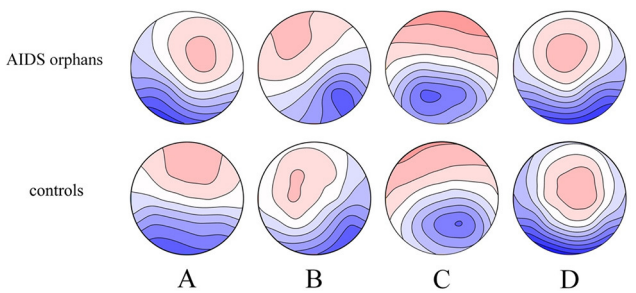

FIGURE 4 | Spatial configuration of the four microstate classes. Each row displays the four topographic configurations **(A–D)** for each group. AIDS orphans, controls.

$p = 0.001$, $\eta_p^2 = 0.044$). In addition, the main effect of duration ($F_{(1,125)} = 4.510, p = 0.036, \eta_p^2 = 0.035$) was significant (**Table 2**).

The group differences were found in specific microstate classes. Specifically, for microstate coverage, orphans showed a significant decrease of microstate B ($F_{(1,125)} = 4.234$, $p = 0.042$, $\eta^2 = 0.033$), and a significant increase of microstate C ($F_{(1,125)} = 6.227$, $p = 0.014$, $\eta^2 = 0.047$) than controls. The occurrences of microstate B ($F_{(1,125)} = 8.262$, $p = 0.005$, $\eta^2 = 0.062$) and D ($F_{(1,125)} = 8.613, p = 0.004, \eta^2 = 0.064$) were higher in controls than in AIDS orphans. AIDS orphans showed significantly increased microstate C duration ($F_{(1,125)} = 8.028$, $p = 0.005$, $\eta^2 = 0.060$) compared with controls (**Table 3**).

TABLE 2 | The results of the 2-way ANOVA for duration, occurrence, and coverage.

	F(df)		*p*	η_p^2
Duration				
Main effects				
Class	$F_{(3,375)}$	0.424	0.709	0.003
Group	$F_{(1,125)}$	4.51	**0.036**	0.035
Age	$F_{(1,125)}$	9.792	**0.002**	0.073
2-way interaction				
Class * group	$F_{(3,375)}$	2.25	0.091	0.018
Class * age	$F_{(3,375)}$	0.181	0.886	0.001
Occurrence				
Main effects				
Class	$F_{(3,375)}$	0.963	0.403	0.008
Group	$F_{(1,125)}$	3.243	0.074	0.025
Age	$F_{(1,125)}$	10.549	**0.001**	0.078
2-way interaction				
Class * group	$F_{(3,375)}$	5.756	**0.001**	0.044
Class * age	$F_{(3,375)}$	1.127	0.335	0.009
Coverage				
Main effects				
Class	$F_{(3,375)}$	0.616	0.605	0.005
Group	$F_{(1,125)}$	1.609	0.207	0.013
Age	$F_{(1,125)}$	2.685	0.104	0.021
2-way interaction				
Class * group	$F_{(3,375)}$	3.492	**0.020**	0.027
Class * age	$F_{(3,375)}$	0.504	0.658	0.004

F(df), F-test (degrees of freedom); p, p-value; η_p^2, partial eta square.
Significant results and differences are marked in bold.
Class, microstate class.

DISCUSSION

The present study aimed to investigate the difference in brain function between AIDS orphans and controls from the perspective of whole brain activities. Here, two novel analytical approaches were used to extract the information from the resting-state EEG data. First, microstate analysis evaluated the spontaneous brain activity and temporal dynamics resting-state networks (RSNs). Second, the altered FC of large-scale brain networks in AIDS orphans was measured. The result of this study showed alterations in microstate parameters and lower FC in all frequency bands for AIDS orphans. These results provide new insight into the brain development of AIDS orphans.

The results of FC suggest that the brain structure and function, as well as development, can be altered even damaged by ELS. This finding is consistent with previous studies that demonstrated ELS may have a negative effect on brain. A large body of studies has highlighted the impaired cognitive and

TABLE 3 | The mean for all microstate parameters of AIDS orphans and controls.

		Microstate A	Microstate B	Microstate C	Microstate D
Duration (ms)	orphans	67.13 ± 9.95	67.38 ± 10.98	68.65 ± 13.71	64.22 ± 11.59
	controls	67.93 ± 10.57	70.19 ± 10.65	63.95 ± 10.33	64.10 ± 7.98
	F (*p*)	1.896 (0.171)	0.028 (0.869)	8.028 (**0.005**)	1.562 (0.214)
Occurrence (s)	orphans	3.78 ± 0.64	3.78 ± 0.73	3.97 ± 0.79	3.77 ± 0.68
	controls	3.66 ± 0.59	4.03 ± 0.65	3.61 ± 0.69	3.90 ± 0.78
	F (*p*)	0.002 (0.964)	8.262 (**0.005**)	1.365 (0.245)	8.613 (**0.004**)
Coverage (%)	orphans	24.76 ± 4.81	24.98 ± 5.54	26.46 ± 6.63	23.81 ± 5.82
	controls	24.58 ± 5.75	27.71 ± 5.65	23.02 ± 6.29	24.69 ± 5.84
	F (*p*)	0.432 (0.512)	4.234 (0.042)	6.227 (0.014)	1.952 (0.165)

Values are expressed as means ± SD; analysis of variance (ANOVA) test followed by Greenhouse-Geisser correction.
Significant differences are marked in bold.
Orphans, AIDS orphans.

affective functioning in children who experienced ELS (36–38). Wang et al. (39)found a decrease FC within prefrontal-limbic-thalamic-cerebella in major depressive disorder patients with ELS. In a study of adolescents with post-traumatic stress disorder, decreased connectivity between the amygdala and mPFC was observed compared with controls (40). In addition, the current study investigated the difference of functional networks between AIDS orphans and controls in four frequency bands. Oscillations in different frequency bands are often related to cognitive functions. The relationship between alpha oscillation and alertness has been reported in several studies (41, 42). Theta oscillation play an important role in working memory (43). Activity of the delta band was observed during the feedback and oscillation of beta related with sensorimotor decision-making (44–48). Thus, the decrease of FC in all frequency bands indicates that the defects in the brain function of AIDS orphans.

In this study, we found an increase in duration and coverage of microstate C in AIDS orphans compared with controls. This result is consistent with previous studies which found the sensitivity to perception altered (49) and neural responses to salient stimuli enhanced in the ELS sample (50). These neural responses are included in SN, which correspond to microstate C. Thus, the increase of microstate C may represent the individual becoming more sensitive to salience events (51). In addition, the SN connectivity in insula was found to be increased in trauma-exposed youth (52) and the SN alteration was found in patients with major depressive disorder (53), posttraumatic stress disorder (54), and anxiety disorders (55).

In contrast to microstate C, we found a reduction in occurrence and coverage of microstate B and a reduction in the occurrence of microstate D in AIDS orphans. According to previous studies, microstate B and D are related to the visual network and attention network, respectively. The decrease in microstate may represent a deficit in attention of AIDS orphans (56–58), which is consistent with the results of FC. Similar results were reported in patients with psychiatric disorders. For instance, studies with schizophrenic found the reduction in microstate B and D (56, 59, 60). A study on bipolar disorder showed that patients with bipolar disorder have a significant reduction in microstate B (61). In combination with the result of microstate C, this study provided further evidence that individuals who experience ELS are more likely to develop psychiatric disorders. Therefore, the altered microstate in AIDS orphans may be a predictor of mental illness.

It is possible that our results reflect impaired brain function in AIDS orphans. These findings give further support to the diatheses-stress hypotheses that the brain adapts to ELS by releasing mediators which may provoke dendritic stunting and atrophy (62, 63) and consequently affect the structure and function of the brain. In addition, previous studies on the effect of ELS on attention were based on task or certain regionals (36, 64). However, in this study, two methods based on the large-scale resting-state EEG data analysis found defects in attention function, which provided further evidence that ELS has effect on attention.

CONCLUSION

The present study showed decreased FC and different microstate dynamics in AIDS orphans. With two independent approaches to analyze EEG resting-state data, we found alterations in the brain function in AIDS orphans, and those alterations were likely to be caused by ELS. These results suggest that functional imaging may be used to detect latent neurodevelopmental effects of ELS exposure, facilitating a better understanding of the pathophysiology and treatment of ELS-related conditions.

Limitations and Future Directions

One limitation of this study is that we only explore the whole-brain network from two different perspectives. Other methods, such as graph theory as well as long- and short-distance FC, have been used to analyze FC in recent studies. Hence, these methods will be taken into account to investigate the large-scale brain network in further studies. In addition, the research is a cross-sectional study. According to previous studies, ELS has a sustained and life-long impact on the brain.

The results of this study reveal the development trajectory of brain with individuals who are preadolescents and undergoing ELS. Thus, the developmental trajectory throughout puberty needs to be explored in a longitudinal study in future studies. Furthermore, this study only explored the characteristics of large-scale resting-state EEG and found the effect of ELS on brain function. However, the effect of ELS on specific cognitive function and its potential neural circuit have not been explored and analyzed. Therefore, in future studies, we will focus on the role of the ventral prefrontal cortex in the acquisition of threat conditions in individuals who experience ELS and exploring its subregional contributions to fear learning and extinction.

DATA AVAILABILITY STATEMENT

The datasets presented in this article are not readily available due to privacy or ethical restrictions. Requests to access the datasets should be directed to JZ, jfzhao63@hotmail.com.

ETHICS STATEMENT

The study protocol was approved by the Institutional Review Boards at University of South Carolina in the United States and Henan University in China. Written informed consent to participate in this study was provided by the participants' legal guardian.

AUTHOR CONTRIBUTIONS

HG, XS, and HH designed the study and drafted the manuscript. XS and HH performed the study, analyzed the data, and editing of the paper. JZ and XL revised the paper. All authors contributed to the article and approved the submitted version.

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Future Orientation Among Children Affected by Parental HIV in China: An Exploratory Analysis of Complex Interactions

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We utilized an exploratory analytic approach to examine predictors of children's future beliefs, an internal asset associated with resilience among children affected by HIV, with emphasis on complex interactions among multisystem factors. Children (N = 1221) affected by parental HIV in China reported on psychosocial functioning, as well as internal, familial, and community resilience assets. Exploratory data analysis was conducted using a binary segmentation program. Six binary splits on predictors accounted for 22.78% of the variance in future expectation, suggesting interactions between children's perceived control of their future, loneliness, caregiver trust, and social support. Four binary splits accounted for 23.15% of the variance in future orientation, suggesting multiway interactions between control of the future, loneliness, social support, and perceived stigma. Findings suggest combinations of resilience factors are associated with children's positive future beliefs. Implications for screening, prevention, and intervention among Chinese children affected by parental HIV are discussed.

Keywords: resilience, future orientation, children affected by HIV, social support, stigma

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INTRODUCTION

Since the beginning of the human immunodeficiency virus (HIV) epidemic in the 1980s, ∼76 million individuals have acquired HIV, and ∼38 million individuals are currently living with the virus [Joint United Nations Programme on HIV/AIDS (UNAIDS, 2020)]. In the past two decades, the number of children infected with HIV through mother-to-child transmission has been dramatically reduced through expanded HIV testing among pregnant women and increased access to antiretroviral therapy for pregnant and breastfeeding women living with HIV (Joint United Nations Programme on HIV/AIDS, 2011; Panel on Treatment of Pregnant Women with HIV Infection Prevention of Perinatal Transmission, 2020). Currently, ∼1.8 million children (i.e., < 15 years of age) are estimated to be living with HIV worldwide (Joint United Nations Programme on HIV/AIDS, 2020). However, many more children are indirectly impacted through parental HIV infection or parental death from Acquired Immune Deficiency Syndrome (AIDS)—particularly in low- and middle-income nations (WHO, 2013).

In China, the earliest documented HIV cases occurred in the 1980s among people with histories of injection drug use and hemophiliacs; these were followed by a rapid rise in HIV cases in central China in the mid-1990s caused primarily by unhygienic commercial blood and plasma collection practices (Wu et al., 1995, 2019; Neild and Gazzard, 1997). Multiple rural farming communities across central China experienced devastating largescale HIV outbreaks over a relatively short period of time (Wu et al., 2001; Sun et al., 2010). By 1995, the outbreaks were identified, resulting in the closure of blood and plasma collection centers in the region and the establishment of nationwide blood collection facilities (Sun et al., 2010). However, by this time, HIV had spread widely within many rural communities in central China, with HIV prevalence rate estimates ranging from 10 to 60% among plasma donors across local villages (Wu et al., 2001; China Ministry of Health UN Theme Group on HIV/AIDS in China, 2003; Li et al., 2010). In addition, the majority of paid plasma donors were young and middle-aged adults between the ages of 20 and 50 years (Wu et al., 2001); thus, many individuals who acquired HIV through plasma donation had spouses and children—creating unique psychosocial challenges for affected families.

Parental illness and parental death have profound impacts on children's development and are heightened within the context of HIV—a highly stigmatized health condition (Cluver et al., 2013). Children who are made vulnerable through parental HIV face a range of challenges, including the potential for orphanhood, if parents are unable to access and adhere to antiretroviral therapy, which did not become widely available in China until the 2000s with the advent of the Chinese government's "Four Frees and One Care" policy (Sun et al., 2010). This policy was designed to provide free access to HIV medications, free voluntary counseling and HIV testing, free prevention of mother-to-child transmission, free schooling for children affected by parental HIV, and social relief for affected families (Sun et al., 2010). Aside from the threat of orphanhood, children made vulnerable by parental HIV are often separated from their HIV-positive parents (i.e., due to parental illness, due to stigma and shame within extended families), and economic insecurity within HIV-affected families is common (Foster and Williamson, 2000; Li et al., 2008; Sherr et al., 2008).

Much of the seminal work exploring the impact of parental HIV on children's mental health has been conducted in central China in partnership with impacted rural communities—notably in Henan province. Chinese children affected by parental HIV have been shown to be at-risk for internalizing disorders (e.g., anxiety, depression), adjustment problems and school-related challenges (Fang et al., 2009; Guo et al., 2012; Du et al., 2015). A systematic review of the impact of parental HIV on children's psychosocial wellbeing found inconsistent effects of children's gender and age on psychosocial outcomes; some studies have found that boys are more susceptible to negative mental health outcomes (e.g., feelings of hopelessness, poor quality of life) than girls following the AIDS-related death of a parent, while other studies have shown no gender differences (Chi and Li, 2013).

Notably, three clusters of risk factors have been consistently identified across contexts to heighten risk for children affected by parental HIV: exposure to traumatic or stressful life events, experience of HIV-related stigma, and socioeconomic disadvantage (Chi and Li, 2013). Within the context of the central China HIV outbreak of the 1990s, children affected by parental HIV are at high risk for trauma exposure (Li et al., 2009). When compared to children not affected by HIV, children with parents who were living with HIV or who had died from AIDS were more likely to have experienced a range of trauma—not only parental death or illness, but also serious accidents and injuries, parental separation or divorce, removal from their biological family, child maltreatment, child sexual abuse, assault, and property crimes (Li et al., 2009).

Children affected by parental HIV also frequently experience high levels of stigma. HIV-related stigma has been defined as the prejudice, discounting, discrediting, and discrimination directed toward individuals living with HIV and groups associated with the virus (Herek, 1999). Importantly, stigma is not only an individual experience but also a socio-cultural process that creates and maintains inequity in cultural standing and social class and contributes to longstanding inequities in systems and structures of power (Foucault, 1977, 1990; Parker and Aggleton, 2002). Children whose parents acquired HIV during the Henan outbreak have reported experiencing significant public stigma from their communities. Both perceptions of community-held stigma and personal experiences of stigma are associated with poorer psychosocial functioning (Lin et al., 2010).

Fortunately, not all children impacted by parental HIV demonstrate adverse outcomes over time, and efforts to identify and cultivate resilience factors among children affected by HIV have gained momentum in the past decade (Chi et al., 2014a). Here we define resilience as, "the process and outcome of successfully adapting to difficult or challenging life experiences, especially through mental, emotional, and behavioral flexibility and adjustment to external and internal demands" (VandenBos, 2007). Notably, Li et al. (2015) have developed a conceptual framework that delineates resilience factors across three levels—child, family, and community—that can help buffer the negative impacts of parental HIV for children. Specifically, the model integrates concepts from Bronfenbrenner's (1979) ecological systems theory of human development and from theories of resilience (Luthar et al., 2000; Masten, 2011; Ungar et al., 2013) to highlight protective factors across child (e.g., positive beliefs, coping skills), family (e.g., secure caregiver attachment, positive parenting skills), and community domains (e.g., peer and community support) that can reduce risk and promote positive developmental outcomes for children made vulnerable by HIV. This framework of psychological resilience for children affected by HIV (Li et al., 2015) builds on existing calls for moving away from deficit-based perspectives in order to adopt resilience or strengths-based approaches to mitigate the negative impacts of parental HIV on children's development (Skovdal and Daniel, 2012; Betancourt et al., 2013; Li et al., 2015).

In terms of individual resilience assets, children's beliefs—particularly beliefs about the future—have been identified as salient to a range of cognitive and behavioral processes that impact developmental outcomes. Children who believe they will be successful in the future are more likely to persist when

confronted with challenges (Bandura, 1977a,b; Masten, 2011), and positive beliefs about the future are a key protective factor associated with reduced engagement in risky behaviors for children and adolescents (Robbins and Bryan, 2004; Herrenkohl et al., 2005; Peters et al., 2005; Cabrera et al., 2009). At-risk children who have consistently high future orientation or who show positive growth in future orientation during adolescence have been shown to have greater achievement of key developmental milestones in adulthood (i.e., greater income, social capital, employment; Oshri et al., 2018). In addition, positive future orientation mitigates the impact of adversity on child outcomes (Cui et al., 2020).

Because children affected by parental HIV often lack family support and community resources to set them up for future success, their own beliefs and motivations about the future are very important for maintaining mental health and wellbeing as they cope with the adversity associated with familial HIV (Auslander et al., 1998; Li et al., 2015). In fact, future orientation has also been found to be an important mediator of the relationship between trauma exposure and psychosocial functioning among children affected by HIV in rural central China (Zhang et al., 2009). Thus, within the uniquely stigmatizing context of HIV, children's beliefs about the future and related constructs, such as sense of control over their environment, self-efficacy, and self-esteem, are potentially vital resilience assets (Wang et al., 2012; Li et al., 2015). And given a more recent shift from a deficit focus (e.g., on psychopathology outcomes) to a more resilience-based focus (i.e., to more positive outcomes), it will be essential to understand how these individual assets might be promoted. To complement research on how these internal assets are protective against poor mental health outcomes, it will also be critical to study these resilience factors as outcomes, to better understand which youth might be at risk for low levels of these internal assets, as well as how these essential assets might be bolstered.

Beyond individual resilience assets, social support is critical for children's development. For example, previous research among Chinese children affected by parental HIV indicates that, when controlling for key covariates (e.g., gender, age, socioeconomic status [SES], orphanhood status), having a trusting relationship with a caregiver is significantly associated with a range of positive psychosocial outcomes such as self-esteem, school interest, social skills, and hopefulness about the future; Zhao et al., 2011). In addition, perceived social support from friends, family, and teachers has been identified as a significant predictor of positive psychosocial adjustment among children affected by parental HIV in Henan, China, independent of children's gender, age, SES, and orphanhood status (Hong et al., 2010).

While multi-level resilience factors have been identified as protective for psychosocial development among Chinese children made vulnerable by HIV, greater understanding is needed of how risk and resilience factors interact to promote the internal assets of youth. Here we focus on the outcome future orientation, which has been linked to other positive developmental outcomes and is likely an essential asset to target in preventive interventions for this population (Bandura, 1977b; Masten, 2011; Oshri et al., 2018). It has long been recognized that interactions amongst risk and protective factors are integral to models of resilience for at-risk children (Masten, 2001). For children affected by parental HIV, internal assets, family resources, and community resources interact to buffer or mitigate the deleterious effects associated with parental HIV (e.g., stigma, trauma; Li et al., 2015). The current research uses an exploratory analytic approach to examine salient protective factors from Li et al. (2015) resilience framework to predict future orientation outcomes. Specifically, we leverage the SEARCH algorithm, a binary segmentation program for exploratory data analysis, that aims to account for unexplained variance in a defined outcome (Morgan and Sonquist, 1963; Sonquist et al., 1973; Morgan, 2005). SEARCH has been coined an "automatic interaction detector", given utility in detecting complex, multiway interactions (Sonquist et al., 1973). Using SEARCH, we aim to improve prediction of an important resilience-related asset, positive future orientation, by splitting all possible candidate predictors in a sample of Chinese children impacted by parental HIV. By using candidate predictors informed by the resilience framework outlined by Li et al. (2015), the current research places an emphasis on understanding the manner in which multisystem factors interact to bolster this important internal asset among children affected by parental HIV.

MATERIALS AND METHODS

Sample and Procedures

Data for the current study are derived from the baseline data collection of a broader project to understand psychosocial adjustment of children affected by parental HIV in China. Participants include children and adolescents from Henan, China, a province that has been highly impacted by the HIV epidemic due to unhygienic blood and plasma donation practices in the 1990s (Wu et al., 1995, 2001; Neild and Gazzard, 1997). Children aged 6 to 18 years were eligible to participate in the current study. Additionally, children had to either have a biological parent living with HIV or be an AIDS orphan (i.e., lost one or both parents to an AIDS-related death) to be eligible for this secondary data analysis.

Children were recruited for the study in partnership with local government-funded orphanages and group homes, as well as local village leaders. A total of four government-funded orphanages and eight village-level group homes took part in recruitment efforts. In addition, the research team worked with village leaders to generate lists of families affected by the HIV outbreak (i.e., in which one or both parents had acquired HIV) and to identify lists of families caring for local AIDS orphans. Working in close partnership with community leaders and stakeholders, the research team approached orphanages, homes, and families about the study opportunity, and children were invited to take part, with children providing assent and parents or government-appointed guardians providing consent. The study protocol, including consenting process, was approved by institutional review boards at Wayne State University in the United States and Beijing Normal University in China.

This recruitment process yielded a sample for the current study that consisted of 1,221 Chinese children impacted by parental HIV. Child demographic information is shown in **Table 1**. Each child participating in the study completed a paper-pencil survey battery in Chinese. The battery included demographic items as well as scales assessing psychosocial factors. The entire battery took around 75 to 90 minutes to complete, depending on the age of the child. Research staff read items aloud to younger children and those with reading difficulties, and breaks were provided to children as needed. Research staff also provided clarification if children had questions about items. All children who participated received a small gift at the completion of the survey battery in appreciation of their time.

Measures

Selection and translation (when needed) of scales used in the current study have been described in detail elsewhere (Fang et al., 2009). Briefly, the research team initially identified scales that were available in Chinese and had already been validated with Chinese samples. Chinese scales were not initially available for some variables of interest. In these instances, a Chinese-English bilingual research team used a forward-backward translation process to translate English scales into Chinese; items and wording were reviewed by a group of Chinese faculty in psychology and education departments at the partnering Chinese university to ensure cultural and developmental appropriateness. All translated scales were piloted with Chinese children to check for comprehension and ensure that meaning remained intact.

Outcome Measures

The primary outcomes of the current study were two measures assessing children's beliefs about their future.

TABLE 1 | Child demographic information.

	Frequency	Percentage
Male	622	50.9
Children in orphanage care	176	14.4
Children in kinship care	579	47.4
Children living with an affected parent	466	38.2
Age		
6	1	0.1
7	5	0.4
8	26	2.1
9	65	5.3
10	114	9.3
11	122	10.0
12	188	15.4
13	176	14.4
14	194	15.9
15	158	12.9
16	131	10.7
17	28	2.3
18	3	0.2
Missing	10	0.8

Future Expectation

Children's future expectations were assessed with a modified Chinese scale based on the *Children's Future Expectation Scale* (Bryan et al., 2005). This modified scale consisted of six items rated on a five-point Likert scale that assessed children's certainty of accomplishing generalized outcomes in the future. Example translated items include, "How sure are you that you can handle the problems that might come up in your life in the future?", "How sure are you that you will have interesting things to do in your life?", and "How sure are you that you will have a happy life?" Higher mean scores indicated greater certainty in generalized outcomes in the future. The measure demonstrated good internal consistency in the analytic sample ($\alpha = 0.84$).

Future Orientation

Children's future orientation was measured with a translated scale consisting of four items rated on a four-point Likert scale (Whitaker et al., 2000). The four items captured aspects of specific future socioeconomic attainment, for example, "How likely do you think it is that you will graduate from high school or get your GED some day?" and "How likely do you think it is that you will get a good job some day?". Higher mean scores indicated a more positive future orientation specifically related to socioeconomic attainment. Cronbach's alpha showed adequate internal consistency ($\alpha = 0.78$) for the future orientation scale.

Predictor Variables

Several predictor variables were selected for potential inclusion in the binary segmentation model that corresponded to the difficulties associated with parental HIV, as well as the child, family, and community resources that are theorized to be assets that promote resilience among these vulnerable children (Li et al., 2015). Descriptive statistics for all potential predictors are presented in **Table 2**.

Demographic Covariates

Children reported on a variety of demographic characteristics including gender, age, and county of residence; these were all specified as potential predictors for the model.

Impact of Parental HIV

The following covariates were included as potential predictors to reflect some of the ways in which a child may be impacted that may reduce the likelihood of positive resilience related outcomes.

Orphan Status. The sample included children made vulnerable by parental HIV (i.e., one or both parents are HIV-positive), single orphans (i.e., one parent has died due to AIDS), and double orphans (i.e., both parents have died due to AIDS). The potential additive effect of being an orphan, in comparison to a vulnerable child living with an HIV-positive parent, was specified as a potential predictor.

Living Situation. Previous literature has suggested that AIDS orphans have different psychosocial outcomes based on their living situation (i.e., institutional care vs. familial care; Fang et al., 2009). Therefore, this variable was included as a potential predictor of resilience related outcomes.

