

1 **Father's involvement associated with rural children's depression and anxiety: a**  
2 **large-scale analysis based on data from seven provinces in China**

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6

7 **[Abstract]**

8 **Introduction:** To investigate the relationship between father involvement in  
9 parenting and mental health problems among children and adolescents in rural China.

10 **Methods:** The Rural Children's Mental Health dataset includes mental health  
11 information from 2489 children and adolescents aged 5-16 in seven provinces in  
12 China. The relationship between father involvement in children and adolescents  
13 depression risk and anxiety was analyzed by Spearman's correlation analysis, logistic  
14 regression analysis, and restricted cubic spline.

15 **Results:** Father involvement was significantly and negatively associated with  
16 depression scores ( $r = -0.38$ ,  $P < 0.001$ ) and anxiety scores ( $r = -0.18$ ,  $P < 0.001$ ) in rural  
17 Chinese children and adolescents. Both multivariate models indicate that the highest

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1 level of father involvement has a protective effect on the risk of depression among  
2 children and adolescents ( $OR = 0.268$  and  $0.303$ ,  $95\% CI: 0.149\sim 0.483$  and  
3  $0.144\sim 0.636$ ), while the association with anxiety risk is only significant in  
4 multivariate model. 1 ( $OR = 0.570$ ,  $95\% CI: 0.363\sim 0.896$ ).

5 **Conclusions:** Father involvement is a protective factor for the risk of depression  
6 among children and adolescents in rural China. The level of father involvement  
7 should be increased, and active participation should be encouraged to reduce the risk  
8 of depression in their children and to further promote the mental health of children  
9 and adolescents in China.

10 **[Keywords]** Father involvement; Depression; Anxiety; Children and adolescents;

11 A Large-scale Analysis

### 13 **Impact Statements**

14 Mental health problems in children and adolescents have become one of the most  
15 important public health challenges of the 21st century, with negative mood disorders  
16 such as depression and anxiety being the most common and prevalent mental health  
17 problems, with family environments such as father involvement being an important  
18 influencing factor.

19 However, there is still relatively little research on the correlation between father  
20 involvement and mental health problems among children and adolescents in rural  
21 China. The current study, using information from a mental health database of rural

1 children in China, analyses the relationship between father involvement and  
2 depressive and anxiety symptoms among children and adolescents in rural China.

3 This study demonstrates that father involvement is a protective factor for the risk  
4 of depression among children and adolescents in rural China. The level of father  