TABLE 2 | Descriptive statistics and correlations for potential SEARCH predictors and outcomes.

Scale	Mean (SD)	Percent Missing	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Future expectation	3.02 (0.92)	0.98	1.00													
2. Future orientation	2.80 (0.74)	0.90	0.47**	1.00												
3. Perceived control of the future	2.93 (0.50)	1.15	0.43**	0.50**	1.00											
4. Life incidence of traumatic events	2.93 (2.53)	3.03	−0.01	−0.05	−0.08**	1.00										
5. Stigma against children affected by AIDS scale	2.13 (0.70)	0.57	−0.16**	−0.14**	−0.18**	0.12**	1.00									
6. Experienced stigma scale	1.61 (0.60)	3.44	−0.10**	−0.10**	−0.25**	0.28**	0.31**	1.00								
7. Depression scale for children	0.97 (0.43)	0.16	−0.10**	−0.09**	−0.22**	0.30**	0.23**	0.53**	1.00							
8. Trusting relationship questionnaire	2.51 (0.71)	0.16	0.28**	0.24**	0.27**	0.06*	−0.11**	0.05	0.01	1.00						
9. Children's loneliness scale	2.52 (0.70)	0.33	−0.39**	−0.31**	−0.43**	0.05	0.20**	0.32**	0.31**	−0.25**	1.00					
10. Perceived social support–family	3.26 (1.04)	0.49	0.27**	0.21**	0.21**	−0.02	−0.14**	−0.06*	−0.09**	0.40**	−0.23**	1.00				
11. Perceived social support–friend	3.00 (1.01)	0.66	0.24**	0.22**	0.18**	0.00	−0.09**	−0.04	−0.03	0.37**	−0.23**	0.59**	1.00			
12. Perceived social support–teacher	2.93 (1.07)	0.74	0.20**	0.17**	0.10**	−0.04	−0.10**	0.02	−0.03	0.26**	−0.13**	0.52**	0.51**	1.00		
13. Perceived social support–other	3.16 (1.06)	0.49	0.25**	0.23**	0.23**	−0.01	−0.15**	−0.08**	−0.05	0.37**	−0.26**	0.63**	0.63**	0.47**	1.00	
14. Schoolagers coping strategies inventory	1.73 (0.40)	0.66	0.05	0.01	−0.05	0.30**	0.11**	0.34**	0.32**	0.28**	0.10**	0.12**	0.19**	0.10**	0.12**	1.00

*Correlation is significant at the 0.05 level. **Correlation is significant at the 0.01 level.

Life Incidence of Traumatic Events (LITE). The LITE (Greenwald and Rubin, 1999) was utilized in the current project to assess children's exposure to traumatic events. The original 17-item LITE was utilized in a translated format with the addition of one item specifically associated with being impacted by parental HIV. Example items include being "taken away from family" and "been hit, whipped, beaten, or hurt by someone". The focal composite score from this measure was the total number of types of incidences that the child endorsed experiencing. Higher scores indicated that the child endorsed experiencing more types of traumatic events.

The Stigma Against Children Affected by AIDS Scale. This scale (Zhao et al., 2010) consisted of 10 Likert-style items aimed at assessing the child's perspective of public stigma toward children impacted by parental HIV. Items were rated on a four-point scale, with higher scores suggesting that the child perceived greater public stigma against children affected by HIV. Example items include, "Most people think AIDS orphans should leave their villages" and "Most people do not think AIDS orphans deserve sympathy". A mean score was used as a predictor in the current project, with higher scores indicating greater perceived stigma against children impacted by parental HIV. This scale demonstrated good internal consistency ($\alpha = 0.87$).

Experienced Stigma Scale. This scale (Zhao et al., 2012) consisted of 14 Likert-style items that assessed how frequently children had experienced a range of stigmatizing acts related to being affected by parental HIV. Items were rated on a five-point scale ranging from "never" to "always". Example items include, being "physically abused by other people or other kids" and "kids stopped playing with me". In the current study, a mean score was employed as a predictor, with higher scores indicating increased experiences of stigma. This scale demonstrated good internal consistency ($\alpha = 0.88$).

Center for Epidemiological Studies Depression Scale for Children. This measure (Fendrich et al., 1990) was a 20-item, self-report of symptoms of depression during the past week. Children responded on a four-point scale. Example items include, "I felt down and unhappy" and "I felt like crying". A mean score was used in the current study, with higher scores indicating greater depressive symptoms. This measure demonstrated good internal consistency ($\alpha = 0.81$).

Children's Loneliness Scale. The Chinese-adapted version of this scale (Asher et al., 1984; Wang, 1993) was utilized which consisted of 24 total items. Of the 24 items, eight items were unrelated items and not utilized to calculate a score (e.g., "I play sports a lot"). Sixteen items were child self-reported items assessing a child's perceived level of loneliness and social dissatisfaction. Items were rated on a five-point scale ranging from "strongly disagree" to "strongly agree". Example items include, "I have nobody to talk to" and "I have lots of friends", which was reverse scored. A mean score of the 16 items was used in the current study, with higher scores reflecting increased levels of loneliness and social dissatisfaction. Alternatively, lower scores demonstrated social strengths (e.g., "I'm good at working with

other children" [reverse scored]). This measure demonstrated good internal consistency (i.e., $\alpha = 0.80$).

Resilience Assets—Children's Internal Resources

The internal, possible resilience-promoting assets were assessed by the following scales:

Schoolagers Coping Strategies Inventory. This measure (Ryan-Wenger, 1990) was a 26-item scale assessing the child's frequency of utilization of various types of coping strategies. The child rated each item on a four-point scale. Example items included how often the child endorsed that they: "Draw, write or read something" and "Pray". A mean score was used in the current study, with greater scores indicating more frequent use of the various types of coping strategies. In the current study sample, this measure demonstrated adequate internal consistency (i.e., $\alpha = 0.81$).

Perceived Control of the Future. This is a seven-item scale (Whitaker et al., 2000) that assessed a child's disposition-oriented beliefs about their control of the future, a construct closely tied to general self-efficacy (Bandura, 1977a). Items were rated on a four-point scale. Example items include, "I can do just about anything I set my mind to do" "What happens to me in the future mostly depends on me", "It's really no use worrying about the future, because what will be will be", and "My future is what I make of it". A mean score was used in the current study, with higher scores indicating greater perceived control of the future. The internal consistency estimate (α) of this scale was 0.63.

Resilience Assets—Family Resources

The following scale was used to assess a possible resilience-related asset in the caregiving domain:

Trusting Relationship Questionnaire. This scale (Mustillo et al., 2005) was comprised of 15-items that assessed the child's perceptions of whether they had a quality relationship with their current caregiver. Items were rated on a five-point scale. Example items include, "Do you share personal information about yourself with 'caregiver'?" and "Do you enjoy spending time with 'caregiver'?". A mean score was used as a predictor in the current study, with higher scores indicating a higher quality, trusting relationship between the child and current caregiver. This measure demonstrated good internal consistency ($\alpha = 0.86$).

Resilience Assets—Community Resources

The following scale was used to reflect broad community assets related to social support (e.g., peer, teacher):

Multi-dimensional Scale of Perceived Social Support. This scale was adapted from the original scale created by Zimet et al. (1988) to add items assessing support from teachers and to reduce the number of Likert-style response options (i.e., five-point scale rather than seven-point scale). The full scale consisted of 16 items with four subscales reflecting social support from family, friends, teachers and other sources (i.e., a "special person"). Items were rated on a five-point scale. Example items include, "I can count on my friends when things go wrong", "I can talk about my problems with my family" and "My teachers really try to help me". In the current study, a mean score for each subscale (i.e., family support, friend support, teacher support, other support) was used as a predictor, with higher scores indicating increased levels of social support. These subscales demonstrated adequate internal consistency ($\alpha = 0.70 - 0.75$).

Analytic Plan

Analysis was conducted using the SEARCH algorithm in STATA, a binary segmentation program for exploratory data analysis (Morgan and Sonquist, 1963; Sonquist et al., 1973; Morgan, 2005). As described in Sonquist et al. (1973, p. 11), "[SEARCH] divides the sample, through a series of binary splits into a mutually exclusive series of subgroups…They are chosen so that at each step in the procedure, the two new means account for more of the total sum of squares (reduce the predictive error more) than the means of any other pair of subgroups." SEARCH has been coined an "automatic interaction detector" (Sonquist et al., 1973), given its utility in detecting complex, multiway interactions. While exploratory in nature, SEARCH also incorporates theory by selecting among researcher-specified, candidate predictors, here specified per the conceptual framework of risk and resilience for Chinese children affected by parental HIV, to optimally account for unexplained variance in child future orientation and future expectations.

One SEARCH run was conducted for each specified outcome, for a total of two runs of analysis. Each analysis was conducted with the same set of potential predictors described above. Program defaults were used to reduce the error variance in each outcome. For a split to occur, the minimum increase in explanatory power was set at 0.80%. The maximum number of splits and the fewest number of cases allowable in a subgroup were set at 25. Analyses were conducted on cases that had complete data across all selected predictors and the outcome.

RESULTS

SEARCH Algorithm Results

Demographic data for the full sample and descriptive statistics for all SEARCH predictors are shown in **Tables 1**, **2**, respectively. Results from the SEARCH binary segmentation are presented in **Tables 3**, **4** and shown in **Figures 1**, **2**. Key algorithm results for the two future-oriented outcomes are described below.

Future Expectation

The overall analytic sample mean (n = 1,105) for future expectation was 3.03 as rated on the five-point scale. The SEARCH algorithm was conducted with the full array of potential predictors described above. The run resulted in six binary splits on four predictors (i.e., future control, loneliness, caregiver trust, and family social support) and seven final groups (see **Figure 1**; final groups 7–13). Altogether, this model accounted for 22.78% of the variance in future expectations. A one-way ANOVA suggested a significant main effect of final group membership on future expectation, $F(6, 1{,}098) = 53.97$, $p < 0.001$. See **Table 3** for final group descriptive statistics, between-group

TABLE 3 | SEARCH-ing for future expectation: final search groups, descriptive statistics, and mean differences.

Final group	Description	N	Future expectation		Tukey HSD *post-hoc* test (Hedge's *g* [95% CI])					
			M	*SD*	*v. Gr 8*	*v. Gr 9*	*v. Gr 10*	*v. Gr 11*	*v. Gr 12*	*v. Gr 13*
Gr 7	Mid-high future control; Mid-high loneliness	381	3.15	0.81	−1.21** (−1.46) [−1.77 – −1.55]	−0.65** (−0.77) [−0.96 to −0.59]	−0.51** (−0.62) [−0.87 to −0.37]	−0.13 (−0.16) [−0.33 to 0.001]	0.06 (0.09) [−0.25 to 0.42]	0.59** (0.78) [0.59 to 0.97]
Gr 8	Low-mid future control; Mid-high loneliness; Low family social support	49	1.95	0.89		0.55** (0.61) [0.29 −0.93]	0.70** (0.78) [0.40 – 1.15]	1.08** (1.38) [1.05 – 1.71]	1.27** (1.42) [0.94 to 1.90]	1.80** (2.48) [2.09 to 2.88]
Gr 9	Low-mid future control; Mid-high loneliness; Mid-high family social support	175	2.50	0.90			0.14 (0.16) [−0.11 −0.43]	0.52** (0.63) [.43 −0.84]	0.72** (0.80) [.44 – 1.16]	1.25** (1.57) [1.33 to 1.81]
Gr 10	Low-mid future control; Low-mid loneliness; Low caregiver trust	75	2.64	0.89				0.38* (0.48) [0.23 to 0.75]	0.57* (0.65) [0.25 to 1.05]	1.10** (1.49) [1.19 to 1.79]
Gr 11	Low-mid future control; Low-mid loneliness; Mid-high caregiver trust	219	3.02	0.75					0.20 (0.26) [−0.09 to 0.61]	0.73** (1.02) [0.81 to 1.23]
Gr 12	Mid-high future control; Low loneliness; Low family social support	37	3.22	0.90						0.53* (0.74) [0.38 to 1.10]
Gr 13	Mid-high future control; Low loneliness; Mid-high family social support	169	3.75	0.67						

*$p < 0.01$, **$p < 0.001$.

TABLE 4 | SEARCH-ing for future orientation: final search groups, descriptive statistics, and mean differences.

Final group	Description	*N*	Future orientation		Tukey HSD *post-hoc* test (Hedge's *g* [95% CI])			
			M	*SD*	*v. Gr 6*	*v. Gr 7*	*v. Gr 8*	*v. Gr 9*
Gr 4	Low-mid future control; low-mid loneliness	294	2.68	0.69	0.26** (0.42) [0.23 to 0.60]	0.47** (0.77) [0.62 to 0.93]	−0.36** (−0.49) [−0.68 to −0.30]	−0.84** (−1.15) [−1.46 to −0.84]
Gr 6	Mid-high future control, low other social support	180	2.95	0.58		0.20* (0.36) [0.19 −0.54]	−0.62** (−0.90) [−1.12 to −0.69]	−1.10** (−1.67) [−2.02 to −1.32]
Gr 7	Mid-high future control, high other social support	409	3.15	0.54			−0.82** (−1.32) [−1.51 to −1.12]	−1.30** (−2.22) [−2.54 to −1.89]
Gr 8	Low-mid future control, mid-high loneliness, low-mid perceived stigma	176	2.32	0.80				−0.48** (−0.57) [−0.89 to −0.25]
Gr 9	Low-mid future control, mid-high loneliness, mid-high perceived stigma	49	1.85	0.89				

*$p < 0.01$, **$p < 0.001$.

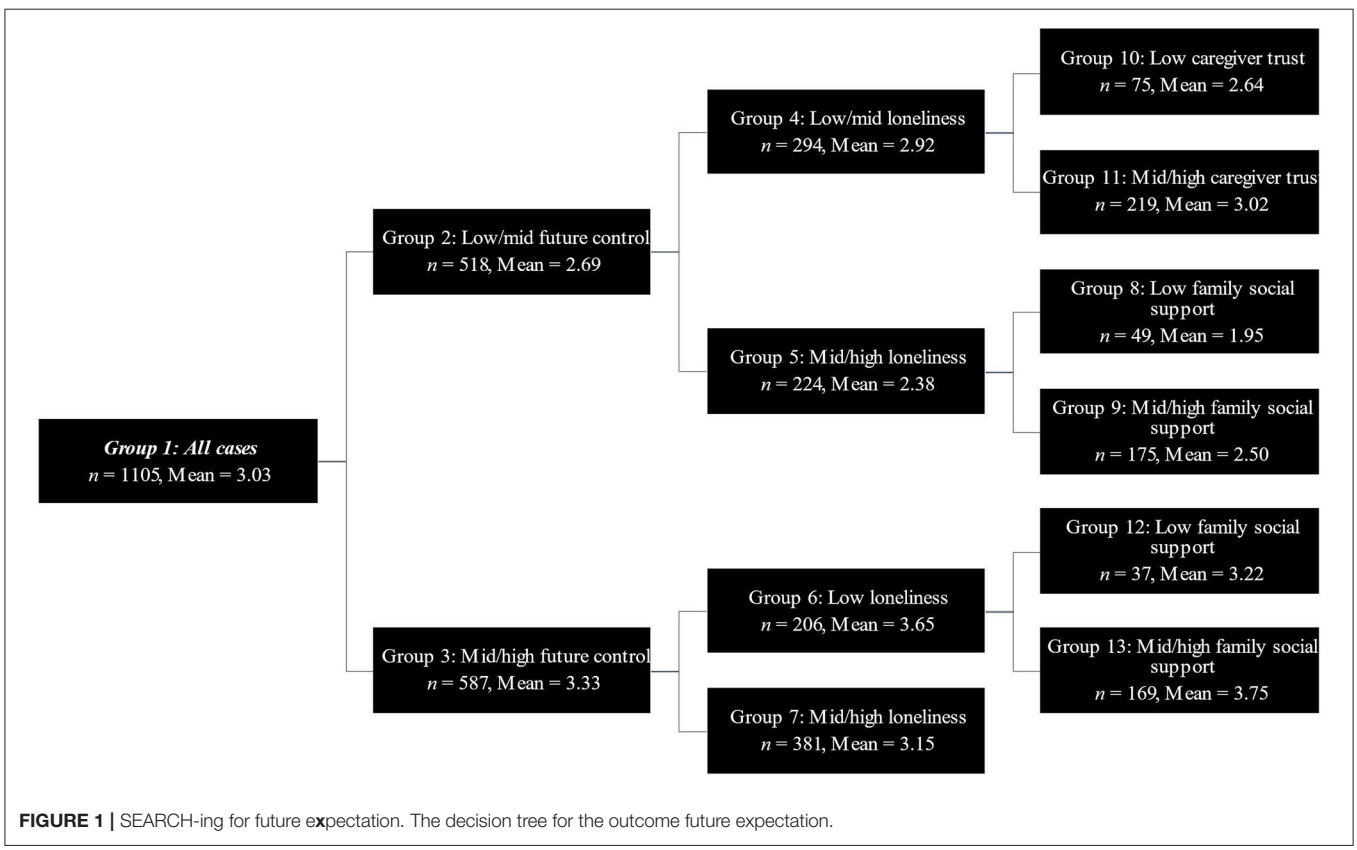

FIGURE 1 | SEARCH-ing for future e**x**pectation. The decision tree for the outcome future expectation.

effect size estimates (i.e., Hedge's *g*) and *post hoc* comparisons using Tukey's Honestly Significant Difference (HSD) *post hoc* test. Notably, group 13, which consisted of children reporting mid-high control of the future, low loneliness, and mid-high family social support, reported the highest mean level of future expectation ($M = 3.75$, $SD = 0.67$, $N = 169$). Group 8, which consisted of children reporting low-mid future control, mid-high loneliness, and low family social report, reported the lowest levels of future expectation ($M = 1.95$, $SD = 0.89$, $N = 49$).

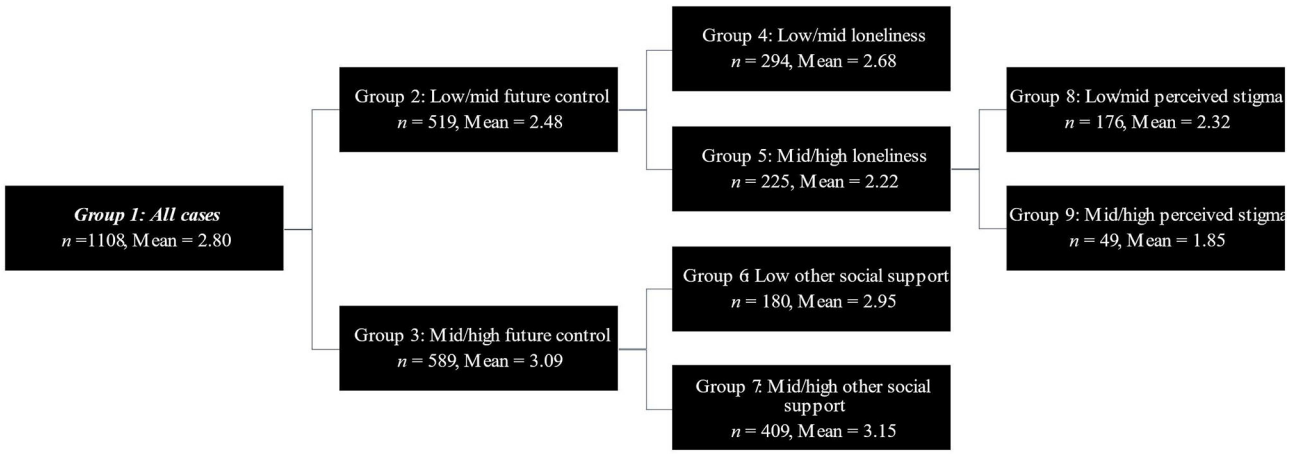

FIGURE 2 | SEARCH-ing for future orientation. The decision tree for the outcome future orientation.

Future Orientation

The overall sample mean (n = 1,108) for future orientation was 2.80, as rated on a 4-point scale. The SEARCH algorithm was conducted with the full array of potential predictors described above. The run resulted in four binary splits on four predictors (i.e., future control, loneliness, other social support, and perceived stigma) and five final groups (see **Figure 2**; final groups 4, 6–9). Altogether, these binary splits accounted for 23.15% of the variance in future orientation. A one-way ANOVA suggested a significant main effect of final group membership on future orientation, $F(4, 1{,}103) = 83.06$, $p < 0.001$. See **Table 4** for final group descriptive statistics, between-group effect size estimate (i.e., Hedge's g), and *post hoc* comparisons using Tukey's HSD *post hoc* test. Children in group 7, who reported mid-high control of the future and mid-high other social support, also demonstrated the highest mean levels of future orientation ($M = 3.15$, $SD = 0.54$, $N = 409$). Alternatively, children in group 9, who reported low-mid control of the future, mid-high loneliness, and mid-high perceived stigma, reported the lowest mean levels of future orientation ($M = 1.85$, $SD = 0.89$, $N = 49$).

DISCUSSION

While parental HIV places affected children at risk for negative social, emotional, behavioral, and educational outcomes (Li et al., 2008; Cluver et al., 2013), not all children demonstrate negative developmental trajectories (e.g., Chi et al., 2014a). Recent work has emphasized the need for a "shift from a deficit perspective to strength perspective" (Li et al., 2015, p. 218) to focus on resilience in children impacted by parental HIV. In particular, resilience-related assets at the child, family, and community levels have been identified as important for helping to buffer the risks associated with parental HIV, including HIV-related stigma (Li et al., 2015). The present research aimed to identify factors that interact to bolster positive future beliefs that have been identified as important resilience-related internal assets (Bandura, 1977a,b; Masten, 2011; Li et al., 2015).

Exploratory binary segmentation analyses identified several important predictors that interacted to predict children's future beliefs, including their perceptions about control of the future, trust in and support from others (e.g., caregivers, other family members, peers), feelings of loneliness, and perceptions of stigma. In the first exploratory analysis, children who reported high levels of perceived control of the future, low levels of loneliness, and high levels of family social support had the highest mean level of positive expectations about the future, such as expecting that they will have a happy life and be able to successfully cope with future challenges. Conversely, the group of children with the lowest mean levels of future expectation were children with low perceived control of the future, high levels of loneliness, and low family support. In the second analysis, children that had high perceived control over the future and reported high social support demonstrated the highest mean levels of future orientation. Alternatively, children that reported low perceived control of the future, high levels of loneliness, and high levels of perceived stigma against children impacted by parental HIV demonstrated the lowest mean levels of future orientation.

In line with current literature (Betancourt et al., 2013; Chi et al., 2015), this research suggests that many children impacted by parental HIV demonstrate important resilience-related assets. For instance, more than half of children in the current sample reported that they believed that it was "possible" or "very possible" that they would achieve specific positive outcomes in the future (e.g., graduate high school, achieve a good job, own a car, have a nice place to live). This suggests, that within this at-risk sample impacted by parental HIV, many children maintain a positive future outlook despite their challenging life circumstances (e.g., parental illness and separation, socio-economic disadvantage, community stigma).

Further, findings from our analyses suggest that, it may be important to jointly target several support systems external to the child, as well as internal resilience-related assets, to promote positive future-oriented beliefs for this vulnerable group of

children. Child control of the future has been identified as an important factor that is promotive of positive child psychosocial outcomes in at-risk children in China (Zhang et al., 2009; Su et al., 2017). In the current study, children's perceptions about control over their future, a construct closely tied to self-efficacy, were associated with positive future beliefs. It is important to note here that conceptually and statistically (i.e., see bivariate correlations in **Table 2**), future expectation, orientation, and control are related but distinct constructs (i.e., all $rs < 0.5$). While the future expectation scale assesses a generalized belief about the future (e.g., "How sure are you that you will have a happy life?") and the future orientation scale assesses specific expectations about socioeconomic attainment (e.g., "How likely do you think it is that you will graduate from high school or get your GED some day?"), the future control scale assesses how the child's efforts, capabilities, and agency are specifically linked to their future (e.g., My future is what I make of it"). This suggests a potentially important role for self-efficacy—or an individual's beliefs about their ability to perform a given task—in promoting resilience among this population (Bandura, 1977a; Betz and Hackett, 1981). At least one community-based intervention has been developed for children affected by parental HIV in South Africa that specifically targets children's self-efficacy; the Make A Difference (MAD) about Art program in South Africa aims to increase self-efficacy among children and adolescents (ages 8–18 years) affected by parental HIV, with children assigned to a quasi-experimental intervention condition showing increases in self-reported self-efficacy when compared to a comparison group that did not take part in the intervention (Mueller et al., 2011). This intensive intervention (i.e., 50+ sessions over a 6-month period) was led by trained and supervised peer 'youth ambassadors' who delivered therapeutic art and psychoeducation content, with an emphasis on self-advocacy and empowerment (Mueller et al., 2011).

Moreover, children demonstrating greater perceived control of the future and greater social support (i.e., family or other social support from a "special person"), demonstrated the highest levels of future orientation. Findings in the current study highlighted important roles for loneliness and social support for children affected by parental HIV, with low levels of loneliness and increased family or other social support associated with more positive future beliefs. Previous research has shown that parental HIV infection can be associated with social maladjustment and disruptions in important social supports (for review see Chi and Li, 2013). For example, parental HIV can strain parenting behaviors and caregiver-child relationships (Rochat et al., 2017). The current study emphasizes the potential protective role of supportive familial and/ or caregiver-child relationships for children made vulnerable by HIV and shows a role for these factors in helping children to adopt future-oriented beliefs. Previous research has also underscored the importance of social support for children impacted by parental HIV (e.g., Hong et al., 2010). The present research extends this to highlight how different types of social support (e.g., family support, support of a "special person") interact with other internal assets (e.g., perceived control of the future) to promote positive future orientation.

At the community-level, results suggest that perceived community stigma is detrimental to child wellbeing. This aligns with literature that indicates that perceived and experienced stigma are associated with poorer child outcomes, including poorer mental health (Chi et al., 2014b; Domlyn et al., 2020). However, it should be noted that only perceived stigma, and not experienced stigma, was selected for inclusion as a predictor in the SEARCH algorithm. These findings further suggest that perceived stigma is an important risk factor, with new evidence that perceived stigma interacts with other factors to reduce future orientation. Much of the intervention research to date has targeted a general population and focused on reducing stigmatizing beliefs surrounding infected HIV individuals (Brown et al., 2003). Less intervention research has focused on reducing stigma surrounding affected, but not infected family members (Brown et al., 2003; Chi et al., 2014b). While the present study was not an intervention study, it may inform potential targets for future prevention and intervention efforts. Future research should explore additional strategies to reduce community stigma impacting children affected by parental HIV, paying particular attention to the additional factors that may interact with stigma, notably loneliness and perceived control of the future.

Recently, a multi-level intervention designed to promote resilience among children affected by parental HIV has been developed based on Li and colleagues' conceptual framework of resilience (Li et al., 2015); the *Child-Caregiver-Advocacy Resilience* (*ChildCARE*) intervention aims to reduce risk and bolster positive outcomes among children affected by parental HIV in China by intervening at the child, caregiver, and community level. Recent evaluation of the intervention using a cluster-based randomized controlled trial and following enrolled children over a 3-year period has found the intervention to be efficacious in improving a number of key psychosocial outcomes for both children and caregivers (Harrison et al., 2017, 2018, 2019; Li et al., 2017). Findings from the current study could potentially be used to optimize targeting of internal assets and social support in this and other interventions for Chinese children affected by HIV. For instance, future research could explore the utility of screening children in areas identified by the current algorithm (e.g., social support, feelings of loneliness, perceived stigma) prior to delivering the intervention so that the program could be tailored for different risk groups.

Limitations and Future Directions

There are several limitations to the current research that are important to consider. The future-oriented outcomes were examined in a cross-sectional manner and the research was not conducted in an experimental or quasi-experimental manner to account for potential confounders. As such, these analyses are not meant to be interpreted in a causal manner. Future work could lend additional insight into the relationships amongst these constructs by examining the relationships over time. Additionally, the estimated internal consistency for a few of the candidate predictors fell slightly below recommended cutoffs (i.e., Cronbach's alpha ≥ 0.7). This may be due to our use of brief measures for some variables, as alpha depends both

upon magnitude of the correlations of items as well as the number of items in the scale (Cronbach, 1951). Future work should explore interactions among the same constructs with measures demonstrating more ideal psychometric characteristics. Moreover, we did not explore how measurement properties may differ across development. Although the outcome variables and many of the predictor variables demonstrated adequate reliability in the sample as a whole, measurement properties may have varied by demographic characteristics. Additional measurement work in this vulnerable sample seems warranted.

Further, while this study leverages a large cohort of children affected by HIV, the SEARCH analyses may have been improved by use of a larger sample size, as exploratory data techniques benefit from very large sample sizes (i.e., 1,000 or more; Sonquist et al., 1973). Future work could explore these relationships in larger samples by combining samples from several studies conducted across various contexts utilizing an integrative data analysis (Hussong et al., 2013). An integrative data analysis, using innovative methods such as moderated non-linear factor analysis (Bauer, 2017), may also overcome some of the aforementioned measurement shortcomings related to measurement in the current study (Hussong et al., 2020). Similarly, it will be important to consider additional candidate predictors in future research. For example, research on parental loss suggests that loss of a mother, father, either, or both may be associated with differential outcomes (Berg et al., 2016). In the current study, we did not explore the possible differential impacts of the death of a mother vs. father but this and other variables will be important to explore in future research.

Additionally, these analyses were exploratory in nature to understand how resilience-related assets interacted to promote future orientation. As additional datasets are collected on this population, cross validation will be warranted to further support the robustness of relationships identified in the current research. In addition, complementary exploratory analytic strategies merit exploration in this substantive area, such as considering latent constructs with the use of SEM Trees (Brandmaier et al., 2016). Finally, the analyses here were conducted only in a sample of youth affected by parental HIV in rural China. As such, it is unknown if the results generalize to youth impacted to parental HIV in other contexts or to youth unaffected by parental HIV. Additional work should consider broader samples to ascertain the limits of generalizability.

CONCLUSIONS

The current research, through interaction detection, explicated several important factors that work together to promote future-oriented beliefs among youth impacted by parental HIV in China. Results indicated that children's perceptions about their control of the future, trust in and support from others (e.g., caregivers, other family members, peers), feelings of loneliness, and perceptions of stigma interact to impact future-oriented beliefs, an important, resilience-related belief. Knowledge of how these factors operate in tandem may inform future applied research focused on appropriate screening and tailored prevention and intervention programming to ultimately optimize outcomes for youth impacted by parental HIV in China.

DATA AVAILABILITY STATEMENT

The datasets presented in this article are not readily available because of the sensitive nature of the data and to ensure participant privacy. Requests to access the datasets should be directed to XL, Professor and SmartState Endowed Chair for Clinical Translational Research, XIAOMING@mailbox.sc.edu.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Wayne State University in the United States and Beijing Normal University in China. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

HM, SH, AF, and XL contributed to conception and design of the study. HM organized the database, performed the statistical analysis, and wrote the first draft of the manuscript. SH wrote sections of the manuscript. All authors contributed to manuscript revision, read, and approved the submitted version.

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A Longitudinal Investigation of the Causal Relationship Between Wellbeing and Perceived Discrimination Among Migrant Children in China: The Mediating Role of Self-Esteem and the Moderating Role of School Type

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Background: A large rural labor force has been attracted to urban areas with the acceleration of urbanization in China. This significant change in environment for migrant children from rural to urban may lead to psychological problems, such as decreased subjective wellbeing (WB) and increased perceived discrimination (PD). However, previous studies have focused on the influence of PD on WB by using a cross-sectional design, ignoring the causality and intrinsic mechanisms between WB and PD. The current study investigates the causal association and internal relations between migrant children's PD and WB.

Methods: A total of 466 (222 females, 47.64%) migrant children (M_{age} = 11.78, *SD* = 1.80) were recruited from Beijing in China. The participants filled in the questionnaire twice, with an interval of 1 year, including a basic information questionnaire, wellbeing index scale, perceived discrimination questionnaire, and self-esteem scale.

Results: Overall, cross-lagged regression analysis revealed that WB (T1) had a predictive effect on PD (T2) but that PD (T1) had no predictive effect on WB (T2). Mediation results indicated that self-esteem (SE) (T1) mediated the relation between WB (T1) and PD (T2). Moderated mediation results further proved that the link between WB (T1) on SE (T1) and the indirect effect between WB (T1) and PD (T2) were more robust for migrant children who attended public school than those in the migrant children's school.

Conclusion: These findings implied that a decrease in WB may increase the perception of subjective discrimination and that SE could be an intrinsic factor between migrant children's WB and PD, especially in public schools. Therefore, educators and parents should also pay attention to mental health problems to improve the wellbeing and self-esteem of migrant children.

Keywords: wellbeing, perceived discrimination, self-esteem, school type, migrant children

INTRODUCTION

With the acceleration of urbanization and the increasing demand for quality of life in China, a large rural labor force has been pouring into cities and seeking jobs there. This phenomenon has led to another social group—migrant children. Migrant children are children who have left their rural hometowns to live with their families in the city for above 6 months during the compulsory education stage but who have not obtained local household registration in the city (1). Remarkably, the number of migrant children is still increasing. According to the 2020 census, statistics showed that there were 130 million migrant children in China, accounting for 40% of the total population of children in China (2). The change in circumstances, the increasing economic pressure, and the lack of education guarantees in cities may place migrant children in disadvantaged situations, thus resulting in social, emotional, and behavioral problems (3, 4). Based on previous studies, there are two important indicators for measuring the adaptability of migrant children to a new environment: perceived discrimination (PD) and wellbeing (WB) (4). WB is individuals' overall evaluation of their quality of life, which can serve as an essential indicator of the level of mental health (5, 6). PD, in relation to objective discrimination, is individuals' subjective sense of being treated differently or unfairly due to the group to which they belong (7). Previous cross-sectional studies have indicated a close relationship between PD and WB (4). Little longitudinal research has explored the causal order and underlying influencing mechanism between WB and PD. Given that integrating migrant children into their cities is important since many factors depend upon it, a more comprehensive understanding of WB and PD is beneficial and necessary in modern society. Thus, the present study utilized a longitudinal sample of migrant children to explore (a) the causal association between migrant children's WB and PD, (b) whether migrant children's WB and PD could be mediated by self-esteem (SE), and (c) whether the pathways between WB and PD are moderated by school type (ST).

The Causal Relationship Between Wellbeing and Perceived Discrimination

Researchers have increasingly explored the correlation between WB and PD from the perspective of different groups. Although numerous studies have shown that WB is closely related to PD, the causal relation between these two variables remains unclear (8, 9). On the one hand, most studies have regarded perceived discrimination as a predictor of wellbeing, including direct roles and indirect effects (4, 10, 11). A meta-analytic study comprehensively explored 110 PD and mental health studies and found that one's perception of discrimination could significantly negatively predict WB (9). Recent studies also found similar results for migrant children (8). To our knowledge, PD is a low-status group's social stress based on group membership (e.g., gender and socioeconomic status), separating them from the dominant group (11); thus, migrant children with higher PD are likely to have negative emotions. Such negative emotions may further lead to the loss of migrant children's WB. However, on the other hand, some researchers maintain that WB is the antecedent of PD, with PD being more susceptible to one's emotions (12, 13). Based on the broaden-and-build theory, positive emotions allow individuals to build psychological, intellectual, and social resources, whereas negative emotions lead to narrow self-perception and poor interpersonal relationships (14, 15). Wellbeing is an individual's feelings of positive emotional experience (16). Therefore, migrant children with a low level of WB are more likely to have low self-evaluation, be unable to actively adapt to environmental changes, and experience poor interpersonal relationships (17, 18), which may lead to exaggerated or increased PD. Moreover, mental development in childhood is not mature or stable, and the perception of surrounding social activities is more susceptible to the influence of negative emotions (19). Such negative emotions may further lead to an increase in subjective discrimination perceptions.

Overall, there are different theoretical explanations for the bidirectional relationship between WB and PD. However, previous studies primarily used the cross-sectional method, making the causal relations unclear. Therefore, this study verifies the causal association between WB and PD based on longitudinal data. Based on the evidence reviewed above, we hypothesize that migrant children's WB and PD mutually affect each other (hypothesis 1).

The Mediating Role of Self-Esteem

The associations among wellbeing, self-esteem, and discrimination has been widely investigated (10, 20). However, few studies have focused on the role of SE in the longitudinal relationship between PD and WB. Self-esteem (SE), formed by evaluating self-characteristics, is the feeling of self-worth and self-respect (21, 22). According to the identity theory of SE, an individual with a high level of SE can mobilize individual resources and buffer negative emotional experiences. Otherwise, it will aggravate negative emotions (23). Individuals may internalize prejudice caused by discrimination as a part of self-verification, which will lead to more negative views of themselves, thus leading to the loss of WB (24). An empirical study showed that PD hurts SE (7). For example, PD reduces the SE of people with physical disabilities and migrant children (20, 25). In addition, abundant evidence shows that SE can significantly predict WB (20, 26). Hence, PD may influence the WB of migrant children through SE.

Conversely, the WB of migrant children may also influence their PD through self-esteem. As the broaden-and-build theory suggests, positive emotion can help individuals build more psychological skills and resources by enhancing self-efficacy and SE (15, 17); individual WB is associated with positive emotion and involves the overall assessment of individual life (27). Thus, it may also affect the SE covering overall judgment about oneself or social group. For example, a meta-analytic study showed that positive affect influences multiple life domains, including social relationships and positive perceptions of self and others (e.g., SE) (28). In addition, SE could further affect migrant children's PD. Many empirical studies have found that high SE is related to low PD (10, 29, 30). Moreover, high SE allows people

to maintain self-worth and rate themselves more positively (31–33), so SE may be a protective factor against PD (34, 35). Therefore, the wellbeing of migrant children may influence their PD through SE.

Taken together, SE may have a mediating effect on the reciprocal association between WB and PD. Given previous theories and empirical literature, we hypothesize that SE mediates the mutual association between WB and PD among migrant children (hypothesis 2).

Moderating Role of School Type

School life takes up most of the migrant children's time, so it is essential to examine the moderation of the relationship between WB and PD. In China, migrant children have access to public schools and migrant children's schools to receive an education (36, 37). Public schools are organized and funded by the government and have strict requirements for local household registration, so they are dominated by city children (38). Migrant children's schools were established and funded by the government or individuals to provide education for the children of migrant workers. Compared to migrant children in public schools, migrant children in migrant children's schools experience greater deficiencies in education resources, education standards, and teacher resources (39).

Although some empirical studies have examined the difference in the SE, PD, and life satisfaction between the children of migrant workers in public schools and those in public schools, the role of school type (ST) in the longitudinal relationship between WB and PD is unclear (40). Notably, migrant children in public schools have a strong sense of urban belonging and are likely to enter into identity crises and social exclusion when integrating into schools (41, 42). Thus, once they feel that city children reject their membership (i.e., belong to the city), their subjective perceptions of discrimination may increase along with negative emotions. In addition, ecological systems theory suggests that individuals experience stress and negative emotions when they perceive themselves in a disadvantageous situation and lack sufficient social support (43). Moreover, migrant children in public schools are prone to have negative emotions related to inferiority and loneliness (44, 45). These adverse emotions also affect individuals' perceptions of the friendliness of the surrounding environment, such as increased PD (46, 47). As a previous study showed, migrant adolescents' PD in public schools has a stronger connection with WB than in those in migrant children's schools (4). Therefore, the link between migrant children's WB and PD was significantly stronger in public schools than in migrant children's schools. Given these findings, we hypothesize that ST moderates the mutual association between WB and PD among migrant children (hypothesis 3).

The Present Study

Overall, this study explored three key topics. First, the study explored the causal association between WB and PD. Second, the study tested the mediating role of SE on the link between WB and PD. Last, the study tested the moderating role of ST on the link between PD and WB. **Figures 1A,B** illustrates the research model.

MATERIALS AND METHODS

Participants

The data were acquired through two measurement waves, with an interval time of 1 year. First, a public elementary and middle school and a migrant children's school were selected by simple random sampling in Beijing, China. Next, 486 migrant children completed the surveys in two waves, and valid data were collected from 466 participants (222 girls, 47.64%) after eliminating incomplete responses and extreme values at T1 and T2. Among them, 224 migrant children (48.07%) were educated at migrant children's schools. In the first wave, 273 migrant children were pupils in the third (69 migrant children, 14.81%), fourth (83 migrant children, 17.81%) or fifth grade (121 migrant children, 25.97%), and the rest of the migrant children were middle school students in the first (112 migrant children, 24.03%) or second grade (81 migrant children, 17.38%). The average age of the migrant children was 11.78 years (SD = 0.91), ranging from 8 to 16.

Measures

Wellbeing Index Scale

Migrant children's WB was measured by the wellbeing index scale (48), consisting of 9 items. The 9 items were divided into the overall affective index and life satisfaction. All the nine items were rated on a 7- point Likert scale (1 = disagree entirely, and 7 = agree entirely). The total score was the average score of part I (8 items) added to the score of Part II (1 item) according to a 1:1 ratio. On this scale, higher scores suggest a higher level of WB. This scale was widely applicable in various groups (49). In the present study, the scale shows good reliability (Cronbach's α is 0.79∼0.88).

Perceived Discrimination Questionnaire

Migrant children's PD was measured by a perceived discrimination questionnaire (50), consisting of 21 items. The 21 items covered speech discrimination, bodily assault, and avoidance. Each item was rated on a 5-point Likert scale (1 = disagree strongly, and 5 = agree strongly). On this questionnaire, higher total scores suggest a higher level of PD. This scale is widely used to investigate the discrimination perception of migrant children in China (8). In the present study, the questionnaire shows good reliability (Cronbach's α is 0.85∼0.80).

The Rosenberg Self-Esteem Scale

Migrant children's SE was assessed by the Rosenberg Self-Esteem Scale (21) consisting of 10 items. The participants rated each item on a 4-point Likert scale (1 = not very true of me, and 4 = very true of me). On this scale, higher total scores suggest a higher level of SE. The scale was proven to be suitable for children aged 7–12 years and migrant children in China (51, 52). In the present study, the scale shows good reliability (Cronbach's α is 0.80).

The Socioeconomic Status of Families

The socioeconomic status (SES) of families was measured by parents' occupation and education level (53). The parents' occupations were separately coded into five grades according

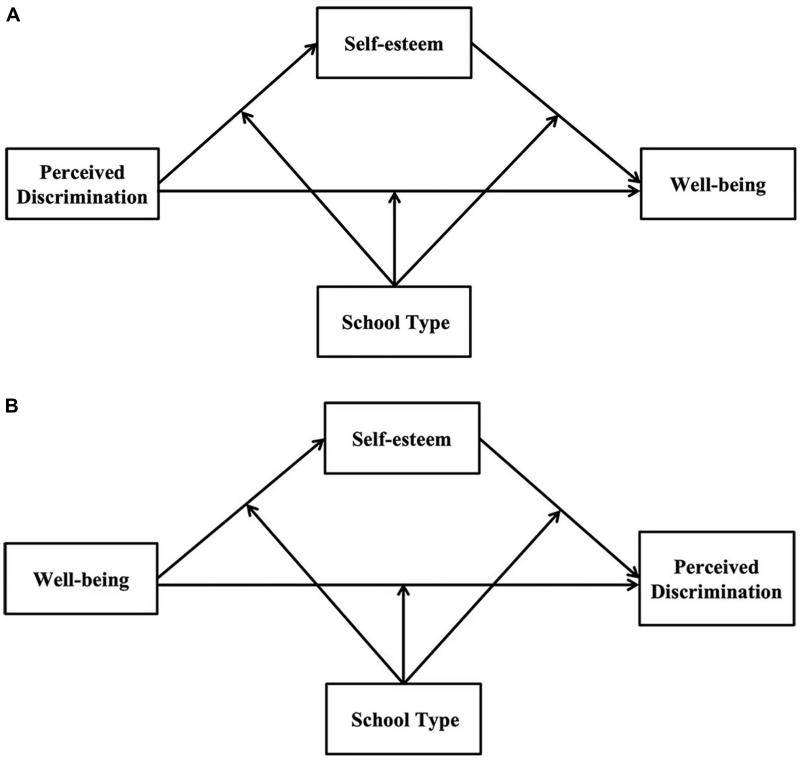

FIGURE 1 | The proposed moderated mediation model. **(A)** The moderated mediation model of perceived discrimination to well-being; **(B)** the moderated mediation model of well-being to perceived discrimination.

to the standard of occupational classification (1 indicating "temporary workers, the unemployed, unskilled workers and farmers" and 5 indicating "senior manager, senior technicians and the professional supervisor") (54). The parents' education levels were converted into six grades (1 indicating "uneducated" and 6 indicating "graduate degree"). The SES of the family equals the sum of the parents' occupation grade and education grade, and the score ranges from 4 to 22, with a higher score representing a higher families SES.

Procedure

This study followed the principles of the Institutional Review Board of the author's university and the participating school. First, we sought consent from the participants and their parents. Next, we informed the participants that they could withdraw at any time, and the survey was anonymous to ensure the truthfulness of their responses before completing the questionnaire. Third, the participants finished self-report scales. We provided specific guidance for third-grade pupils to fill out the scales. It took 10 min to complete the survey. Finally, the information on schools was obtained from the official website of the Beijing Municipal Education Commission, and the schools were classified as public schools or migrant children's schools.

Statistical Analyses

We conducted data analysis with SPSS 22.0 and Mplus 8.0. All models were adjusted for gender, age, and family SES. The fit indexes were used to assess the overall fit of the models, and the models were acceptable if the normed chi-square model (χ^2/df) < 5, the root mean square error of approximation (RMSEA) < 0.08, and the comparative fit index (CFI) > 0.95 (55).

First, all data were analyzed by Harman's single-factor to test for common method bias. Second the multiple imputation method (MIm) was conducted to estimate missing data to accurately obtain parameter estimation results (56, 57). Third, descriptive statistics and partial correlations of all variables were used to perform the preliminary analyses. Fourth, the cross-lagged model was tested to verify the causal associations between WB and PD. Fifth, the mediation model was examined by a four-step procedure (58, 59), which required that (a) the migrant children's WB was significantly associated with PD, (b) the migrant children's WB was significantly associated with SE, (c) the migrant children's SE was significantly associated with PD, and (d) the indirect path between WB and PD *via* SE was significant. In addition, the indirect effect needs to be justified by 5,000 bootstraps to obtain the 95% confidence interval (CI) of parameter estimation and is statistically significant if the confidence interval does not contain 0 (60). Finally, the moderated mediation was examined to estimate the moderating effect of ST on the mediation model of the migrant children's WB and PD. It required the interaction effect to be significant, and the 95% CI of the interaction effect did not contain 0. Moreover, the effect of variables (WB or SE) no interaction with ST on PD is fixed to be independent of W and any other variable in the model

(61). In addition, we further analyze the conditional results and plot the slope diagram to present the difference between public schools and migrant children's schools in the indirect effect and all paths between WB and PD.

RESULTS

Common Method Biases

Harman's single-factor method was a reliable method to examine whether common method biases exist in this study. The results showed that 10 eigenvalues greater than one were extracted from the unrotated exploratory factor analysis. Moreover, 20.69% of the variation was explained in the first eigenvalues, which do not reach a critical value (40%). Thus, this study did not have severe common method bias (62).

Missing Data

The raw data were relatively complete, and they were missing at random. Therefore, we used the multiple imputation method (MIm). The number of imputations on the missing data was 50, given that previous studies have pointed out that the more interpolations there are, the more accurate the estimation and that 20 interpolations are acceptable (63).

Preliminary Analyses

Table 1 reported the mean, *SD* and partial correlation coefficients among variables. The partial correlational coefficients excluded the influence of gender, age and family SES. The results were consistent with our expectations. The repeated measures of WB and PD were positively correlated over time among migrant children ($r = 0.30$, $p < 0.001$) ($r = 0.54$, $p < 0.001$). In addition, the migrant children with high levels of WB at T1 were likely to generate low levels of PD at T1 ($r = -0.30$, $p < 0.001$) and T2 ($r = -0.36$, $p < 0.001$). Similarly, the migrant children with high levels of WB at T2 were likely to generate low levels of PD at T1 ($r = -0.17$, $p < 0.001$) and T2 ($r = -0.26$, $p < 0.001$). The migrant children with high SE at T1 were likely to generate high WB and low PD at T1 ($r = 0.30$, $p < 0.001$) ($r = -0.42$, $p < 0.001$) and T2 ($r = 0.19$, $p < 0.001$) ($r = -0.32$, $p < 0.001$).

The Causal Relationship of Wellbeing and Perceived Discrimination

Hypothesis 1 assumed that WB and PD mutually affect each other. Model fit indexes for the cross-lagged model were saturated ($\chi^2 = 0.000$, RMSEA = 0.000, CFI = 1.000), indicating that the model was acceptable. The cross-lagged model between the migrant children's WB and PD was presented in **Figure 2**. First, path analysis indicated that the migrant children's WB at T1 significantly and positively predicted WB at T2 ($\beta = 0.27$, $p < 0.001$). The migrant children's PD at T1 significantly and positively predicted PD at T2 ($\beta = 0.45$, $p < 0.001$). Second, the migrant children's WB was significantly negatively correlated with PD at the two time points ($\beta = -0.32$, $p < 0.001$) ($\beta = -0.16$, $p = 0.002$). Finally, path analysis indicated that the migrant children's WB at T1 significantly and negatively predicted later PD (T2) ($\beta = -0.22$, $p < 0.001$). However, the migrant children's PD at T1 did not predict later WB (T2) ($\beta = -0.09$, $p = 0.074$). These results indicated that the migrant children's WB was a stable antecedent variable of PD. Thus, Hypothesis 1 was partially rejected.

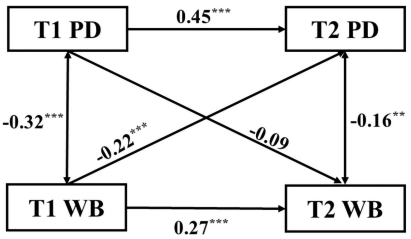

FIGURE 2 | Cross-lagged model of perceived discrimination and wellbeing. PD, Perceived discrimination; WB, Wellbeing; T1, Time 1; T2, Time 2; $^{**}p < 0.01$; $^{***}p < 0.001$.

Test of the Mediating Effect

Hypothesis 2 assumed that SE (T1) mediates the relationship between WB (T1) and PD (T2). Model fit indexes for the cross-lagged model were saturated (χ^2/df 0.000, RMSEA = 0.000, CFI = 1.000), indicating that the model was acceptable. The mediation results of SE between the migrant children's WB and PD were presented in **Table 2**. First, Model 1 showed that the migrant children's WB (T1) was significantly negatively related to their PD (T2) ($\beta = -0.35$, $p < 0.001$). Second, Model 2 showed migrant children's WB (T1) was significantly positively related to SE (T1) ($\beta = 0.30$, $p < 0.001$), and Model 3 showed that SE (T1) was negatively related to PD (T2) ($\beta = -0.22$, $p < 0.001$). Last, the indirect effect of WB on PD (T2) corrected by 5000 bootstrap was significant (*indirect effect* = −0.07, *SE* = 0.02, 95% *bias-corrected CI* = [−0.10, −0.04]). Therefore, the mediation effects of

TABLE 1 | Descriptive statistics and partial correlations between variables ($N = 466$).

	M (SD)	1	2	3	4	5
1. T1 WB	9.89 (3.27)	1				
2. T2 WB	9.81 (3.41)	0.30***	1			
3. T1 PD	48.06 (11.26)	−0.30***	−0.17***	1		
4. T2 PD	45.84 (12.44)	−0.36***	−0.26***	0.54***	1	
5. T1 SE	28.45(3.78)	0.30***	0.19***	−0.42***	−0.32***	1

*PD, Perceived discrimination; WB, Wellbeing; SE, Self-esteem; T1, Time 1; T2, Time 2; ***p < 0.001.*

TABLE 2 | Testing the mediating effect of self-esteem (T1) on perceived discrimination (T2).

	Model 1 (T2 PD)				Model 2 (T1 SE)				Model 3 (T2 PD)			
	β	*t*	*LLCI*	*ULCI*	β	*t*	*LLCI*	*ULCI*	β	*t*	*LLCI*	*ULCI*
T1 WB	−0.35	−8.11***	−0.42	−0.28	0.30	6.78***	0.23	0.37	−0.28	−6.25**	−0.36	−0.21
T1 SE									−0.22	−4.89***	−0.30	−0.15
R^2	0.21				0.13				0.26			
F	5.91***				4.07***				6.91***			

*All models controlled for gender, age, SES; PD, Perceived discrimination; WB, Wellbeing; SE, Self-esteem; T1, Time 1; T2, Time 2; **p < 0.01; ***p < 0.001.*

TABLE 3 | Testing the moderated mediation effect of wellbeing (T1) on perceived discrimination (T2).

Predictors	T1 SE				T2 PD			
	β	*t*	*LLCI*	*ULCI*	β	*t*	*LLCI*	*ULCI*
T1 WB	0.76	4.82***	0.50	1.02	–0.27	–1.89	–0.53	–0.03
ST	0.53	3.34**	0.27	0.79	–0.20	–0.68	–0.65	0.26
T1 WB × ST	–0.49	–2.73**	–0.78	–0.19	0.16	0.88	–0.11	0.43
T1 SE					–0.40	–3.76***	–0.57	–0.22
T1 SE × ST					0.42	1.42	–0.07	0.91
R^2	0.15				0.43			
F	4.68***				5.68***			

Indirect effect	β	*Boot SE*	*t*	*BOOT LLCI*	*BOOT ULCI*
Public school	–0.14	0.04	–3.98***	–0.20	–0.08
Migrant children' school	–0.05	0.02	–2.21*	–0.09	–0.01

*All models controlled for gender, age, SES; PD, Perceived discrimination; WB, Wellbeing; ST, School type; SE, Self-esteem; T1, Time 1; T2, Time 2; *p < 0.05; **p < 0.01; ***p < 0.001.*

SE between WB and PT were fully proved according to the four criteria. Therefore, the results partly supported Hypothesis 2.

Test of Moderated Mediation

Hypothesis 3 assumed that ST moderates the relationships between WB and PD (**Figure 1**). The model fit indexes of the moderated mediation model were poor ($\chi^2/df = 56.54 > 5$, RMSEA = 0.35 > 0.08, CFI = 0.90 < 0.95). As shown in **Table 3**, this effect between the migrant children's WB (T1) and PD (T2) was not moderated by ST (β = 0.16, $p = 0.32$), and this effect between SE (T1) and PD (T2) was not moderated by ST (β = 0.42, $p = 0.16$). Last, the effect between the migrant children's WB (T1) and SE (T1) was significantly moderated by ST (β = –0.49, $p = 0.006$). Moreover, the migrant children's SE (T1) was significantly negatively related to their PD (T2) (β = 0.40, $p < 0.001$). For clarity, we plotted WB (T1) on SE (T1) separately at the public school and migrant children's school (see **Figure 3**). The simple slope analyses found that the effect between WB and SE (T1) was stronger for the migrant children in public school ($\beta_{simple} = 0.44$, $p < 0.001$) than for those in the migrant children's school ($\beta_{simple} = 0.26$, $p = 0.002$). The mediating effect of WB (T1) on PD (T2) through SE (T1) was moderated by ST. Specifically, the indirect effect was stronger for the migrant children in public school (β = –0.14, *SE* = 0.04, 95% *CI* = [–0.20, –0.08]) than for those in the migrant children's school (β = –0.05, *SE* = 0.02, 95% *CI* = [–0.09, –0.01]). Thus, these results partly supported Hypothesis 3.

DISCUSSION

Most studies of PD and WB have suggested only a correlational relationship between the variables; however, few studies have made strong causal inferences and further explored the underlying influencing mechanism between PD and WB. To fill this gap, a cross-lagged model was used to verify the causal association between PD and WB; a moderated mediation model was used to examine whether the causal association could be mediated by SE and moderated by ST in a two-wave survey. The results showed that the migrant children's WB (T1)

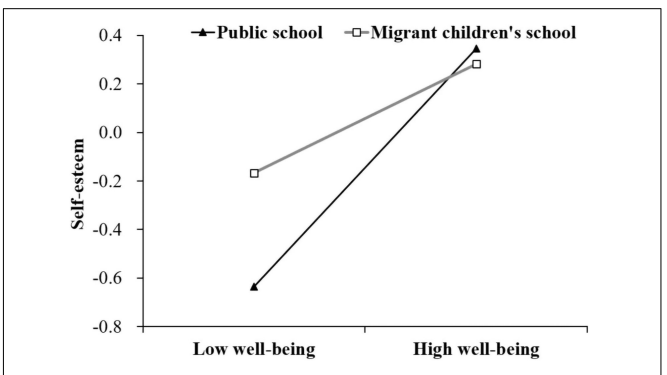

FIGURE 3 | School type moderates the relationship between self-esteem (T1) and wellbeing (T1) for public school and migrant school children.

strongly affected their PD (T2). Moreover, SE (T1) mediated the relationship between the migrant children's WB (T1) and PD (T2), and the link between WB (T1) and SE (T1) are robust in public school. We discussed these finding separately in the following parts.

Wellbeing as a Predictor of Perceived Discrimination

The study proved that migrant children's WB stably and negatively predicts their PD *via* the two-wave tests. Nevertheless, the results are unable to support the opposite direction. Thus, the results partially rejected the hypotheses that migrant children's WB and PD are bidirectional and supported that migrant children's WB was a stable antecedent variable of PD. This finding is interesting because the migrant children's WB predicted PD 1 year later. Previous studies have shown that one's perception of discrimination can lead to the loss of psychological WB (4, 9, 10, 64). In addition, a meta-analytic review found that PD has a causal effect on WB (13). This result is somewhat counterintuitive. However, it is remarkable that most previous studies on individual WB and PD were cross-sectional studies that provided only correlational data, thus limiting the ability to make causal inferences. Moreover, compared to objective encounters with discrimination, PD is the subjective perception that one faces discrimination, and it is more susceptible to one's emotion (12, 13). On the one hand, longitudinal studies showed that WB precedes a host of other desirable outcomes, including good health, prosocial behavior, academic satisfaction, and school achievement (65–67). Moreover, WB has been shown to improve the quality of interpersonal relationships and intimacy and increase prosocial behavior (14, 68, 69). In other words, compared with children with low WB, migrant children with high WB are better at socializing and establishing friendly relations with others and experience less discrimination. On the other, adverse emotions limited one's attention to support specific action tendencies (15, 70). That is, the reduced WB of migrant children due to the sudden changes in their living environment is likely to lead to negative impressions of the surrounding environment and group and exaggerated perceptions of discrimination. Therefore, migrant children's WB could be a stable predictor of PD. The finding illustrated the causal association between migrant children's PD on WB which go beyond the cross-sectional studies. Although this finding is somewhat counterintuitive, it emphasizes the importance of the influence of individuals' positive emotions on their perceptions of themselves and the external world.

The Mediating Role of Self-Esteem

The current funding proved that SE mediates the link between migrant children's WB and PD. These findings explain how the reduction of migrant children's WB can lead to an increase in PD. That is, migrant children's WB is positively associated with SE, and SE is negatively associated with migrant children's PD. As we all know, SE is a leading factor affecting happiness based on most cross-sectional studies, which can only prove that WB and SE are related (71–73). In addition, a longitudinal study also revealed that SE affects happiness (74). However, the main weakness of previous studies is ignoring the potential impact of individuals' WB on all aspects of psychology and behavior (27). For example, individuals with a high sense of WB have higher self-evaluations, are less self-critical, and have higher SE (75, 76). In contrast, individuals with more negative affect appear to have lower SE (77). Moreover, children's subjective judgments are more easily affected by their emotions (78). Thus, migrant children's WB may affect their SE. Another possible explanation for this is that most migrant children are forced to follow their parents to live in cities due to economic pressure, so the loss of WB may be inseparable from the economic pressure on their families (79). As previous research suggests, economic WB is one of the essential factors in developing and cultivating SE among young adults (80). Migrant children's family economic status is generally low compared with that of urban children (81). Therefore, the loss of WB related to economic pressure may decrease migrant children's SE.

In addition, migrant children's SE also affects their perceptions of discrimination. On the one hand, migrant children with high SE can identify self-worth better than migrant children with low SE and thus have weaker subjective feelings of external objective discrimination (31–33). On the other hand, SE is associated with peer relationships and peer acceptance (82, 83). This also leads to migrant children with high SE experiencing less discrimination. Therefore, a low level of SE can explain the reason for why migrant children with a low level of WB are likely to have strong perceptions of discrimination. More importantly, there could be a vicious circle between the low WB of migrant children and PD. Consequently, it would be helpful for educators and parents to apply this theory to improve migrant children's WB and SE and reduce PD.

The Moderating Role of School Type

The current study revealed that ST moderates the link between migrant children's WB and SE and the indirect path between WB and PD. Specifically, the effects were stronger in public schools, which suggests that the migrant children' SE and PD was more vulnerable to WB when they are educated in public schools. As previous research proved, the association between migrant adolescents' adverse events and SE is more salient in public schools than migrant children school (4). As mentioned before, migrant children educated in public schools have a more robust demand for self-identity transformation (84). They are more likely to form upward comparisons, resulting in a loss of SE and psychological gaps, leading to a strong link between WB and SE (85). Taken together, the results reveal that ST plays a pivotal role on affecting the connection between migrant children's WB and SE. It also shed light on the targeted prevention and intervention process should be applied for migrant children in different environments, especially those in disadvantaged situations.

Contrary to our expectation, ST does not moderate the link between migrant children's WB and PD. Moreover, it does not moderate the link between migrant children's SE and PD. This may be because both migrant children's WB and SE have robust effects on PD whatever kind of school they attend. As we mentioned in the cross-lagged regression, WB can significantly negatively predict PD. In addition, previous studies have also indicated that WB and SE are consistently negatively related to

PD (25, 86). Therefore, migrant children's WB and SE significantly predict PD regardless of whether they are in public schools or migrant children's schools.

Limitations and Implications

There are several limitations of this research. First, this study assessed children in only two waves, which may have influenced a comprehensive understanding of the link between migrant children's WB and PD. Additionally, we measured the migrant children's SE only in the first wave, so it is difficult to draw any causal conclusion between WB and SE. Most likely, there is a bidirectional association between them. Second, the data in this study were based on self-reports, so researchers may be able to collect data from multiple informants, such as the participants' parents or teachers, in the future to confirm the findings. Third, the study examined Chinese migrant children. However, it focused on exploring the influence of WB on PD. It can also limit the generalizability of the research results. Therefore, future studies can focus more on collecting data from diverse groups.

Despite the limitations mentioned above, the present study makes several key contributions. First, this study proves that a decrease in individual WB increases the perception of objective discrimination by longitudinal survey and emphasizes the significance of positive emotions. Second, the results provide estimable data and theoretical reference for targeted interventions to improve personal WB and decrease PD. Third, the present study underscore the important role of SE between WB and PD, especially in public schools. Therefore, it is important for educators to guide migrant children to gradually integrate into cities to promote their SE and reduce their subjective perception of discrimination.

CONCLUSION

Overall, this work contributes to existing knowledge by providing the causal relationship as well as the moderated mediation model of PD and WB, which provides a comprehensive understanding of how migrant children's WB affects their PD. The results reveal that the migrant children's WB is a stable antecedent of PD. In addition, migrant children's SE plays a mediating role in the link between WB and PD, especially for migrant children in a public school.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Institutional Review Board of the Capital Normal University. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

QW analyzed the data, wrote the first draft of the manuscript, and revised the manuscript. JY and YT wrote the first draft of the manuscript and organized the database. JL designed the study and revised the manuscript. BS designed the study, analyzed data, and revised the manuscript. All authors contributed to manuscript revision, read, and approved the submitted version.

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The Effect of Social Exclusion on Trust Among Youth Orphaned by HIV/AIDS: Evidence From an Event-Related Potentials Study

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Grounded in a follow-up study among children who lost one or both parents to HIV in central China in the early 2000s, we conducted an event-related potentials (ERPs) experiment to explore the effect of social exclusion on trust and the corresponding neurophysiological mechanism among youth orphaned by HIV/AIDS ("AIDS orphans"). A sample of 31 AIDS orphans (26.16 ± 3.34 years old; 15 female) and 32 age and development status matched controls (25.02 ± 3.45 years old; 14 female) participated in the study. They were all assigned to play Cyberball, a virtual ball-tossing game that reliably induced social exclusion (15 orphans, 16 controls) and inclusion (16 orphans, 16 controls). Then, they played the Trust Game by taking the role of trustor with their electroencephalograms (EEGs) being recorded during the game. In the Trust Game, each participant was required to decide whether to trust their partners in over 150 trials (decision-making stage). The partner's reciprocation strategies were pre-programmed by the experimenter (with an overall reciprocating rate of 50%). All participants were provided with post-decision feedback about the outcome of their decisions (gain or loss of game points) in each trial (outcome evaluation stage). We analyzed their behavioral responses at the decision-making stage and ERP components at the outcome evaluation stage. Behavioral results showed that the proportion of orphans choosing trust was significantly higher than the controls, and the trust ratio of the orphan exclusion (OE) group was significantly higher than that of the orphan inclusion (OI) group, control exclusion (CE) group, and control inclusion (CI) group. Furthermore, the response time of the OE group was significantly shorter than that of other groups. ERP results indicated that the amplitude of the feedback-related negativity (FRN) in the OI group was significantly more negative than that in the CI group with loss feedback, while there was no significant difference between the OE and OI groups. Similarly, the P300 amplitudes following outcome feedback were larger in the CI group than that in the OI group with gain feedback and had no significant difference between OE and OI.

Keywords: social exclusion, trust, youth orphaned by HIV/AIDS, ERP, FRN, P300

INTRODUCTION

In the late 1980s, many rural residents were infected with HIV in Henan province in China, an agricultural province with a population of 96.66 million, because of the unhygienic blood collection (1). Although the commercial blood/plasma collection has been banned by the Chinese government since 1998, the infection has spread widely among former commercial blood/plasma donors and their spouses. The average HIV prevalence rate in this population was 10–20% and even exceeded 60% in some communities, and there were at least 100,000 AIDS orphans in China by 2004. In the year 2020, about 1.053 million people were living with HIV, and 351,000 cumulative reported deaths in China (2). Meanwhile, globally, there were 690,000 adults and children's deaths, aged 0–17 years old, and 240,000 orphans' deaths due to AIDS (3). Children who were orphaned due to the death of parents infected with HIV/AIDS faced many challenges, including parental death, disruption of schooling, stigma, social exclusion, and other negative psychological impacts (4–6). All these early negative events can be extremely stressful for youth orphaned by HIV/AIDS (orphaned youth) and significantly affect their social and interpersonal adaptation during childhood and young adulthood.

Trust is the foundation of interpersonal communication and is a paradoxical phenomenon that encompasses both lofty aspirations and deep fears (7). For example, an online shopper whose product, although already paid for, is not delivered. In other words, the trustor must predict whether the other person is trustworthy. As a result, (8) defined trust as "a psychological state comprising the intention to accept vulnerability based upon positive expectations of the intentions or behavior of another". Based on the above definition, some common characteristics should be included in the laboratory measurements of trust: (a) the trustor has two choices of trust or distrust; (b) choosing trust has potential benefits, but, at the same time, it needs to face risks and vulnerabilities; (c) the outcome of trust depends on the behavior of trustee. The Trust Game is the most used game paradigm among the laboratory measurements of trust (9, 10).

In the Trust Game, the trust decision-making process includes the behavioral decision stage (the trustor chooses to trust or distrust) and the outcome evaluation stage (after choosing, the trustor evaluates the outcome resulting from the trustee's behavior). As trust and distrust behavioral decisions are woven in with the complex social environments addressed in the Trust Game (11), exploring how outcomes are evaluated provides the opportunity to understand how decisions are made. In addition, people often rely on the effective coding and processing of previous results to adjust subsequent behavioral strategies and choices, and then make more appropriate and quick choices (12). Therefore, focusing on the outcome evaluation stage is also one of the most important indicators reflecting trust performance. Psychophysiological research purported that the brain had developed special mechanisms to quickly assess the valence and magnitude of outcomes, as well as their subjective and motivational significance (13). Researchers observed two ERP components related to the outcome evaluation: the feedback-related negativity (FRN) and positive electrophysiological potential P300 (14, 15). FRN is a negative potential at fronto-central recording sites and peaks around 250–300 ms after stimulus onset. Moreover, loss feedback induces more negative FRN than gain feedback (16). Some researchers believed that FRN reflects the individual evaluation of the emotional motivation, meaning, of feedback stimulus (14), while other researchers believed that FRN reflects the degree of deviation between feedback results and prior expectations (expectancy-deviation), and FRN was greater when observing the larger expectancy-deviation (17, 18). P300 is a positive potential and peaks around 300–600 ms after stimulus onset. Researchers believed that P300 was sensitive to the number of feedback results (19, 20) and might reflect the process of attention resource allocation and relevant social information in outcome evaluation (13, 15).

It can be seen from the above that the behavioral decision (trust vs. distrust) and the EEG indicators (FRN and P300) related to the outcome evaluation in Trust Game can reflect the performance of trust. However, the important issues we are concerned with are what are the factors and how to affect trust, especially for orphaned youth?

Social exclusion is one of the most likely challenges faced by orphaned youth in growth and is also a possible negative factor for orphaned youth in interpersonal trust. Studies have shown that the higher the experience of social exclusion, the lower the trust toward others (21). DeWall et al. (22) found that individuals would generate the hostile cognition toward the rejector and irrelevant others after being temporarily rejected by strangers in the laboratory and reduce trust toward the rejector in the subsequent Trust Game. A previous neuroimaging study of social exclusion suggested that people with high rejection sensitivity showed less activation of the right ventrolateral prefrontal cortex (rVLPFC), while viewing representational paintings depicting themes of interpersonal interaction (23), and rVLPFC is positively correlated with trust (24). Similarly, we inferred that orphaned youth might show less trust when they encountered social exclusion.

However, how does social exclusion affect the trust of orphaned youth? In another word, what is the feature of trust decision-making process (behavioral decision stage and outcome evaluation stage) in the Trust Game after orphaned youth experienced social exclusion? In the laboratory, social exclusion can be induced by the Cyberball game, which has proven to be a reliable paradigm to elicit exclusion-related distress (25). In Cyberball, subjects can be divided into social exclusion condition and social inclusion conditions (control conditions). After being ostensibly excluded by two peers in Cyberball, subjects consistently reported heightened levels of distress in the form of higher levels of negative mood, and lower sense of belonging, control, and self-esteem (26, 27). Therefore, compared with the social exclusion condition, orphaned youth in the inclusion condition may expect more reciprocal results from each other. Therefore, the inclusion condition may trigger higher expectations about the outcome of the game than the exclusion condition. Based on previous studies, we predicted that the FRN amplitude would be larger in the inclusion condition with loss

feedback. In addition, according to the existing empirical results of P300, the results of win-win cooperation represent not only the material rewards, but also the social meanings. Thus, we expected that the gain feedback might trigger a larger P300 in the inclusion condition than that in exclusion condition.

Previous studies on orphaned youth have mostly focused on issues, such as resilience and mental health intervention after negative experience, and have paid little attention to interpersonal adaptation (28, 29), such as trust. Especially, little is known about the situation of trust when orphaned youth encountered social exclusion. Accordingly, the current study aimed to explore the effect of social exclusion on trust and the corresponding neurophysiological mechanism among youth orphaned by HIV/AIDS. Therefore, we used Cyberball and Trust Game to induce social exclusion and trust, combined with ERP research, aimed to examine the behavioral decision and EEG indicators of outcome evaluation in orphaned youth when social exclusion was encountered. Specifically, we propose two hypotheses: first, we hypothesized that the trust rate of exclusion condition would be lower than the inclusion condition. Second, we hypothesized that the FRN amplitude would be larger in the inclusion condition with loss feedback than that in the exclusion condition, and the P300 amplitude would be larger in the inclusion condition with gain feedback than that in the exclusion condition.

TABLE 1 | Individual characteristics of the sample.

	Overall	Orphans	Controls
***N* (%)**	64 (100%)	32 (50%)	32 (50%)
Male	34 (53.12%)	16 (50%)	18 (56.25%)
Female	30 (46.88%)	16 (50%)	14 (43.75%)
Mean age in years (SD)	25.79 (3.14)	26.65 (2.70)	25.99 (1.97)
Self-reported health status			
Very good	50 (78.13%)	25 (78.13%)	25 (78.13%)
Good	11 (17.19%)	5 (15.62%)	6 (18.75%)
Fair	3 (4.68%)	2 (6.25%)	1 (3.12%)
Poor	0 (0%)	0 (0%)	0 (0%)
Monthly income			
≤3,000	28 (43.75%)	14 (43.75%)	14 (43.75%)
3,001–6,000	23 (35.94%)	12 (37.50%)	11 (34.38%)
≥6,001	13 (20.31%)	6 (18.75%)	7 (21.87%)
Current working status			
Farming at country	10 (15.63%)	6 (18.75%)	4 (12.50%)
Study in college	9 (14.06%)	4 (12.50%)	5 (15.63)
Work in the city	39 (60.94%)	18 (56.25%)	21 (65.62%)
Work for the government	6 (9.37%)	4 (12.50%)	2 (6.25%)

MATERIALS AND METHODS

Participants

The participants were from a larger sample of a psychological assessment study in central China about 15 years ago, which has been described in detail elsewhere (30). Briefly, the orphan sample was recruited from four government-funded orphanages and eight small group homes. We worked with the village leaders to generate lists of families caring for orphans by HIV/AIDS, approached the families on the lists, and recruited one child per family to participate in the assessment. When there were siblings in an orphanage, group home, or household, a single child was randomly selected. The control sample was recruited from the same villages where the orphans were recruited. We worked with the village leaders to create a list consisting of households, in which no one was known to be HIV-infected or died of HIV/AIDS. At this time, we re-contacted 64 participants (orphaned youth and controls) in the prior study through local schools and invited them to participate in the current study. As shown in **Table 1**, the participants in the current study consisted of 34 males (53.12%) and 30 females (46.88%). The average age was 25.79 years. In the case of orphaned youth, almost ninety-four percent of the orphans considered themselves as having "very good" or "good" health. Most orphans reported their monthly income was under ¥6,000 (about 901 dollars). Approximately 56.25% of orphans were working in the city, and 18.75% of orphans were farming at country. There was no significant difference in the development status (self-reported health status, monthly income, and current working status) between orphaned youth and the controls ($ps > 0.05$). All subjects were right-handed, had normal or correct-to-normal vision, reported no history of neurological diseases or injury, and had no structural brain abnormality. Before data collection, participants were made aware of the potential risks involved in the study and provided their written informed consent.

Among these 64 participants, 16 orphans and 16 controls received social exclusion, and 16 orphans and 16 controls received social inclusion. One orphaned youth (male) was excluded from the further analysis due to excessive artifacts. A total of 31 orphaned youth (15 female, mean age = 26.16) and 32 control groups (14 female; mean age = 25.02), matched with age and development status, successfully completed a computerized version of the Trust Game while recording EEG. They engaged in a 2 (group: orphans, controls) × 2 (condition: inclusion, exclusion) between-participants design.

Stimuli and Procedure

Cyberball was used to induce social exclusion (25, 31, 32), and is the widely used research paradigm in cognitive neuroscience research on social exclusion (33, 34), which needs subjects to participate in an online virtual throwing-the-ball game. Participants, assigned randomly to exclusion and inclusion group, were told to play the game with another two players and to imagine the game situation, which was more important than the performance in the task. The number of the toss of ball is 30. In the exclusion group, participants caught the ball only at the beginning and never again (two tosses). While in the inclusion group, participants were just as likely to catch the ball as the other players (10 tosses). In fact, there were no other players, and the player's throw is predetermined. Immediately following the Cyberball game, all participants completed a 24-item Needs-Threat Scale, including a 14-item Basic Needs Questionnaire and an 8-item mood measure, along with 2-item, estimated their percentage of game participation and ball receipt (35).

All responses had a 9-point Likert-type scale and were reverse-scored where appropriate so that higher numbers indicated more fulfillment of the particular need and a more positive mood.

Then, participants were informed to play a Trust Game with their partners from Cyberball game. In fact, the partner is virtual, during which their EEG activities were recorded. The Trust Game task used in this study is based on the original investment/Trust Game of (36), in which the participants need to act as trustors and complete 150 rounds of games. Before the beginning of each round, both the trustor and the trustee will receive an initial fund of 10 points. The participant (trustor) needs to decide whether to give all 10 points to the trustee. If the participant choose not to give it to the trustee, the current round of the game ends, and both parties receive their own 10-point appearance fee; If the participants choose to give them to the trustee, these points will be tripled to the trustee, and the trustee will decide how to distribute their points (the original 10 points appearance fee plus the doubled 30 points, a total of 40 points). The trustee has two options: sharing all points equally or swallowing all points. No matter which allocation option is selected, the current round of the game ends and both parties get corresponding points.

After finishing the Cyberball game, the experimenter introduced the rules of Trust Game to participants in detail. Then, the participants sat comfortably on the chair in a quiet and sound attenuated electric shielding room, about 1 m away from the computer screen, and began to wear electrode caps and other preparations. The presentation order of stimuli in each round was shown in **Figure 1**. At the beginning of each round, a sample decision tree of the Trust Game (1,500 ms) was presented to prompt all possible options and results of the current task. After a cross lasting for 500 ms, a decision option diagram (2,000 ms) was presented on the computer screen, and participants needed to press the key to make the decision of trust or distrust within the presentation time of the decision option diagram. Participants were instructed to press "F" when they selected trust and press "J" when they selected distrust. It was regarded as invalid data if it exceeds 2,000 ms. Then, after a prompt waiting screen of 1,000 ms, the results of the current round (1,200 ms) and the total accumulated income (2,000 ms) were presented on the screen.

Event-Related Potentials Data Recording and Analysis

The EEG was recorded from 32 channels using the 10–20 system (Brain Products, Gilching, Germany) with a bandpass from 0.01 to 100 Hz and a 500 Hz sampling rate. All channels were online-referenced to FCz during recording. Recording impedance for all electrodes was held beneath 10 kΩ .

After data acquisition, EEG data were transferred into the Brain Vision Analyzer 2.0 software (Brain Products, Munich, Germany), which was used to analyze neurophysiologic data. The EEG was offline, re-referenced to the average of the two mastoids, and filtered with a bandpass of 0.1–30 Hz. Epochs were extracted between the 200-ms pre-stimulus and 800-ms post-stimulus interval. For each ERP, activity in the −200 to 0 ms time window prior to feedback presentation served as a baseline. Ocular (blink and saccade) and any other remaining artifacts (muscular, cardiac) were isolated by independent component analysis' (ICA) algorithm decomposition. In case of doubt, the rejection occurred only if all researchers involved in the data treatment reached an agreement. Eye movement artifacts and trials with EOG artifacts (e.g., a mean EOG voltage exceeding ± 80 μV) were automatically rejected.

This study analyzed the ERP components' FRN and P300 in the stage of feedback presentation. The FRN peaks approximately to 250 ms following feedback presentation (16, 37). Therefore, the mean amplitudes from 200 to 400 ms following feedback presentation were calculated. The P300 component was measured as the mean amplitude between 300 and 550 ms (38). Amplitudes of the FRN and P300 were measured as mean values (14, 15). The electrodes for further analysis were chosen according to ERP topographical distribution and previous studies (39–41). Statistical analyses were conducted at three midline electrodes: Fz, FCz, and Pz.

Statistical Analysis

The SPSS 24.0 was used to perform a chi-square test to investigate the manipulation check and behavioral difference between the orphan exclusion (OE) group, orphan inclusion (OI) group, control exclusion (CE) group, and control inclusion (CI) group. To test whether participants perceived the social exclusion as expected, a multivariate analysis of variance (MANOVA) was conducted using the factors of the group (orphans, controls) and condition (inclusion, exclusion). The four ratings of the manipulation check ("basic needs", "mood", "percentage of game participation", and "percentage of ball receipt") served as dependent variables. A repeated-measures ANOVA was conducted on ERP data with electrode point (Fz, FCz, and Pz) and feedback (gain, loss) as within-subject factors, group (orphans, controls), and condition (inclusion, exclusion) as between-subject factors. For all the analyses in this study, $p < 0.05$ was considered to be statistically significant, and the p-values were adjusted using the Greenhouse-Geisser correction when appropriate.

RESULTS

Manipulation Check

As shown in **Table 2**, there was no significant difference between orphans and controls in the four ratings of the manipulation check. The group × condition interaction was significant only for "percentage of ball receipt", with a lower percentage rating in exclusion compared to the inclusion only for controls. However, both orphans and controls in the inclusion condition reported significantly lower scores in basic needs and mood and had significantly higher rates of game participation and ball receipt than youth in the exclusion condition. In short, social exclusion was induced successfully.

Behavioral Performance

Overall, the trust rate of participants was significantly higher than the distrust rate. In orphans, the rates of trust in the

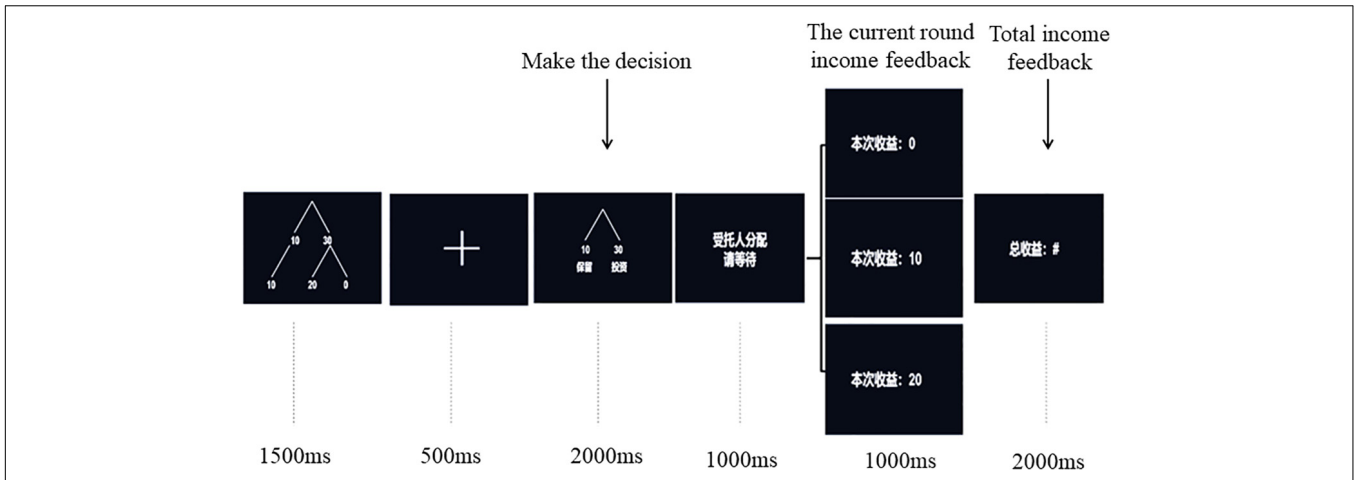

FIGURE 1 | Procedures for the Trust Game.

TABLE 2 | Manipulation check of social exclusion.

Dependent variable	Orphans *n* = 31		Controls *n* = 32		Statistics (*df* = 1, 59)		
	Mean	S.D.	Mean	S.D.	Condition	Group	Interaction
Basic needs[a]							
Inclusion	3.53	1.30	3.58	1.02	$F = 18.21$, $p < 0.001$, $\eta_p^2 = 0.24$	N.S.	N.S.
Exclusion	5.15	1.54	4.89	1.53			
Mood[a]							
Inclusion	3.09	1.91	2.68	1.17	$F = 9.89$, $p = 0.003$, $\eta_p^2 = 0.14$	N.S.	N.S.
Exclusion	4.15	1.26	3.43	1.77			
Percentage of game participation[a]							
Inclusion	7.00	2.07	6.50	1.67	$F = 39.12$, $p < 0.001$, $\eta_p^2 = 0.40$	N.S.	N.S.
Exclusion	3.33	1.99	3.75	2.35			
Percentage of ball receipt[a]							
Inclusion	4.96	1.53	6.13	2.03	$F = 30.32$, $p < 0.001$, $\eta_p^2 = 0.34$	N.S.	$F = 5.19$, $p = 0.026$, $\eta_p^2 = 0.08$
Exclusion	3.53	2.64	2.44	0.96			

N.S., not significant; condition = inclusion/exclusion, Group = orphans/controls, Interaction = Situation × Group. [a]Manipulation check ratings from the Needs-Threat Scale.

OE group and OI group were 75.50% (SD: 14. 19%) and 64.20% (SD: 17.31%), respectively. In controls, the rates of trust were 57.72% (SD: 13.15%) in the CE group and 55.75% (SD: 13.97%) in the CI group. Multiple comparisons showed that the trust rate of the orphans group was significantly higher than that of the control group ($p = 0.003$), and the trust rate of the OE group was significantly higher than that of the OI group (**Figure 2**).

Taking the trust and distrust mean response time of participants as the dependent variables; repeated measure ANOVA results showed that the interaction between group and condition was significant, $F_{(1,\ 62)} = 5.17$, $p = 0.027$, $\eta_p^2 = 0.09$. As shown in **Figure 3**, the reaction time of the OE group (724.66 ± 139.69) was significantly shorter than that in the CE group (1,161.25 ± 150.06); and the reaction time of the CE group (1,161.25 ± 150.06) was significantly longer than that in the CI group (713.03 ± 131.22).

Event-Related Potentials Data Analysis

FRN

There was a significant main effect of feedback, $F_{(1,\ 62)} = 13.88$, $p = 0.001$, $\eta_p^2 = 0.19$, with loss eliciting more negative FRN (5.01 ± 0.39 μV) than gain (5.75 ± 0.46 μV). The main effect of the electrode was significant, $F_{(1,\ 62)} = 13.28$, $p = 0.001$, $\eta_p^2 = 0.18$, for which pairwise comparisons suggested that the FRN amplitude was greater at FCz (6.12 ± 0.50 μV) than at Fz (5.64 ± 0.42 μV) and Pz (4.36 ± 0.37 μV). Results also showed a marginally significant difference in group, $F_{(1,\ 62)} = 3.02$, $p = 0.081$, $\eta_p^2 = 0.49$, with orphans eliciting more negative FRN (4.65 ± 0.60 μV) than controls (6.10 ± 0.59 μV), see **Figure 4**.

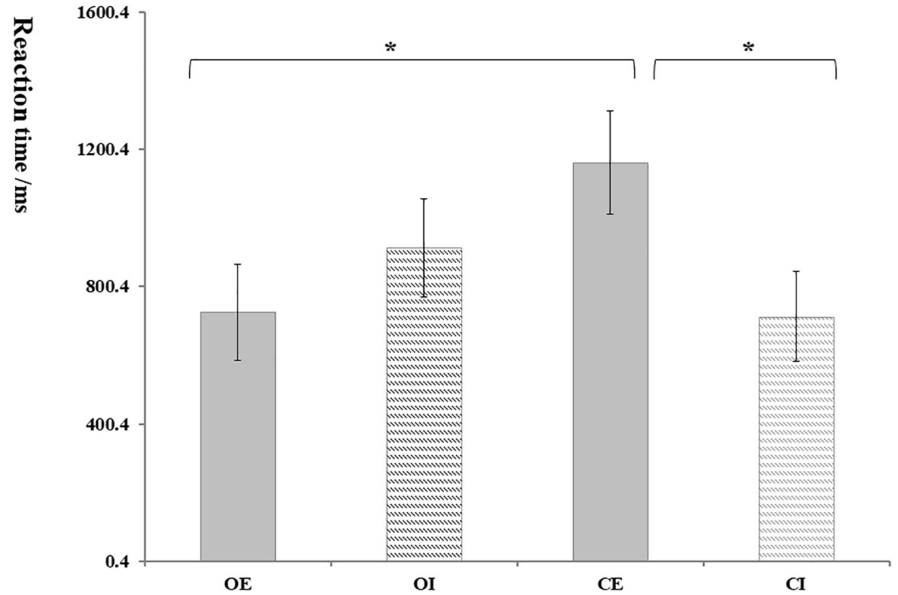

FIGURE 2 | The rate of trust. OE, orphans and exclusion group; OI, orphans and inclusion group; CE, controls and exclusion group; CI, controls and inclusion group. Error bars represent the standard errors. *$p < 0.05$.

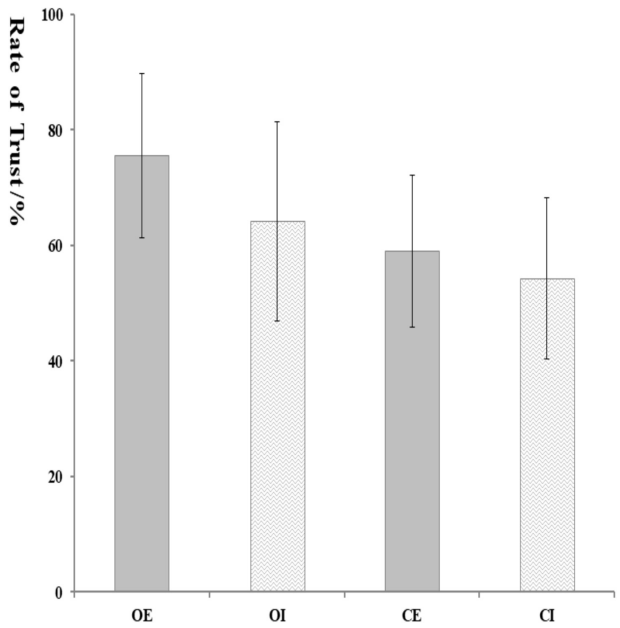

FIGURE 3 | The reaction time of trust decision. Error bars represent the standard errors.

The interaction effect of group × condition was significant, $F_{(1,\ 62)} = 5.03$, $p = 0.029$, $\eta_p^2 = 0.80$. Further analysis indicated that the significant group difference was only found in inclusion condition, with a more negative FRN in orphans (4.38 ± 0.83 μV) compared to controls (7.82 ± 0.83 μV), but not in exclusion. The interaction effect of group × condition × feedback was significant, $F_{(1,\ 62)} = 4.60$, $p = 0.036$, $\eta_p^2 = 0.08$. As shown in **Figure 5A**, the significant group difference was only found in inclusion and loss, with a more negative FRN in orphans (4.33 ± 0.81 μV) compared to controls (7.02 ± 0.78 μV). From another perspective, the CE group (4.22 ± 0.78 μV) elicited a more negative FRN than CI group (7.02 ± 0.78 μV) only in loss, while there was no significant difference between the OE and OI groups.

P300

The P300 amplitudes were entered into a 2 (group) × 2 (condition) × 2 (feedback) × 3 (electrode) ANOVA (see **Figure 4**). The main effect of feedback was significant, $F_{(1,\ 62)} = 3.79$, $p = 0.056$, $\eta_p^2 = 0.06$, with gain (5.98 ± 0.51 μV) eliciting larger P300 than loss (5.53 ± 0.44 μV). There was also a significant main effect of electrode, $F_{(1,\ 62)} = 34.28$, $p < 0.001$, $\eta_p^2 = 0.34$, with the P300 amplitude being greater at FCz (6.22 ± 0.53 μV) than at Pz (5.56 ± 0.47 μV) and Fz (5.48 ± 0.45 μ V).

The interaction effect of group × condition was marginally significant, $F_{(1,\ 62)} = 3.05$, $p = 0.082$, $\eta_p^2 = 0.50$. Further analysis indicated that the significant group difference was only found in inclusion condition, with a larger P300 in controls (7.93 ± 0.92 μV) compared to orphans (5.08 ± 0.95 μV), but not in exclusion. The CI group (7.93 ± 0.92 μV) elicited a larger P300 than that in CE group (4.81 ± 0.92 μV). The significant feedback × group × condition interaction effect indicated that the significant group difference was only found in gain and inclusion condition, $F_{(3,\ 60)} = 2.95$, $p = 0.04$, $\eta_p^2 = 0.13$, with an overall attenuated P300 in orphans (5.13 ± 1.04 μV) compared to controls (8.73 ± 1.01 μV), but not in exclusion condition (see **Figure 5B**).

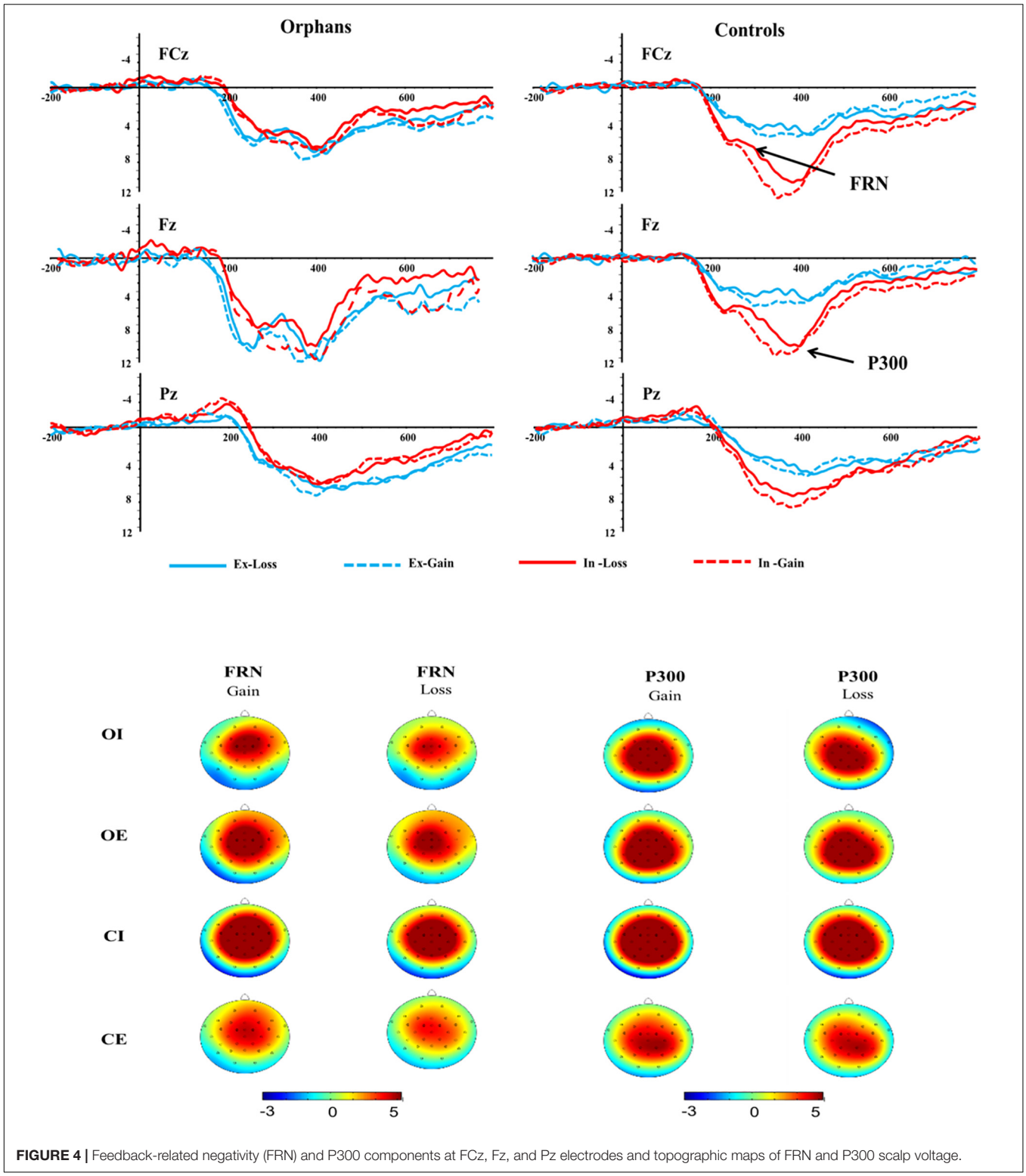

FIGURE 4 | Feedback-related negativity (FRN) and P300 components at FCz, Fz, and Pz electrodes and topographic maps of FRN and P300 scalp voltage.

DISCUSSION

Most of the previous studies about the influence of social exclusion on trust were conducted in the form of questionnaires, and there was a lack of experimental methods to investigate the trust performance after experiencing social exclusion. Furthermore, orphaned youth were invited to participate in this study to explore the influence of social exclusion on trust and the

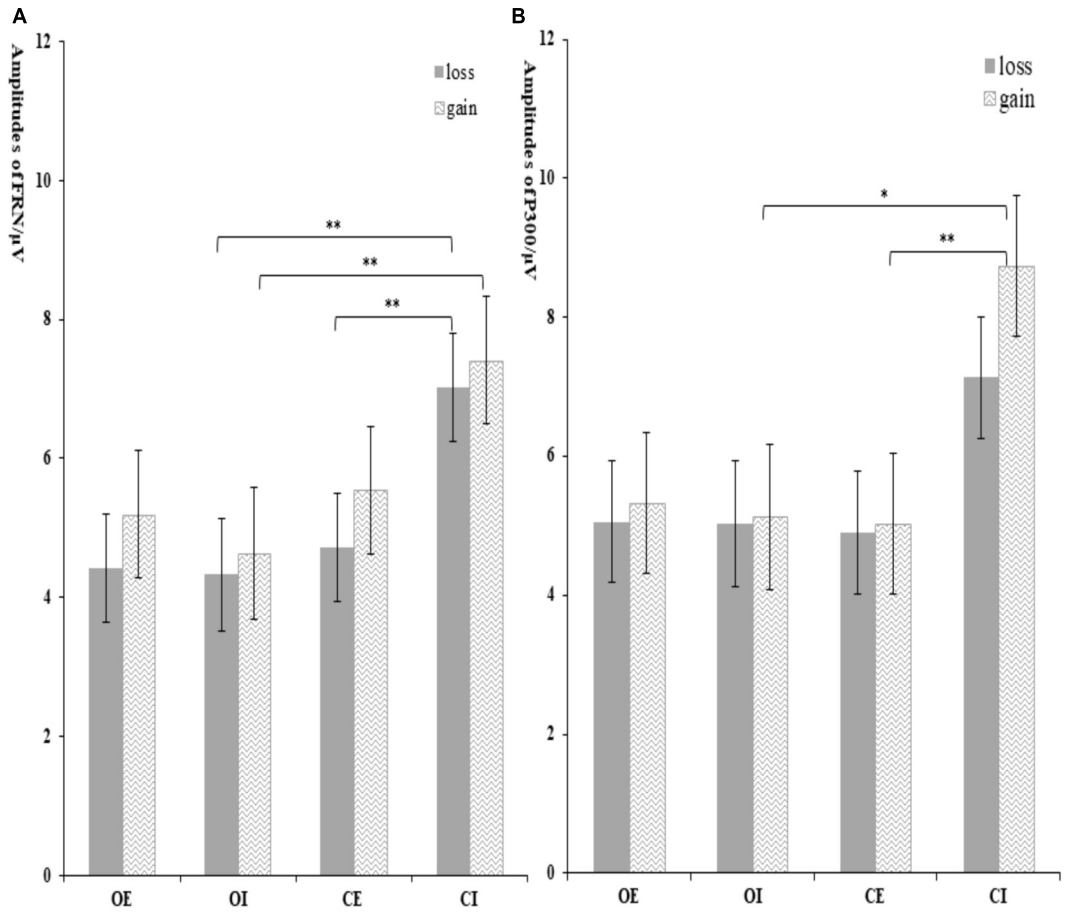

FIGURE 5 | The amplitude of FRN **(A)** and P300 **(B)** at different conditions. Error bars represent the standard errors. *$p < 0.05$ and **$p < 0.01$.

neurophysiological mechanism, which had important practical significance for the social adaptation of orphaned youth.

Behavioral task results showed that the trust ratio of the OE group was significantly higher than that of other groups, and the response time of the OE group was the shortest. Although these results are not consistent with our hypothesis, it clearly suggests that orphaned youth preferred to believe others when they encountered social exclusion. This finding is consistent with Williams et al. (32), who found that the social exclusion induced by the Cyberball game did lead to some verbal or active behaviors to get others' attention and response. The possible reason for this result is when orphaned youth are in a vulnerable position in interpersonal communication, they often choose to show kindness to others to get a response. Moreover, this high rate of trust in orphaned youth may be related to the risk decision-making after social exclusion (42). Studies have found that excluded individuals have more risk-taking behaviors (43) and higher risk preference (44), showing risk-seeking in risk decision-making tasks (45). In the Trust Game of this study, choosing trust represents the risky behavior of investment.

The ERP results showed that the FRN amplitude of orphans (OI) was significantly greater than that of controls (CI) only in inclusion condition and loss feedback. Consistent with prior research on the effect of FRN, the result we found indicated that FRN is very sensitive to the valence of results, reflecting the processing of negative results in the anterior cingulate cortex (22, 40). The rational choice theory holds that FRN is responsible for coding the deviation between feedback results and prior expectations. In our study, the OI group chose to trust others, indicating that they were willing to cooperate with the other party for a win-win, and subjectively expected the other party to choose reciprocity. Therefore, the loss feedback would cause a greater expected decision than the gain feedback, thus, inducing a larger FRN amplitude. Similar to the results of this study, Long et al. (46) found that trust could modulate the amplitude of FRN, compared with the subjects who chose distrust, the amplitude of FRN induced by the subjects who chose trust was larger. Furthermore, researchers pointed out that the loss of FRN effect under the condition of exclusion might be caused by a sense of aloofness, which made participants less likely to anticipate the subsequent results (17). In short, social exclusion may decrease orphaned youths' expectations of reciprocity, resulting in a sense of aloofness and lower expectations of the results of others' feedback. To some extent, this reflects that orphaned youth are

more likely to be accepted by others in society and they are more sensitive to others' feedback when they are accepted. The current data suggested that in a social context, social exclusion tendencies affect how outcomes were evaluated by orphaned youth. It also provided support that FRN is sensitive to the affective properties of social pain.

Interestingly, although we found that gain induced a larger P300 amplitude in the OI group than loss, there was no significant group difference in P300 between the OI group and the OE group. It is generally believed that P300 is associated with the allocation of attention resources in outcome evaluation and a high level of motivation/emotion evaluation (13, 37). These results suggested that social exclusion did not affect the orphaned youths' motivational/emotional evaluations of outcome feedback. We tried to explain this result, according to the emotional numbness theory proposed by Baumeister et al. (47), we suspected that the early negative experiences could cause orphaned youth to become numb, including emotional and physical numbness. This defensive response of self-protection temporarily could reduce the pain and enable them to cope with the negative events. This point can be demonstrated by our results that the P300 amplitude was larger in CI group than OI group. Unlike orphaned youth, the amplitude of P300 induced by CI group was larger than that by CE group, which indicated that social exclusion significantly reduced the sensitivity and the level of motivational/emotional evaluation of the feedback results in control group. The P300 component reflects the late resource allocation in the Trust Game. When the participants encountered social exclusion, they might consume a lot of resources, leading to a sharp decrease in subsequent resources, and attracting less attention in the outcome evaluation. The CI group had a higher level of motivational/emotional meaning due to an inclusive environment, leading to the larger P300 amplitude. The study of Rigoni et al. (48) also found that complex social situations would weaken individual's attention to winning or losing results.

Our study has some limitations. Firstly, although we controlled some key contextual and individual factors, such as gender and age, data on some key contextual and individual factors, such as current social status, were not available in the current study. Future studies need to take into consideration of these factors to get a better understanding of the effect of social exclusion on orphaned youths' trust. Secondly, as this study was conducted in China, the generalizability of the finding to other settings may be limited. Comparing effects across culture or social value orientations would supplement this study to provide a more comprehensive understanding of decision-making after social exclusion. Finally, another limitation pertains to the sample size. Our sample size may be relatively small due to the particularity of the subjects and the increasing difficulty of following up after 15 years. Future studies should further increase the sample size to improve the validity of the study.

CONCLUSION

The current study attempts to demonstrate the behavioral performance and neurophysiological mechanism of trust in orphaned youth with existing stigma experience when they encounter social exclusion in the laboratory. The results found that orphaned youth had contradictory and complex psychological responses. On the one hand, in terms of behavioral responses stage, orphaned youth showed significantly more trusting behaviors; on the other hand, in terms of outcome evaluation stage, orphaned youth showed sensitivity to the deviation of feedback and lower motivational/emotional evaluations of reward. To a certain extent, these findings indicated that orphaned youth might have formed some type of self-protective mechanism to prevent the negative feedback of others from causing a serious blow to themselves. In other words, their previous negative experiences may also play an important role, so we suggest that people should reduce the stigma and exclusion behavior of vulnerable groups, such as orphaned youth, and give them more positive feedback, which may contribute to their interpersonal social adaptation. Simultaneously, it has important implications for understanding the processes by which social exclusion may adversely affect the mental health of youth orphaned by HIV/AIDS.

DATA AVAILABILITY STATEMENT

The datasets presented in this article are not readily available because of privacy or ethical restrictions. Requests to access the datasets should be directed to JZ, jfzhao63@hotmail.com.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Institutional Review Board at the Henan University in China (IRB 00007212). The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

JW, QZ, and JZ designed the study and drafted the manuscript. YZ and LJ performed the study. JW, QZ, and SQ analyzed the data and edited the manuscript. JZ and XL revised the manuscript. All authors contributed to the article and approved the submitted version.

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Working memory deficits in children with schizophrenia and its mechanism, susceptibility genes, and improvement: A literature review

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The negative influence on the cognitive ability of schizophrenia is one of the issues widely discussed in recent years. Working memory deficits are thought to be a core cognitive symptom of schizophrenia and lead to poorer social functions and worse academic performance. Previous studies have confirmed that working memory deficits tend to appear in the prodromal phase of schizophrenia. Therefore, considering that children with schizophrenia have better brain plasticity, it is critical to explore the development of their working memory. Although the research in this field developed gradually in recent years, few researchers have summarized these findings. The current study aims to review the recent studies from both behavior and neuroimaging aspects to summarize the working memory deficits of children with schizophrenia and to discuss the pathogenic factors such as genetic susceptibility. In addition, this study put forward some practicable interventions to improve cognitive symptoms of schizophrenia from psychological and neural perspectives.

KEYWORDS

schizophrenia, children, working memory, genetic susceptibility, cognitive intervention

Introduction

Schizophrenia is now one of the most prevalent and serious mental illnesses in the world with typical symptoms defined (1, 2): (a) positive symptoms centered on delusions, hallucinations, disorganized speech, and grossly disorganized or catatonic behavior; (b) negative symptoms, i.e., affective flattening, alogia, or avolition; (c) cognitive symptoms including deficits in attention, working memory, and executive functions. Multiple psychiatrists proposed that different aspects of symptoms are not separate. For example, negative symptoms (loss of function), by definition, incorporate cognitive symptoms. However, more complex cognitive impairments have been found over the past years and viewed as one kind of independent symptom by multiple psychiatrists. As a result, we should treat schizophrenia symptoms from a unified perspective (3, 4). In addition,

all these symptoms might be linked to the functions of dopamine, serotonin, and glutamatergic neurotransmission systems (5–7).

As shown in surveys, the lifetime prevalence of schizophrenia is estimated to be 0.3% worldwide and 0.83% in China (8, 9) and varies depending on the location, economic conditions, and the diagnostic criteria used. Although the annual cost of schizophrenia for both patients and society is tremendous (10), the therapeutic effect of schizophrenia is still not ideal. A previous investigation showed that only 13.5% of individuals with schizophrenia met the criteria for recovery (11). Furthermore, Phahladira and Luckhoff (12) have found that 70% of patients treated with antipsychotic medication achieved symptom remission, while only 9% achieved both functional remission and good quality of life, implying a large gap between symptom remission and a return to normal life. In a study by Nuechterlein, Subotnik (13), it was highlighted that cognitive functioning is one of the most critical determinants of quality of life for people with schizophrenia compared to symptoms such as delusions or hallucinations. More research provides sufficient support for this statement, for example, the important role of cognitive functioning in socialization has been demonstrated (14) and a longitudinal study has also shown that cognitive impairment predicts slower socialization (15). Therefore, cognitive functioning in patients with schizophrenia has become a key object of research.

People with schizophrenia have deficits in multiple cognitive domains simultaneously (1, 16), A meta-analysis has found that adult patients with schizophrenia perform more poorly than healthy controls in five cognitive domains including IQ, memory, language, executive function, and attention (17). Another systematic review has also indicated worse performance in a broad range of neuropsychological domains like multiple types of memory, intellectual function, sustained attention, as well as set-shifting and response inhibition (18). Specifically, working memory has been considered as one of the most fundamental cognitive functions and is related to a number of core symptoms of schizophrenia (19). Early studies demonstrated that there was a significant correlation between working memory deficits and several schizophrenia symptoms such as affective disorder and disorganized behavior (20, 21).

Working memory is defined as the limited capacity system necessary for short-term storage and manipulation of information in progress (22). In many studies investigating schizophrenia in all age groups, childhood and adolescence have been found to be particularly critical. Cognitive impairments such as working memory deficits tend to present in childhood (age 7–13) and adolescence (age 14–17) before they perform signs and symptoms of schizophrenia (23), so working memory deficits may be one of the predictors of schizophrenia in childhood. In addition, several empirical studies from schools have found that children in the early stages (the pre-psychotic prodromal period and the first 5–10 years after the initial episode) (24) of schizophrenia have poorer educational achievement and impaired social functioning, which may be due to working memory deficits (25–28). Remarkably, schizophrenia, one of the first-episode psychoses (FEP), often develops in childhood and adolescence (29), and patients with FEP tend to show a high remission rate owing to early intervention (30, 31), suggesting that the earlier the intervention was given, the more effective the intervention would be.

Therefore, it is meaningful to study schizophrenia in children from the perspective of cognitive impairments like working memory deficits, however, few reviews have been made. To conclude, the current study aims to summarize studies on working memory deficits in children with schizophrenia from both behavioral and neuroimaging aspects, try to explain deficits with possible susceptible genes and recommend some available interventions.

Working memory deficits in children with schizophrenia

Behavioral studies of working memory deficits in children with schizophrenia

Childhood and adolescence represent a rapid physical and psychological development. However, it is also a period when neurodevelopmental disorders such as schizophrenia begin to appear, accompanied with cognitive deficits (e.g., working memory deficits), (32). Cognitive Neuroscience Treatment Research to Improve Cognition in Schizophrenia (CNTRICS) has suggested four components of working memory deficits including goal maintenance, interference control, rehearsal (active maintenance over time), and updating (33). Previous studies have found deficits in goal maintenance among schizophrenia patients with several working memory tasks such as the anti-saccade task (34) and Dot Pattern Expectancy task (35). Some other studies also indicate impaired updating function in schizophrenia with updating and maintenance paradigm (36) and auditory target detection task (37). Eye-movement studies have also provided some evidence for abnormal working memory inhibitory processes in ultra-high-risk subjects and siblings (38, 39). These findings indicate that schizophrenia affects the working memory function of patients from multiple dimensions and we suggest that different mechanisms should be distinguished among these effects. In addition, some early field studies demonstrated possible working memory deficits in children with schizophrenia. A meta-analysis also showed that children with schizophrenia had worse general academic and mathematics achievements (40), meanwhile, accompanied by poorer social functions characterized by inadequate emotional reactions, the disorder of thinking, and loss of will (41, 42), which could be considered main markers of working memory deficits. Then, a questionnaire study on a large

sample of adolescents and young adults has shown that specific psychotic-like experiences are associated with low working memory capacity (43). Furthermore, previous behavioral studies have found that children with schizophrenia tend to present more slow response time and low accuracy in different types of working memory tasks including visual, auditory, and verbal tasks (44–47). To conclude, sufficient behavioral evidence has told us that various working memory deficits exist in (high-risk) schizophrenia subjects and could be markers of the disease progression.

Neuromechanism of working memory deficits in patients with schizophrenia

Over the past few years, an increasing number of neuroscientists have turned to explore the neuromechanism of working memory deficits in patients with schizophrenia. Many functional magnetic resonance imaging (fMRI) studies have reported altered engagement of the cerebral cortex during working memory processing in early-onset (EOS; the age of onset <18 years) schizophrenia, particularly in the dorsolateral prefrontal cortex (DLPFC), ventrolateral prefrontal cortex (VLPFC), and anterior cingulate cortex (ACC) (48–50). These regions have been shown to be closely associated with a wide range of executive dysfunction, especially memory deficits (51). For example, a previous study (52) found the decreased DLPFC connectivity within the working memory network and suggested that patients with EOS schizophrenia showed significant late developmental changes. Nielsen, Madsen (53) found that first-episode schizophrenia had decreased forward connectivity from the left inferior parietal lobe (IPL) to the left inferior frontal gyrus (IFG), which indicated the impaired working memory modulation of the frontoparietal network and the failure of context-sensitive coupling in the early phase of schizophrenia. Moreover, the degree of impact on different working memory functions varies, which perhaps means discrepant neuromechanism. A previous study found the increased activation when patients engaged in the manipulation plus maintenance task. Meanwhile, the changes of brain activation were disproportionately less in the DLPFC and greater in the VLPFC. This result suggested that manipulating function is selectively more affected than storing function in working memory (54). In addition, some researchers have found abnormal hyperactivation in the above-mentioned brain regions, reflecting the use of compensatory cognitive strategy while solving WM tasks (55), which might be another sign of working memory deficits. Furthermore, Loeb et al. (48) also pointed out that decreased activation and functional connectivity in the working memory network in childhood-onset schizophrenia were associated with the severity of the disease. To conclude, although there is no consensus on the neuromechanism of schizophrenia, it's clear that no matter in function or structure, numerous studies have offered enough evidence that children with or at risk of schizophrenia develop with apparent or potential working memory deficits and these deficits tend to present relatively early during schizophrenia.

Genetic susceptibility factors of working memory deficits in schizophrenia patients

Previous studies provided sufficient evidence that schizophrenia is a highly heritable disease. An early twin study showed that the estimate of heritability in liability of schizophrenia was nearly 81% (56) and this result was still supported by some recent studies (57, 58). Similarly, working memory deficits in patients with psychosis are genetic with heritability estimates of up to 49% (59). Thus, numerous psychologists and psychiatrists have committed themselves to exploring possible susceptible genes linked with working memory deficits in patients with schizophrenia.

Previous genome-wide association studies (GWAS) have indicated some susceptibility genes are significantly associated with schizophrenia. The most compelling studies came from the psychiatric genomics Association (PGC), which provided the largest sample size for the GWAS study of schizophrenia. With the release of three PGC studies (60–62), researchers further clarified the genetic nature of schizophrenia. In 2014, the landmark GWAS study conducted by the PGC identified 128 independent single nucleotide polymorphisms (SNPs) in 108 gene loci that met genome-wide significance (61). Some associations at DRD2 and several genes involved in glutamatergic neurotransmission were consistent with previous leading pathophysiological hypotheses and highlight molecules with known and potential therapeutic relevance to schizophrenia. While 83 of 128 SNPs have not been reported previously, providing entirely new insights into etiology. In the recent GWAS study conducted by PGC, they identified 120 genes involved 106 protein-coding, of which more gene loci related to neurodevelopmental disorders were found (62). These GWAS studies have identified multiple susceptibility genes significantly related to schizophrenia. However, the specific mechanisms of these genes in schizophrenia are still unclear, which hinders the determination of promising drug molecular targets.

Some researchers chose to focus on the effects of schizophrenia susceptibility genes identified in the GWAS study on cognition and its brain mechanisms, many of which involved the working memory function. For example, the rs1344706 within the zinc finger protein 804A gene (*ZNF804A*) has been found a compelling candidate single nucleotide polymorphism (SNP) for schizophrenia (63). Recent studies have also provided support for altered brain activities among

ZNF804A variant rs1344706 schizophrenia carriers, such as influenced hippocampal-DLPFC functional connectivity during resting-state (64), abnormal prefrontal connectivity (65), and altered cortical network dynamics (66). Some of them also play a significant role in working memory performance and a previous cognitive-measuring study has indicated higher polygenic scores of *ZNF804A* were associated with poorer working memory (67). Linden, Lancaster (68) has found worse working memory performance for face processing among *ZNF804A* carriers. Additionally, impaired cognitive control function in working memory has also been found (69, 70).

The dopamine receptor type 2 gene (*DRD2*) polymorphism was also known as one of the risk variants for schizophrenia (71). The polymorphism of *DRD2* (C957T) has been known to be associated with schizophrenia (72), while the result seems inconsistent in different populations (73, 74). Meanwhile, the C957T variant has showed closely connected to working memory performance, especially in goal maintenance function (75) but limited effect on executive function (Working Memory, Response Inhibition, Cognitive Flexibility) (76). Moreover, researchers have also found that the rs1076560 variant of *DRD2* significantly contributes to abnormal prefrontal activity and impaired working memory in several task-related studies (77, 78). Braun, Harneit (79) have studied the role of *DRD2* dopamine in whole-brain network dynamics and found decreased stability of working memory representations. Pergola, Di Carlo (80) comprehensively studied the *DRD2* co-expression network and calculated a related polygenic index which could significantly predict the abnormal prefrontal activity and insufficient working memory processing.

Several GWAS studies have also identified the *CACNA1C* gene polymorphism (rs1006737) as a susceptibility locus for schizophrenia (81) which often comes with alterations in prefrontal activation and fronto-hippocampal connectivity during emotional processing and executive cognition (82, 83) and finally lead to poor working memory performance (84, 85), especially impact on the encoding phase of working memory (86). Beyond that, some other SNPs in *CACNA1C* have been identified as risk loci for schizophrenia over the past years (87). However, we are still lacking in profound understanding among them and more evidence is expected.

Moreover, *RELN* variants have been proved to contribute to the endophenotypes of schizophrenia (88) and regulate synaptic plasticity and cognition in psychotic subjects (89). Reproducible studies have shown multiple *RELN* variants (7q21-32) are associated with memory impairments (90, 91). In addition, a study in healthy population carried with *RELN* (rs362691) has shown high cognitive deficits, especially in executive function (92). Although more and more SNPs in *RELN* are confirmed to be related to schizophrenia recently (93), their effect on working memory awaits deeper studies.

In addition, the transcription factor 4 gene (*TCF4*) (94, 95), the microRNA-137 gene (MIR-137) (96–98), and the type-3 metabotropic glutamate receptor gene (*GRM3*) have also been found to be associated with working memory impairment by affecting the functions of brain regions related to working memory processes, including DLPFC, hippocampus, striatum and other regions.

Beyond that, Nicodemus, Kolachana (99) proposed that statistical interactions among multiple susceptibility genes should also be considered. The polygenic risk score (PRS) has become a powerful indicator of GWAS results. Identified SNPs were weighted by their association odds ratio to construct a risk score for each individual. The PRS was positively correlated with the genetic susceptibility of the disease. Wang, Liu (100) calculated the PRS using the formula developed by PGC and found that a higher PRS was significantly associated with impairment in working memory. To sum up, a large number of GWAS studies have shown us that schizophrenia susceptible genes indeed account for working memory deficits. These findings will undoubtedly provide enlightenment for improved treatment for cognitive symptoms in schizophrenia patients in the future. In addition, many newly identified genes are related to neurodevelopmental disorders (62), which further suggests that we need to pay more attention to the children with schizophrenia.

Intervention with cognition deficits in children with schizophrenia

It has been commonly accepted that children, compared to adults, develop with better neural and behavioral plasticity, so early intervention for children with schizophrenia is necessary. In addition, although the main treatment of schizophrenia is antipsychotics, some other therapies have also been put forward to promote the recovery of cognitive function in schizophrenia patients, which in turn help establish adaptive behaviors and have gradually been introduced to children.

Cognitive behavioral therapy (CBT) refers to a class of interventions that share the basic premise that mental disorders and psychological distress are maintained by cognitive factors (101, 102). Therefore, CBT approaches are often used in responding to some cognitive symptoms in a wide range of psychiatric disorders and show a large effect size (103). A review of meta-analysis on the efficacy of CBT has confirmed that the preferential application of CBT in children helped to alleviate behavioral and emotional disorders in various psychosis to some extent (104). In the meantime, a randomized controlled study (105) has found that CBT with treatment as usual (9 months) contributed to better global function and quality of life in adolescents with early-onset schizophrenia, which is considered the external sign of cognitive recovery. Another study on the CBT for adolescents at high risk for serious mental illness (SMI) such as schizophrenia and bipolar disorder indicated that patients asked to engage in several interventions showed

reduced difficulties in emotion regulation, better frustration tolerance, and stronger motivation (106). More importantly, CBT is proved to be highly acceptable and feasible with few side effects (104, 107).

Another similar psychopharmacologic treatment commonly used for mental disorders is mindfulness. The definitions of mindfulness are various and have been divided into five dimensions including awareness and attention, present-centeredness, external events, cultivation, and present centeredness (108). An early meta-analysis showed that mindfulness intervention was moderately effective in treating psychotic negative symptoms (109). Recent meta-analyses have provided more evidence for its efficacy and safety (110, 111). Furthermore, mindfulness among children and adolescents has been suggested to have certain clinical effects, while it still needs to be standardized (112). Therefore, Mindfulness-based cognitive therapy for children (MBCT-C) was developed (113) and significant effects were found, including improved cognitive control, better emotional control, and fewer behavioral symptoms (114–116). More importantly mindfulness-based approaches were highly feasible among children and adolescents (117). However, there are few studies on the efficacy of MBCT-C for children, especially schizophrenia. More clinical studies are expected and a comparison could be made between CBT and mindfulness.

However, the tremendous time and human cost of CBT and mindfulness cannot be ignored. To solve this issue, many researchers have been dedicated to intervention with specific cortexes via several neuro-technologies, such as electroconvulsive therapy (ECT). ECT has been proved to be well-tolerated, well-established, and efficacious in multiple moods and psychiatric disorders including depression and schizophrenia (118, 119). However, the majority of results from older studies in children and adolescents were mixed and its effect on them could not be clearly explained. Nowadays, studies and applications of ECT among children and adolescents with FEP become popular and its efficacy has got some verification (120, 121), while more clinic researches are still required. In addition, the side effect of ECT, particularly in cognitive function (e.g., memory loss), has been in heavy discussion for a long time (122, 123). Dossing and Pagsberg (124) suggested that more attention should be paid to cognitive dysfunction under ECT in further studies. To conclude, ECT has been considered a reliable way especially for antipsychotics-resistance patients, while the effect on cognitive functions remains to be vague.

To avoid the argument about safety and enhance the feasibility of neurotechnology, several non-invasive brain stimulation techniques were developed. Transcranial magnetic stimulation (TMS) uses very brief high intensity magnetic fields to induce currents and thus depolarize neurons in small regions of the cortex (125). A review showed that TMS has been applied for the treatment of auditory verbal hallucinations in schizophrenia patients and proved superior efficacy (126). Another repetitive TMS study in EOS patients (127) also reported a significant improvement in the severity of auditory hallucinations and global functioning over the left temporoparietal junction. Additionally, the author appealed to concern about the TMS used in the treatment of several cognitive functions, especially among children. Related studies have shown that TMS in specific cortex like DLPFC contributed to the improvement of inhibitory and executive function in children and early adults (128, 129). However, recent meta-analyses indicate that cognitive enhancement effects caused by TMS in patients with schizophrenia or other neuropsychiatric conditions are moderate (130, 131) and researchers attribute the result to insufficient subjects and lack of long-term TMS intervention. Therefore, more studies in this field are desperately needed.

Another non-invasive brain stimulation technique is transcranial direct current stimulation (tDCS), which has been the subject of great interest owing to its easiness of operation and relatively low cost. tDCS takes effect by applying a weak current over the scalp to modulate cortical excitability by facilitating or inhibiting ongoing neuronal processes. A review of tDCS in psychiatric disorders has demonstrated its high tolerability in patients with schizophrenia and improvement in positive and negative symptoms (132). Meanwhile, one study has provided support that tDCS also played a role in the treatment of cognitive impairments, especially in working memory (133). On this basis, some other researchers focus on the feasibility and safety of tDCS among children and adolescents which is proved to be well-tolerated (134, 135). A recent study of tDCS among children and adolescents with attention-deficit/hyperactivity disorder (ADHD) have indicated positive result in attention and inhibitory control function (136). Another study has reported enhancing working memory performance in children with ADHD under the intervention of tDCS over the left DLPFC (137). In addition, improved reward processing in children with ADHD has also been found through tDCS in specific regions including the left DLPFC and the right ventromedial prefrontal cortex (138). However, a meta-analysis showed little evidence that 1 to 5 sessions of tDCS improve the cognitive measure of children with ADHD (139), which calls for a persistent tDCS study in psychopathic children. Moreover, the study on the clinical effects of tDCS among children with schizophrenia is limited and its real efficacy with cognitive impairments remains to be further examined.

Above all, the current treatments of children with schizophrenia were focused on antipsychotics, which could greatly improve some positive symptoms such as hallucinations and paranoia. In addition, ECT could further enhance the efficiency of treatment in conjunction. However, the above-mentioned therapies are not very effective for negative symptoms (e.g., avolition) and cognitive symptoms (e.g., working memory deficits). Therefore, it is highly recommended to use TMS and tDCS. Moreover, psychopharmacologic

treatment including CBT and mindfulness play an important role in helping children with schizophrenia improve cognitive functions and adapt to daily life. Moreover, it is worth emphasizing that persistent treatment is necessary no matter what kind of therapy is chosen.

Conclusion

The current review mainly discusses the cognitive impairments in patients with schizophrenia, especially in children. Previous studies have confirmed that children with schizophrenia are prone to show worse academic grades and more conflicting relationships, accompanied by poor performance in several working memory tasks. In addition, numerous neuroimaging studies have demonstrated altered activation of working memory networks and weak functional connectivity in schizophrenia children. To further explain the pathogenesis of schizophrenia, many susceptible genes have been put forward to take effect in related activities among specific cerebral cortexes which finally accounts for working memory deficits in schizophrenia. Thus, findings of the early presence of cognitive symptoms both in behavior and cerebral cortex offer the opportunity for prevention and treatment of schizophrenia in children. Currently, lots of psychologists and psychiatrists have contributed to the enhancement of cognitive impairments of children with schizophrenia by employing CBT, mindfulness, ECT, TMS, and tDCS.

Although studies on working memory deficits among children with schizophrenia have been constantly emerging, several limitations still exist. Firstly, most working memory tasks used in experiments are mainly designed for adults, and their difficulty and duration might be unsuitable for children. Thus, adapted working memory tasks are required to assess multiple working memory functions more efficiently. Similarly, the treatment for children with schizophrenia is nearly the same as that of adults, and there is also a lack of child intervention studies. Considering the better brain plasticity of children, the brain activity of children might be different from that of adults, so more specific treatment should be studied and developed. Furthermore, the intervention duration of several existing studies on children is not enough which may be one of the reasons for the inconsistent treatment effects. Therefore, more long-term follow-up studies are needed.

In the future, the mechanism of working memory and other cognition impairments in schizophrenia are needed to be explored. On this basis, it is worth looking forward to the more effective and lower-cost therapy for schizophrenia patients, especially for children.

Author contributions

WZ had full access to all the information in this review. WZ, JZ, and JL managed the literature searches and selection. WZ and QZ reviewed the logicality of the manuscript. PO and QZ polished the manuscript in language expression. JZ wrote the first draft of the manuscript. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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Mental health and adaptive functioning among school-aged children living with HIV in Zambia

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Background: The number of children living with HIV (CLWHIV) has been increasing, reflected by lower mortality. However, this change is coupled with higher rates of morbidity, where CLWHIV face considerable challenges, including neurocognitive delays and mental health and behavioral functioning challenges. Despite Sub-Sahara accounting for the highest number of CLWHIV, there is still limited research on the effects of HIV on child mental health and adaptive functioning.

Method: Mental health and adaptive functioning were assessed in 120 children. The sample included 62 CLWHIV and 58 demographically-matched HIV-uninfected children aged 6–12 years. Mental health was assessed using the Connors, while adaptive functioning was assessed using the Vineland Adaptive Behavioral Scale (VABS).

Results: Scores obtained were within average ranges for mental health (T-score 40–59) and adaptive functioning standard scores (70–115). However, CLWHIV had significantly higher mental health problems than uninfected children in executive functioning and aggressiveness ($p < 0.05$). CLWHIV had lower adaptive functioning scores on the VABS Communication domain although these differences were not significant. In the Daily Living Skills domain, CLWHIV had significantly higher scores than the HIV-uninfected children ($p < 0.05$). There were no significant differences in the Socialization subdomain. Furthermore, CLWHIV had significantly higher scores on the Maladaptive Behavior scales of the VABS' internalizing and externalizing subdomains.

Conclusion: Challenges to mental health and adaptive functioning are still pervasive among CLWHIV. These findings support the need to develop support mechanisms for CLWHIV to help address mental health and adaptive functioning problems, especially as they progress into adolescence.

KEYWORDS

mental health, HIV, adaptive function, children, low- to middle-income countries

Background

It is estimated that about 22.5 million people live with HIV in Sub-Saharan Africa (SSA) (1). Approximately 1.8 million children under the age of 15 live with HIV, globally, and 80% of these children live in SSA (2). It is estimated that there are currently 72 000 Zambian children living with HIV (3). It was previously reported that 49 000 children living with HIV (CLWHIV) in Zambia do not have access to ART (4). Although access to ART has undoubtedly reduced mortality, children diagnosed with HIV tend to suffer developmental delays; they are also prone to mental health problems and poor adaptive functioning (5).

Poor mental health and adaptive functioning have been highlighted among CLWHIV, particularly in high-income countries [HICs; (6)]. In low- to middle-income countries (LMICs), the incidence of mental health problems has also been documented; however, most of the studies among CLWHIV did not include a comparative HIV-uninfected sample to ascertain whether mental health problems are comparable (7). Despite not including comparative samples, studies on mental health among CLWHIV in LMICs have shown that there is a high incidence of mental health problems that are associated with several challenges, including poor access to health services, lack of youth-friendly mental health services, and the inability to continually access treatment as they transition to adult hospitals, which all affect treatment adherence in the long run (8, 9). Comparing mental health problems among CLWHIV with HIV-uninfected children offers better understanding of mental health among younger children. Studies in HICs that have evaluated mental health problems among CLWHIV have shown lower rates of mental health problems than community prevalence. The lower rates of mental health problems in CLWHIV are attributed to the fact that CLWHIV have regular clinical visits and tend to benefit more from early detection and management of mental health problems than HIV-uninfected children in the community. Therefore, a better understanding of mental health problems among CLWHIV and uninfected children can inform treatment options that might be used to manage mental health problems, particularly in low-income environments where access to mental health services is limited. Furthermore, mental health studies in CLWHIV have mostly been conducted among older children and adolescents, with limited research on mental health problems among younger children (10).

The effects of pediatric HIV go beyond mental health and may affect other areas of a child's well-being. Adaptive functioning is an area of functioning that has been identified as a key factor that is relevant to identifying the competencies and abilities of children diagnosed with developmental and intellectual disabilities (11). Adaptive functioning generally relates to areas such interpersonal communication and activities of daily living that include a broad spectrum of activities including personal hygiene and care. It also includes competencies in community living, academic achievement skills, and effectively managing the necessities of a personal ecological setting (12, 13).

Studies on adaptive functioning among CLWHIV in HICs have had mixed findings, with some reporting no differences in adaptive functioning between CLWHIV and uninfected children (14), while other studies have indicated poorer adaptive functioning scores in CLWHIV (15). Nonetheless, studies on adaptive functioning among CLWHIV particularly in HICs have shown that poor adaptive functioning puts children at risk of poorer outcomes in other areas of life including academic achievement and neurocognitive functioning (14–16). In LMICs studies have largely been conducted among HIV-affected households rather than CLWHIV specifically, and these results tend to reflect poorer behavioral functioning, poorer health outcomes and challenges in cognitive functioning (17, 18). An adaptive functioning study in South Africa established that, similar to studies in HICs, CLWHIV with poor adaptive functioning have poorer neurocognitive functioning and poor academic achievement (19).

With the growing number of CLWHIV surviving into adolescence and adulthood, it is important to consider the challenges in mental health and adaptive functioning that these children may encounter. This study thus aimed to establish whether HIV affects the mental health and adaptive functioning of school-aged children living with HIV compared to HIV-uninfected children in Zambia.

Materials and methods

The study took place in Lusaka, the capital city of Zambia. The data was collected between September, 2015 and December, 2016. Two peri-urban clinics were included as study sites. The clinics selected are centers that provide services to CLWHIV and Prevention of Mother to Child Transmission (PMTCT) services. The target population included children of primary school age (6–12 years). The study employed a cross-sectional quasi- experimental design that compared two pre-existing groups, CLWHIV and an HIV-uninfected matched control group. CLWHIV were recruited from ART centers at the participating clinics. Community health workers identified the HIV-uninfected children from the clinic in the outpatient department. They approached mothers attending PMTCT clinics and the pediatric outpatient department at the participating clinics and enquired whether they have children who might want to participate in the study. All children identified as exposed to but uninfected by HIV were not included in the study. There was no known relationship between the CLWHIV and the HIV-uninfected children. Routine HIV

testing at every clinic visit is mandatory in Zambia; therefore, an HIV-negative test was not taken from the uninfected children, as it was based on the standard testing conducted at the participating medical facility. The CLWHIV were unaware of their HIV status as medical guidelines do not recommend the disclosure of HIV status to children below the age of 12 who were the target age group (20).

For both the CLWHIV and the HIV-uninfected controls, exclusion criteria included previous neurological conditions such as epilepsy, cerebral Malaria, cerebral palsy, infantile meningitis, and a previous head injury that had led to a loss of consciousness. Other exclusion criteria for the CLWHIV-group and HIV-uninfected group included acute illness or hospital admission at cognitive assessment and inability to perform neuropsychological tests.

Written informed consent was obtained from parents/caregivers of children participating in the study, and children and their parents/caregivers were informed that participation in the study was voluntary. Ethical approval was received from the ERES Converge IRB in Zambia. Additional consent was obtained from the Ministry of Community Development, Mother and Child Health, and the Lusaka District Health Medical Office to access clinics where recruitment was carried out.

Data was collected by two trained psychology graduates. The research assistants went through an additional training by a neuropsychologist on the administration of the measures used in the assessment as well as on working with CLWHIV and their caregivers. The data collected was further evaluated by two senior neuropsychologists to ensure that it was done correctly and based on standardized procedures of administration and scoring. The data collection process was carried out in English as this is the official language of the country.

Mental health measures

We used the Conners 3, a revised version of the Conners Rating Scales (21) to assess mental health and behavioral functioning. It is a well-standardized and widely used assessment tool to diagnose Attention-Deficit/Hyperactivity Disorder (ADHD) and other developmental disorders in children and adolescents. The test has three versions available in both a full version and a short form: Parent and Teacher Rating Scales which can be used for children aged 6 to 18 years, and a Self-reporting scale for children aged 8 to 18 years. In this research, the Parent Rating Short form was used, containing 45 items in which parents/caregivers rate their children's behavior on a five-point Likert scale from *not at all* to *most of the time*. There are six subtests: Inattention, Hyperactivity/Impulsivity, Learning Problems, Executive Functioning, Defiance/Aggression, and Peer relations. The information provided triangulates the child's behavior at home, at school, in social settings, and interactions with peers (21). Although not previously used in Zambia, the test has been successfully used in other African studies, particularly in South Africa (22, 23).

Adaptive functioning measures

We used the Vineland Adaptive Behavior Scale (VABS) (24) to assess adaptive functioning and maladaptive, internalizing, and externalizing behavior. The scale provides subscales on children's adaptive functioning in various areas of daily living. In this version, parents/caregivers are asked to rate whether the child has performed an activity based on the following scale: "usually," "sometimes or partially," or "never." The scale has been widely used in research in Zambia to assess adaptive competencies in both clinical and non-clinical samples (25–27). The subscales cover the domains of daily living skills (including items on socially appropriate feeding, toileting, and grooming), community living skills (including rule-following, reliability, respect for privacy, and understanding of rights), and social skills (including sensitivity to others' needs, prosocial attitudes, cooperation, sharing, respect for property, and good sportsmanship). The parents' interview form version of the VABS was used in this study.

Data analysis

Data were analyzed using IBM SPSS Statistics Version 28. Independent *t*-tests were used to determine whether there were any differences in performance between CLWHIV and HIV-uninfected children. Bootstrapping was run on all between-group comparisons. Boot strapping provides reliable estimates given the small sample size and non-normality in the data through the generation of a thousand possible data sets (28). Cohen's *d* was used to establish the effect size estimate (ESE) on the observed differences between the two groups.

Results

Sample characteristics

The sample included 120 children aged 6–12 (*M: 9.8; SD: 1.8*) years, with 58 (45.7%) children living with HIV (CLWHIV group) and 62 matched controls (HIV-uninfected group; 54.3%; see Table 1). Fifty-six (56%) participants within the total sample were male. All the CLWHIV were vertically infected and the majority were taking ART at the study time. The majority of the participants were from a low socioeconomic status background, with most of the parents having <7 years of education and 77.5% of the families earning less than $1 per day. There were no

TABLE 1 Participant characteristics.

		HIV status		Test statistics		
		CLWHIV	Uninfected	χ^2/t	p	*ESE*
Sex (Male: Female)		28:30	26:36	0.693	0.490	0.501
Age (Mean: SD)		9.81:1.82	9.87:1.89	−0.179	0.858	−0.033
Parents education	No education	2 (3.5%)	1 (1.6%)			
	Grade 1–6	18 (31.6%)	13 (21%)	a	0.609	0.197
	Grade 7	17 (29.8%)	23 (37.1%)			
	Grade 8–9	9 (15.8%)	6 (9.7%)			
	Grade 10–11	4 (7%)	7 (11.3%)			
	Grade 12	5 (8.8%)	9 (14.5%)			
	13+	2 (3.5%)	3 (4.8%)			
Level of income[1]	0–1,999	41 (71.9%)	51 (82.3%)	a	0.210	0.196
	2,000–3,999	14 (24.6%)	10 (16.1%)			
	4,000–6,999	0 (0%)	1 (1.6%)			
	7,000–9,500	1 (1.8%)	0 (0%)			
	9,600–12,500	1 (1.8%)	0 (0%)			
Parents employment	Higher executive	1 (1.8%)	1 (1.6%)	a	0.221	0.210
	Business	1 (1.8%)	0 (0%)			
	Managers					
	Administrative	2 (3.5%)	1 (1.6%)			
	Clerical	0 (0%)	2 (3.2%)			
	Skilled manual	7 (12.3%)	11 (17.7%)			
	Semi-skilled	15 (26.3%)	9 (14.5%)			
	Unskilled	30 (52.6%)	33 (53.2%)			
	Homemaker	0	4 (6.5%)			
	No occupation	1 (1.8%)	1 (1.6%)			

[1]Amounts presented in Zambian Kwacha. At the time of data collection, the Zambian Kwacha was trading at US$1 to ZMW 8.6. [a]Fisher's exact test was used because >20% of cells had an expected count of <5.

significant differences in any of the demographic data presented in Table 1.

Mental health and behavioral functioning

Table 2 shows that parents/caregivers of CLWHIV reported significantly more behavioral problems for this group than parents/caregivers of the HIV-uninfected children in the Executive Functioning and Aggressiveness domains. There were no significant differences in mental health and behavioral domains of Inattention, Hyperactivity, Learning Problems or Peer Relations.

Adaptive functioning

Scores of adaptive functioning on all four domains are shown in Tables 3–6. Table 3 shows that parents/caregivers of CLWHIV reported significantly poorer scores in the receptive language domain for this group, as compared to scores reported by parents/caregivers of the HIV-uninfected group.

Table 4 shows statistically significant differences in the overall Daily Living Skills subdomain between the CLWHIV group and the HIV-uninfected children. In this domain, parents/caregivers of CLWHIV reported better daily living skills for this group than the parents/caregivers of the HIV-uninfected group.

A similar pattern was observed in the level of coping skills on the VABS, where parents/caregivers of the CLWHIV group reported higher levels that parents/caregivers of the HIV-uninfected group (see Table 5).

Finally, Table 6 shows significant differences on the Maladaptive scale of the VABS in the Maladaptive, Internalization, and Externalization domains. According to the caregiver reports of the CLWHIV group, there were higher reports of maladaptive, internalizing, and externalizing behavior for this group than for the HIV-uninfected children.

TABLE 2 Between group comparisons on Connors[a].

HIV status	Infected			Uninfected			Test statistics		
	M (SD)	Range	*N*	M (SD)	Range	*n*	*t*	*p*	*ESE*[b]
Inattention	40.83 (1.41)	40–65	40	41.53 (2.57)	40–54	30	−0.1.363	0.185	−0.356
Hyperactivity	42.53 (2.11)	40–79	40	42.77 (1.81)	40–60	30	−0.868	0.194	−0.210
Learning problems	49.23 (6.55)	40–81	40	48.03 (6.52)	40–90	30	0.755	0.459	0.182
Executive functioning	47.85 (5.45)	40–70	40	44.53 (4.70)	40–67	30	2.669	0.006	0.645
Aggressiveness	47 (4.76)	43–90	40	44.87 (1.07)	44–77	30	2.740	0.027	0.580
Peer relations	47.00 (4.47)	44–77	40	45.83 (4.76)	44–71	30	1.051	0.320	0.254

[a]Higher scores in each domain are indicative of mental health challenges.
[b]ESE is Cohen's d (0.2-small, 0.5- medium, 0.8-large).

TABLE 3 Between group differences on the Vineland Adaptive Behavior Scale: Communication domain[a].

HIV status	CLWHIV			Uninfected			Test statistics		
	M (SD)	Range	*N*	M (SD)	Range	*n*	*t*	*p*	*ESE*[b]
Vinelandcommunication	68.17 (6.06)	56–86	57	69.71 (4.88)	59–124	59	−1.24	0.200	−0.276
Vineland receptive	10.94 (1.77)	7–15	57	11.74 (1.48)	8–34	59	−2.18	0.034	−0.485
Vineland expressive	9.38 (1.54)	6–13	57	9.49 (1.46)	5–12	61	−0.333	0.757	−0.073
Vineland written	7.42 (1.86)	3–12	58	7.51 (1.33)	5–11	53	−0.278	0.786	−0.059

[a]Higher scores in each domain are indicative of better functioning.
[b]ESE is Cohen's d (0.2-small, 0.5- medium, 0.8-large).

TABLE 4 Between group differences on the Vineland Adaptive Behavioral Scale: Daily living skills[a].

HIV status	CLWHIV			Uninfected			Test statistics		
	M (SD)	Range	*N*	M (SD)	Range	*n*	*t*	*p*	*ESE*[b]
Vineland daily living skills	71.60 (8.68)	54–95	55	68.37 (6.07)	51–87	59	2.04	0.036	0.455
Vineland personal care	11.58 (2.58)	6–16	53	10.89 (1.60)	8–61	58	1.64	0.122	0.347
Vineland domestic care	10.44 (3.04)	4–17	58	9.20 (2.47)	2–17	61	1.97	0.054	0.439
Vineland community functioning	8.15 (1.14)	5–11	54	8.23 (1.89)	4–12	60	−0.229	0.821	−0.055

[a]Higher scores in each domain are indicative of better functioning.
[b]ESE is Cohen's d (0.2-small, 0.5- medium, and 0.8-large).

TABLE 5 Between group comparisons on the Vineland Adaptive Behavioral Scale: Socialization subscale[a].

HIV status	CLWHIV			Uninfected			Test statistics		
	M (SD)	Range	*N*	M (SD)	Range	*n*	*t*	*p*	*ESE*[b]
Vineland socialization	62.27 (5.29)	51–75	57	61.43 (5.73)	51–143	60	0.691	0.503	0.154
Vineland interpersonal relationships	7.92 (1.08)	4–10	58	8.31 (1.27)	5–13	62	−1.52	0.131	−0.339
Vineland play and leisure	7.02 (1.15)	4–10	58	7.11 (1.53)	3–11	62	−0.317	0.752	−0.070
Vineland coping skills	8.85 (1.95)	3–14	57	7.94(1.47)	5–14	62	2.316	0.022	0.515

[a]Higher scores in each domain are indicative of better functioning.
[b]ESE is Cohen's d (0.2-small, 0.5- medium, and 0.8-large).

TABLE 6 Between group comparisons on the Vinelands Adaptive Behavioral Functioning: Maladaptive behavior subscale[a].

HIV status	CLWHIV			Uninfected			Test statistics		
	M (SD)	Range	*N*	M (SD)	Range	*n*	*t*	*p*	*ESE*[b]
Vinelands maladaptive behavior	12.31 (1.85)	1–16	58	12.03 (0.16)	12–13	54	3.79	0.003	0.729
Vinelands internalizing behavior	15.67 (2.41)	10–12	58	14.00 (1.53)	12–18	59	3.75	0.004	0.733
Vinelands externalizing behavior	15.21 (2.13)	8–12	57	13.60 (1.94)	12–18	62	2.98	0.003	0.634

[a]Higher scores in each domain are indicative of more problem behavior.
[b]ESE is Cohen's d (0.2-small, 0.5- medium, and 0.8-large).

Discussion

This study was a small, cross sectional study that aimed to establish whether CLWHIV experienced more mental health and adaptive functioning problems than HIV-uninfected children. The reports of adaptive functioning and mental health and behavioral functioning were based on caregiver reports. This study shows that HIV has a significant role in the mental health, behavioral functioning, and adaptive functioning of CLWHIV when compared to demographically matched HIV-uninfected children. However, due to the limited sample size in this study, the results should be interpreted cautiously.

Mental health and behavioral functioning

The current study evaluates mental health problems among younger CLWHIV matched demographically with a group of HIV-uninfected children. The results showed that CLWHIV had higher mental health scores (suggesting more difficulties) than the HIV-uninfected in all domains. However, these differences in scores were only significant in the executive functioning and aggressiveness domains. The results of this study are consistent with previous studies carried out in Zambia, where parents/caregivers of CLWHIV reported more mental health problems relative to established test norms, despite the norms being based on a United Kingdom population (29, 30).

Unlike most studies that looked at mental health among adolescents with HIV (ALWHIV), our study focused on younger school-aged children. A study conducted in Malawi within a similar population group showed that CLWHIV had higher caregiver reports of emotional and behavioral problems than established test norms; however, like most studies, there was no inclusion of a comparison group (10). A similar study was conducted with a much younger study group of CLWHIV between the ages of 6 and 8 in South Africa, which showed a high prevalence of mental health problems, particularly among the younger children (31). Our study equally showed higher caregiver reports of poor mental health and behavioral function among CLWHIV in aggression and executive functioning. In this study, we identified particular domains of mental health that may be of concern among younger CLWHIV in SSA. Most recommendations to date have been to implement policies in helping adolescent children transition to adult clinics and accessing mental health services. However, earlier interventions would be helpful in assisting pre-adolescent children to navigate living with HIV and to manage knowledge of disclosure and treatment adherence.

The finding that executive functioning is one of the domains affected in CLWHIV is similar to what was observed in a multisite study of caregiver depression and cognitive functioning where an association was observed between higher levels of depression in caregivers and poor executive functioning in children (32). Based on caregiver reports, CLWHIV had more executive function problems than the uninfected children. These findings align with other studies that indicate that executive function continues to be a domain of concern among young CLWHIV (33, 34).

Other studies have pointed to mental health problems being associated with low SES neighborhoods, which would predispose both CLWHIV and HIV-uninfected children to more mental health problems due to exposure to several environmental traumas (35). In this study, based on comparative scores, the parents/caregivers of CLWHIV reported higher mental health problems than the parents/caregivers of uninfected children. However, based on cut-off points set by the Conners, the parents/caregiver reports in both the study and control group had scores within the average range; therefore, the role of environment increasing mental health problems outside of HIV infection was not supported within the parameters of the current study. However, it could be argued that the Conners being interpreted against international norms may not be the most appropriate route to understanding mental health as expressed in the local Zambian community. The majority of standardized tests used in SSA are normed on western populations. The implications of the use of tests that do not have local norms are usually that the test may fail to give a clear representation of mental health to the local population, which may be argued to have been the case in this study.

Adaptive functioning

Regarding adaptive functioning, parents/caregivers of the CLWHIV reported more difficulties in the Communication domain than parents/caregivers of the HIV-uninfected children. This result is similar to what has been reported in the literature on adaptive functioning among CLWHIV in HICs (14, 36). The communication domain on the VABS assesses how well an individual can exchange information with others. This ability extends to how well a person can process information, verbal skills, and reading and writing (37).

Our findings are similar to those observed in other studies among CLWHIV where communication skills were lower than for HIV-uninfected children or established test norms (15, 38). In our study, the receptive language domain largely accounted for this difference, and this too is similar to what was obtained in a study carried out in Canada with an immigrant sample where poor language skills were attributed to the transition to use of a second language (15). However, this was not the case in our study, as all participants used the same language and came from a similar SES background. Therefore, communication differences in the current study's groups could be attributed to the effect HIV may have on language development among children. In younger, HIV-exposed but uninfected children, poor receptive scores on the VABS have been associated with poor cognitive functioning and poor developmental outcomes (39, 40). In older ALWHIV, poor receptive skills have been associated with poor treatment adherence, primarily related to poor communication with caregivers (41). The findings in our study thus show the prevalence of poor communication skills in younger CLWHIV. Interventions in this age group would help alleviate CLWHIV's communication skills challenges as they transition through adolescence and later adulthood.

Significant differences between CLWHIV and the HIV-uninfected children were also seen in the Daily Living Skills domain, with parents/caregivers of CLWHIV reporting better performances in this domain than parents/caregivers of the HIV-uninfected children. This finding is consistent with some studies showing that CLWHIV tend to learn better home management and daily living skills as they usually take up the role of caregiver for an unwell parent or when a parent is not present (42). In this study, none of the children came from a child-headed household as they were all accompanied by a parents/caregiver; however, CLWHIV may still be taking the role of caregiver when the parents/caregivers are unwell. This finding is important as it speaks to the different needs and challenges that CLWHIV may face compared to adults and the need to create child-specific interventions relevant to specific age groups and populations.

In the maladaptive domain of the VABS, parents/caregivers of the CLWHIV group reported higher maladaptive scores than parents/caregivers of the HIV-uninfected children. Significantly higher scores were equally observed in the internalizing and externalizing subdomains than in the HIV-uninfected children. Previous findings on internalizing and externalizing behaviors among CLWHIV have been mixed. Some studies have shown that CLWHIV or their parents/caregivers report more externalizing and internalizing behavioral problems than their uninfected peers (14). However, studies in LMICs have demonstrated no significant differences in externalizing and internalizing scores between ALWHIV and established test norms (30, 43). Inconsistent results may be related to differences in measures used and methodical differences employed in the various studies. Further, most of these studies were carried out with adolescents, so differences in age groups could also account for the variations in the findings. An indication of poor or increased maladaptive behavior can point to the role that HIV may play in the developing brain among younger CLWHIV. Furthermore, early identification of problem behavior in CLWHIV would help develop suitable interventions as research has shown that in the absence of interventions, externalizing and internalizing behaviors may persist into adolescence and adulthood (44).

Limitations

Our study was not without limitations. First, the study had a small sample size which reduced the statistical power of the data analysis, and may make generalization of the findings difficult. Second, was the fact that the study was cross-sectional and thus could not look at whether mental health problems experienced in younger children would persist into adolescence. A third limitation was the reliance on caregiver reports of mental health, behavioral, and adaptive functioning. Previous research has indicated that caregivers of CLWHIV tend to experience some mental health challenges themselves and may in turn report similar outcomes in their children (42, 45). Previous research has highlighted that parents/caregiver mental health impacts the mental health of CLWHIV (42); however, this study did not collect data to ascertain caregiver characteristics. Further studies to consider long-term outcomes of mental health status among CLWHIV in LMICs are needed.

Conclusion

Mental health problems and poor adaptive functioning were present among CLWHIV in Zambia. Interventions for children concerning mental health need to begin early. Most interventions are designed for adolescents (46); however, this study indicates that younger children are equally vulnerable to mental health and adaptive functioning problems. Our study was one of the first studies to evaluate adaptive

functioning among CLWHIV, particularly highlighting that in some cases, CLWHIV may have poor adaptive functioning, but these problems do not extend to daily living skills. Interventions in terms of adaptive functioning should therefore be targeted specifically at affected domains. Lastly, CLWHIV would benefit from early mental health screening to help learn better- coping strategies as they progress into adolescence.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving human participants were reviewed and approved by ERES Ethics Board of Zambia. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

Author contributions

All authors made significant contribution in the conception, development and finalization of this manuscript.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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School adaptation and adolescent immigrant mental health: Mediation of positive academic emotions and conduct problems

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Introduction: Immigrant adolescents must adapt their physical and mental attitudes to attain healthy development due to dramatic changes in their living and learning environments after relocation. From the perspective of positive psychology, this study explored the specific influence of school adaptation on mental health among immigrant adolescents, mainly focusing on the mediating effects of positive academic emotions and conduct problems.

Methods: We selected primary and secondary school students from five relocated resettlement schools in Qianxinan Buyi and Miao Autonomous Prefecture, which has the largest population of relocated people in Guizhou Province, China. Using cluster sampling, 550 relocated students in Grades 5–12 from the five schools were recruited to complete a battery of questionnaires, including the Immigrant Adolescents' School Adaptation Scale, the General Health Scale, and the Positive Academic Emotions Questionnaire, and the Adolescents' Behavioral Tendency Questionnaire. In addition, this study used the bias-corrected bootstrap method to explore the chain-mediating effect of positive academic emotions and conduct problems between school adaptation and mental health.

Results: The results showed that immigrant adolescents had significant gender differences only in conduct problems. However, significant learning stage differences existed in school adaptation, mental health, positive academic emotions, and conduct problems. School adaptation, positive academic emotions, and mental health were significantly positively correlated. In contrast, conduct problems were significantly negatively correlated with mental health. School adaptation influenced mental health through the mediation effects of positive academic emotions and conduct problems. These effects contained three paths: the separate mediation effects of positive academic emotions and conduct problems and the chain mediation effect of positive academic emotions and conduct problems.

KEYWORDS

immigrant adolescents, school adaptation, mental health, positive academic emotions, conduct problems

Introduction

The term *relocated migrants* refers to individuals who move from remote places in mountainous areas to live in cities and towns. Migrants who have relocated have left their place of origin to live, study, and work in a new environment. They experience considerable changes in the environment after relocation. This change inevitably has an impact on their physical and mental health. Therefore, adapting to the new living and educational environments after the relocation and developing in the process of adaptation are practical issues that must be addressed. Due to different cultural influences, they do not adapt their behaviors and living habits immediately. Relocated young people need greater care and support in terms of academic psychology and emotional adjustment. In this study, the term *immigrant adolescents* referred to individuals aged 10–18 who have moved from regions with poor living conditions to places more suitable for survival and development (1). Academic maladjustment in the new environment may lead to negative reactions such as rebelliousness and dislike of school in young people who are relocated. Other possible adverse reactions include rebellion and academic weariness.

Empowerment theory proposes that unmet personal needs and the emergence of problems stem from the experience of exclusion and oppression of the environment. Therefore, it is necessary to enhance the ability to combat pressure from the surrounding environment and its adverse effects (2, 3). According to empowerment theory (4), immigrant adolescents experience a state of disempowerment. When undergoing relocation, they lose their original living and cultural environment, ethnic traditions, and social relations. Furthermore, after relocation, they temporarily cannot be fully integrated into the natural and social environment. As one of adolescents' main living environments, school affects adolescents' development and plays a proximal and long-lasting role in adolescents' mental health (5). Relocated adolescents are school-aged and can be empowered through favorable school resources and effective human interaction. Current research notes that the standards for school adaptation are not uniform. Existing research about circumstances pertaining to relocation has determined four aspects of relocated adolescents' school adaptation: learning, teacher-student relationship, classmate relationship, and environment. Learning adaptation refers to young people's adaptability in terms of learning attitudes and learning emotions in the face of a new school environment after relocation. Teacher-student relationship adaptation refers to how relocated students get along with teachers in a new school environment. Classmate-relational adaptation refers to peer friendships with new classmates in a new school environment. Home-learning environment adaptation refers to having an independent learning space with a better environment in the new home after relocation. Therefore, school adaptation can be used as elements of empowerment for immigrant adolescents to support adjustment to a new environment, gradually increasing psychological well-being and maintaining good long-term mental health.

Mental health has been described at different perspectives. From an adaptive perspective, it mainly includes an individual's anxiety, depression, social dysfunction, and loss of confidence (6). Studies have found that effective life adaptation is the foundation of maintaining mental health (7). In addition, it is an essential criterion for measuring mental health. Therefore, adaptability is a constituent element of mental health, and it can be measured to estimate the mental health of individuals or groups (7). A study of refugees found that the weakening of social adaptation increased internalizing behavioral problems (8). The degree of internalization of problems indicates mental health levels, and mental health outcomes of children of different ethnic cultures are influenced by acculturation. This process is promoted by the interaction of individuals with different educational levels. Cross-ethnic research has investigated cultural adaptation as an avenue to predict mental health adjustment. (9). A longitudinal study by Ratelle et al. (10) found that cognitive adaptation enhances mental health. Their study also provided indirect evidence that adaptation affects mental health. Some scholars have explored the mental health problems, such as depression and anxiety, of ethnic minorities. They found that overall ethnic minority mental health levels were lower than those of the mainstream majority population. In addition, their mental health problems were more pronounced (11, 12). Researchers have identified a relationship model connecting adaptation to mental health based on existing findings (13, 14). One finding is that, for immigrant children, maladaptation can easily lead to psychological problems due to changes in their living and learning environments.

Academic emotions refer to the various emotions that students experience after learning of academic success or failure, in classroom learning, in the process of daily homework, and during exams (15). Academic emotions can be either positive or negative. Studies have shown that improving students' learning adaptability promotes positive emotional experiences for students, and a significant positive correlation exists between learning adaptability and positive academic emotions (16, 17). These positive emotions play a supportive role during crises (18). Having been uprooted, for immigrant adolescents, the experience of positive emotions is indeed a protective factor shaping their mental health. Research has revealed that academic emotions affect students' physical and mental health (19). In addition, studies measuring emotional intelligence have found that academic emotions may affect students' mental health (20). Other studies have pointed out that anxiety affects academic stress (21). This stress is an indicator of mental health, so academic emotions can significantly predict mental health directly and indirectly (22–24). This study proposed a research

hypothesis, positive academic emotions may play a mediating role between school adaptation and mental health.

Families and adolescents have similar emotional and behavioral problems (25). Emotional and behavioral problems may increase as adolescents mature (26, 27). Specific studies have shown that conduct problems are related to executive function impairment (28). In addition, low self-esteem predicts serious behavioral problems, and more conduct problems indicate diminished mental health (29). However, effective parenting is an important protective factor against children's behavioral problems (30). At the same time, emotional and behavioral problems accompany heavy psychological burdens and lower levels of mental health in adolescents (31). Conduct problems also may indicate the presence of anxiety and depression (32). It had also been shown that boys have a higher detection rate of behavior problems than girls (33), while the relative involvement of boys in behavior problems was higher than that of girls (34), and that gender could influence adolescent behavior problems (35). Under the adaptation mental health model, maladaptation may lead to conduct problem behaviors. That is, adolescents' adaptation leads to adaptation differentiation in the behavioral domain (36, 37). So, conduct problem behavior is the manifestation of adaptation differentiation, which ultimately affects mental health. Therefore, conduct problem behavior may play a mediating role between adaptation and mental health. This study presented a research hypothesis, conduct and behavior problems may play a mediating role between school adaptation and mental health.

The role of emotion in child conduct problems had been subject to growing attention in recent years (38). The emotion dysregulation was found to be a stronger predictor for the conduct problems (39). There were studies reported a negative correlation between emotion regulation and externalizing behavior problems and concluded that better emotion regulation was associated with less externalizing behaviors (40). Under the adaptive-health model, it was necessary to explore the chain-mediated mediation of academic emotion and conduct and behavior problems. Therefore, the research hypothesis was put forward, the mediating effect of academic emotions and conduct and behavior problems in school adaptation and mental health.

Poverty is associated with an increased risk of mental health problems in children (41). In addition, poverty vulnerability is an ex-ante predictor of impoverishment, distinguishing states by identifying the possibility of individuals or households succumbing to it in the future (42). Thus, combined with indicators of poverty vulnerability, relocation can effectively reduce poverty vulnerability (43, 44). For immigrant adolescents, the question remains, *What factors affect their mental health through temporarily alleviating relative poverty in living and learning conditions?* Our study aims to answer this question.

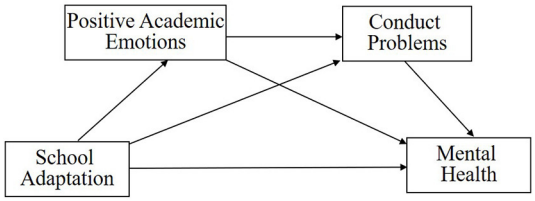

FIGURE 1
Hypothetical model: the chain mediating effect of school adaptation on mental health.

According to the theory of social exclusion (45), immigrant adolescents are inevitably overwhelmed. Being unaccustomed to the new environment, they unavoidably experience incompatibility. In the process of immigrant adolescents' adaptation, the current study aimed to understand the specific impact mechanism of school adaptation related to their mental health. This study firstly explored the relationship between school adaptation and the mental health of immigrant adolescents. Then, it examined the specific mediating mechanism of positive academic emotions and conduct problems between school adaptation and mental health. Figure 1 shows hypothetical Model 1. Therefore, on the basis of previous research, this study further explored the mechanism of school adaptation on mental health. This study not only led us to paying attention to the positive and negative effects on mental health, but also focus on the changes in school adaptation of relocated adolescents on mental health. Therefore, this study had important implications for understanding the mental health of relocated adolescents.

Methods

Participants

Guizhou Province is the province of China with the largest one of relocation scale and the largest overall population. Moreover, Guizhou is a multi-ethnic province. Most of the relocated population originally resided in autonomous ethnic minority autonomous areas. This study used random sampling to select primary and secondary students from five resettlement schools in Qianxinan Buyi and Miao Autonomous Prefecture, which has the largest poverty alleviation and relocation population in Guizhou Province. The participants were students ranging in age from the fifth grade of primary school to the third year of high school. A total of 600 questionnaires were distributed, 600 questionnaires were returned, and the recovery rate was 100%. Among them, 550 were valid questionnaires. Therefore, the effective rate of return was 91.7%. In this study, all subjects participated completely voluntarily. The responses of subjects were anonymous.

Among the participants, the ethnic representations were as follows: 134 Buyi, 146 Miao, 2 Bai, 1 Hui, 28 Yi, 189 Han, and 50 individuals from other minorities. Two hundred thirty-one were male, and 319 were female. The sample included 62 fifth, 74 sixth, 90 seventh graders, and 95 eighth, and 86 ninth-grade students. Forty-seven students were in the first, 49 students were in the second, and 47 students were in the third year of high school. The age range of all subjects was 13.88 ± 2.16.

Measures

School adaptation scale for immigrant adolescents

We used a 15-item scale that is based on the psychological characteristics of immigrant adolescents. It uses a 5-point Likert scale for scoring. In the exploratory factor analysis of all items, the total variance explained rate was 66.771%, the KMO value was 0.881, and the spherical test was significant. Four factors were obtained and designated as follows: *academic adaptation* (including learning attitude, learning method, and others), four factors items; *teacher-student relationship adaptation* (including teachers' attitudes and behaviors toward students and students' attitudes and behaviors toward teachers), four items; *peer relationship adaptation* (including social skills and loneliness, and others), four items; and *new adaptation to family learning environment* (including the family learning environment after relocation, parents' attitude toward learning and others), three items. The factor loading size ranged from 0.569 to 0.825. Confirmatory factor analysis was carried out on the final four-factor structure of the 15 items yielding $\chi^2/df = 1.928$, NFI = 0.887, IFI = 0.942, TLI = 0.926, CFI = 0.941, RMSEA = 0.058. These results indicated that the model fit well. The internal consistency alpha coefficient of the scale was 0.867, showing that the school adaptation scale for immigrant adolescents had high validity and reliability.

General health inventory (GHQ)

The scale was compiled by Mäkikangas et al. (6) and revised by Zhang (46). It consists of 12 items, half of which are negative and half of which are positive. The scale is one-dimensional, using 4-point scoring. The higher the score attained, the more robust the individual's mental health. The internal consistency alpha coefficient of this scale for this study was 0.823.

Positive academic emotions questionnaire

The 30-item positive academic emotions subscale of the Adolescent Academic Emotions Scale was compiled by Yan and Guoliang (15). This subscale is divided into two dimensions: positive-high and positive-low arousal academic emotion. The subscale uses a 5-point Likert scale with higher scores indicating a more positive academic attitude. Its internal consistency alpha coefficient for this study was 0.927.

Behavioral tendency questionnaire for adolescent conduct problems

The questionnaire was compiled by Zhang et al. (47) and has a total of 14 items. Items are scored on a 5-point Likert scale. The questionnaire includes three dimensions: *violation tendencies* (six items), *addiction tendencies* (four items), and *aggressive tendencies* (four items). The higher the score, the stronger the tendency to manifest behavior problems. The internal consistency alpha coefficient of this scale for this study was 0.820.

Analyses

All data were managed and statistically analyzed by SPSS and Amos (Versions 23.0). First, SPSS 23.0 was used to calculate the study variable descriptive statistics and their correlations. Next, we tested the mediating effect of positive academic emotions and conduct problems using PROCESS (Model 6 justified by 5,000 bootstraps). Finally, we used structural equation modeling (Amos 23.0) to investigate the fitness of the chain-mediating effect of positive academic attitude and conduct problems between school adaptation and mental health. The requirement of structural equation model for fitting exponent was $\chi 2/df < 5$, NFI > 0.8, IFI > 0.8, TLI > 0.8, CFI > 0.8, RMSEA <0.08. Additionally, we used the percentile bootstrap method for mediation effect analysis.

Procedure

The participants were recruited from schools in Guizhou Province of China. This study aimed at identifying possible predictors of the for the mental health of immigrant adolescents. Data collection was conducted in Guizhou Province of China and five schools were invited to participate which are in total. A detailed oral presentation was appeared to parents of adolescents attending the participating schools. All tasks were answered on paper. All measures in the study were administered electronically using EXCEL.

Results

Common method bias test

To avoid common method bias and control the quality of the survey, anonymity and reverse scoring were employed.

TABLE 1 *t*-test of immigrant adolescents' conduct problems.

Variables	Gender		*t*	*p*
	Male ($n = 231$)	Female ($n = 319$)		
Conduct problems	1.45 ± 0.48	1.30 ± 0.30	4.535***	0.000

***$p \leq 0.001$.

TABLE 2 Correlation analysis of school adaptation, mental health, positive academic emotions, and conduct problems among immigrant adolescents.

	M	SD	Mental health	School adaptation	Positive academic emotions	Conduct problems
Mental health	3.195	0.481	1			
School adaptation	3.297	0.728	0.534***	1		
Positive academic emotions	3.311	0.696	0.498***	0.667***	1	
Conduct problems	1.364	0.396	−0.464***	−0.327***	−0.321***	1

***p ≤ 0.001.

According to Harman's single factor test, the exploratory factor obtained 19 factors with an eigenvalue >1 in the case of no pivot, and the explained variance of the first factor was 20.89%, far lower than the 40% critical standard proposed by Podsakoff et al. (48). This result confirmed the lack of serious common method bias in this study.

Preliminary analysis

Independent samples *t*-test of variance was carried out to investigate differences in conduct problems by gender. Table 1 shows the results.

There were significant gender differences in conduct problems. Males exhibited far more conduct problems than girls.

Correlation analysis

We calculated the means and standard deviations of school adaptation, mental health, positive academic emotions, and conduct problems among immigrant adolescents and performed a Pearson correlation analysis. Table 2 displays the results.

There were significant positive correlations between school adaptation and mental health, school adaptation, and positive academic emotions. However, school adaptation was significantly negatively correlated with conduct problems. Mental health was significantly related to positive academic emotions. Mental health and conduct problems had a significant negative correlation. Finally, positive academic emotions were significantly negatively correlated with conduct problems.

Mediation effect analysis

After controlling for gender and relocated adolescents' phase of studying, we performed a chain mediation regression analysis taking the school adaptation of the immigrant adolescents as the independent variable, mental health as the dependent variable, positive academic emotions and conduct problems as the mediating variables. We used MODEL6 in PROCESS and bootstrap repeated sampling 5,000 times. The results show that school adaptation significantly and positively predicted positive academic emotions ($\beta = 0.667$, $p < 0.001$). Furthermore, positive academic emotions ($\beta = -0.185$, $p < 0.001$) and school adaptation ($\beta = -0.204$, $p < 0.01$) significantly and negatively predicted conduct problems. Positive academic emotions ($\beta = 0.200$, $p < 0.001$), conduct problems ($\beta = -0.301$, $p < 0.001$), and school adaptation ($\beta = 0.302$, $p < 0.001$) together significantly predicted mental health. See Table 3, Figure 2 for details.

Table 4 shows the results of the chain mediation analysis. The direct effect of school adaptation on mental health was 0.1998 ($t = 6.710$, $p < 0.001$, LLCI = 0.141, ULCI = 0.415), accounting for 56.6% of the total effect size. The total indirect effect size of positive academic emotions and conduct problems between school adaptation and mental health was 0.153, accounting for 43.4% of the total effect. The structural equation of the chain mediation model was established using Amos 23.0, $\chi 2/df = 3.224$, NFI = 0.949, IFI = 0.964, TLI = 0.949, CFI = 0.964, RMSEA = 0.064. It can be seen that the fitting index of the chain mediation model was relatively high. Therefore, school adaptation directly affected mental health and indirectly affected mental health through positive academic emotions and conduct problems. The indirect effects of specific school adaptation

TABLE 3 The effect of school adaptation on mental health of immigrant adolescents: Chain mediation regression analysis.

Outcome variable	Predictor variable	R	R^2	F	β	t
Gender					−0.0708	−2.0103*
Phase of studying					0.0170	0.7526
Positive academic emotions	School adaptation	0.667	0.445	439.469***	0.667	20.964***
Conduct problems	Positive academic emotions	0.355	0.126	39.437***	−0.185	−3.438***
	School adaptation				−0.204	−3.807**
Mental health	Positive academic emotions	0.633	0.401	121.774***	0.200	4.451***
	Conduct problems				−0.301	−8.495***
	School adaptation				0.302	6.710***

*p ≤ 0.05, **p ≤ 0.01, ***p ≤ 0.001.

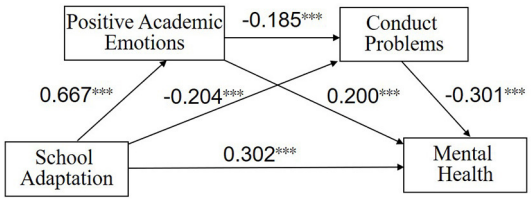

FIGURE 2
The chain mediating effect of positive academic emotions and conduct problems. ***$p \leq 0.001$.

on mental health took three paths: the single mediating effect of positive academic emotions, the single mediating effect of conduct problems, and the chain mediating effect of positive academic emotions-conduct problems.

Discussion

This study found that male immigrant adolescents had significantly worse conduct problems than females, consistent with previous studies (49–52). The three problematic behavior tendencies of violation, addiction, and aggression are all external manifestations. In educational practice, males typically exhibit more conduct problems than females do. When adapting to a familiar environment, people often see that females are better-behaved, males are naughtier, and tend to annoy others more frequently. It is normal for young male immigrant adolescents to increase their nuisance behaviors and unexpected violations in an unfamiliar environment to which they have not yet adapted.

The structure of the school adaptation scale for relocated adolescents

According to the characteristics of school adaptation for relocated adolescents, the factor structure and reliability of the relocated adolescent school adaptation scale are ideal. The internal consistency coefficient of the four dimensions of the relocated adolescent school adaptation scale was above 0.569, and the confirmatory factor analysis showed that the fitting index indicators of the relocated adolescent school adaptation scale were good. Specifically, the scale had a total of 15 items, including four items for academic adaptation, four items for teacher-student relationship adaptation, 4 items for peer relationship adaptation, and three items for new adaptation to family learning environment. However, test-retest reliability analysis and criterion analysis were not carried out in this study, and it was necessary to further explore the structure, reliability and validity of the scale in other groups.

The relationship between school adaptation and mental health

This study found a significant positive correlation between school adaptation and mental health. Social-ecological system theory emphasizes that the developing individual is constantly growing and interacting with the surrounding environment. The impact of the environment on the development of children is multi-dimensional and varies (53, 54). After relocation, school and community culture affected the youth's growth. In addition, social policies affect the mental health of immigrant adolescents. This study found that school adaptation directly predicted mental health. This finding is consistent with previous studies (55), so we concluded that school adaptation is an essential factor affecting mental health.

The mediating role of positive academic emotions and conduct problems

The urban relative poverty rate in many provinces and cities of the central and western regions is about 40% (56). Relative poverty has been shown to have an adverse effect on children's

TABLE 4 Test of chain mediation effect of school adaptation for immigrant adolescents.

	Indirect effect size	Boot standard error	BootCL Lower limit	BootCL upper limit	Relative mediation effect
Total Indirect Effect	0.153	0.025	0.104	0.204	43.4%
School adaptation → Positive academic emotions → Mental health	0.088	0.024	0.041	0.136	25.0%
School adaptation → Conduct problems → Mental health	0.041	0.016	0.013	0.074	11.5%
School adaptation → Positive academic emotions → Conduct problems → Mental health	0.025	0.009	0.007	0.042	6.9%

Boot standard error, BootCL lower limit and BootCL upper limit refer to the standard error of the indirect effect estimated by the bias-corrected percentile bootstrap method (5,000 times), the lower limit and the upper limit of the 95% confidence interval, respectively.

social-emotional development, and research has indicated that the adverse effect of relative poverty is bigger when children are older (57). The results of the current study show that mental health is affected by school adaptation, positive academic emotions, and conduct problem behaviors in relative poverty.

First, this study found that positive academic emotions played a mediating role between school adaptation and mental health. This result suggests that good school adjustment in adolescents has a positive impact on their mental health. The PPCT model ("Person-Process-Environment-Time" model) emphasizes that the systemic factors influencing individual development interact to form a network of forces. These forces blend to influence the individual's psychological development (53). Positive academic emotions in this study were a process factor influenced by school adaptation. The PPCT model proposes that positive emotions benefit individual development. Our results confirm the impact of positive academic emotions on mental health. Furthermore, they clarify the impact mechanism of school adaptation on mental health.

Second, this study found that conduct problems played a mediating role between school adjustment and mental health. This shows that adolescents with strong school adaptation were more likely to form good habits in relational, academic, and learning environments, were less likely to have conduct problems and were more likely to have better overall mental health. Conduct problems are not conducive to students' mental health. They are important indicators of bad behavior in students' development process (58). School adaptation may enhance mental health through the promotion of better behavior. Therefore, school adaptation can affect mental health indirectly by first reducing conduct problems.

Finally, this study found a chain-mediated mediating effect of positive academic emotions and conduct problems in school adaptation and mental health. On the one hand, positive academic emotions negatively predicted conduct problems. This study defined positive academic emotions as based on successful academic experiences. These experiences partly reflect good behavioral habits, which in turn improve conduct. Positive academic emotions facilitate a constructive psychological response mode. This response then influences the individual's ability to think about the environment, prompting young people to have a positive understanding of their character and enhancing mental health. Adolescents with adequate school adaptation develop positive academic attitudes. This disposition directly affects the individual's perception of adaptation and promotes high-quality behaviors. On the other hand, mental health is also a process in which adolescents interact with their own individual, various processes, and situational systems. Therefore, our research results showing that positive academic emotions and conduct problems had a chain-mediating effect on school adaptation and mental health further reveal the developmental mechanism of the psychological well-being of adolescent immigrants.

Implications

It is necessary to strengthen inclusive mental health education for immigrant adolescents. When immigrant adolescents are enrolled in schools, special psychological files should be established for them. They should also be encouraged to deepen their understanding of academics, emotions, interpersonal relationships, and other areas through mental health education courses. This curriculum should help them to look at their learning constructively and form good study habits. At the same time, parents and teachers should provide praise and encouragement to promote the growth of their children. Sincere care and equal and friendly communication can help them reduce any sense of inferiority and alienation, and facilitate the establishment of their self-esteem and self-confidence, better integrating them into the collective and society.

It is also important to improve the comprehensive quality of all training offered to young people who have

been relocated. Faced with changes in their living and educational environments, relocated youths are easily frustrated psychologically. They should receive more technological education, and education about integrating ethnically and culturally in the community. More activities featuring cultural practice should be offered. In addition, they should be encouraged to participate frequently in school and community affairs. At the same time, we should strengthen the cultivation and improvement of their self-esteem, stimulate their sense of future ownership, and help them to adjust to the school and community environments.

Giving relocated youth *fish* is not as effective as teaching them *how to fish*. Home-school co-governance, targeting the specific concerns of the school and the community, can be managed by recruiting volunteers and allowing parents and children to act as volunteers. These strategies will help to realize a virtuous circle of self-management and development and feelings of camaraderie and mutual assistance in many activities.

Limitations

This study focused on the mental health of adolescent immigrants. We found that school adaptation enhanced youth mental health by promoting a positive academic attitude and reducing conduct problems. However, there are some research limitations to address. First, the self-report questionnaire method used cannot be used for robust inferences of causality. Second, the two mediating factors proposed in this study cannot be presumed to be the only ones from the perspective of theory and data. Therefore, in follow-up research, we should combine longitudinal research and other methods to continue to explore possible causal relationships. At the same time, we should further investigate other variables (e.g., self-esteem, resilience, and conflict adaptation) affecting the mental health of immigrant adolescents to define a more reasonable impact mechanism. Finally, the generalization of the study results requires further support from future studies.

Conclusion

This study yielded important findings on how school adaptation relates to mental health among adolescent immigrants, requiring replication, extension, and further exploration. This study's results suggest that academic attitude and conduct problems are underlying mechanisms through which school adjustment is associated with mental health. In addition, it reveals a chain mediation relationship between positive academic emotions and conduct problems with school adaptation and mental health. Therefore, experimental and longitudinal designs can be employed in future studies to infer causal relationships between variables. In relocation situations, there should be a focus on the impact of relocation on adolescents' adaptation on their mental health.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving human participants were reviewed and approved by the Research Ethics Committee of the School of Education Science, Xingyi Normal University for Nationalities. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

Author contributions

LX: conceptualization, investigation, writing–original draft, visualization, and revised manuscript. WZ: conceptualization, methodology, investigation, statistical analysis, data curation, and visualization. HW: project administration and funding acquisition. All authors read and approved the final manuscript.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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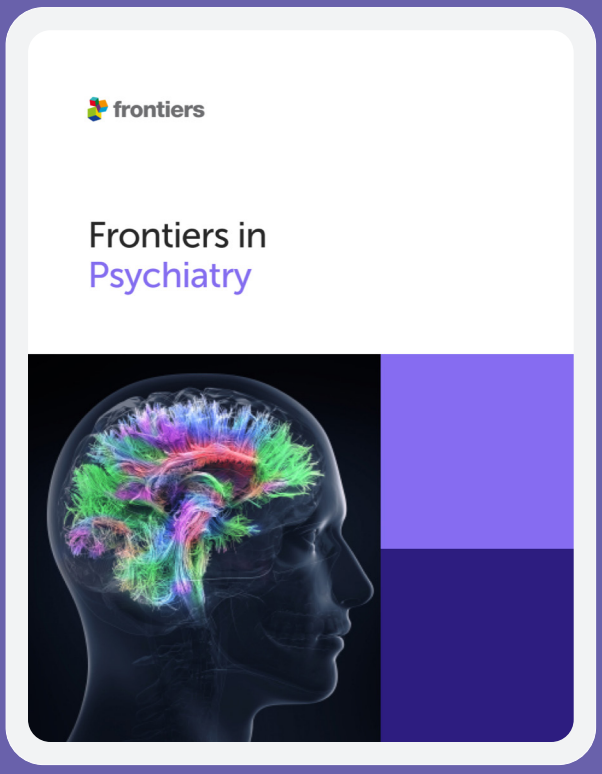

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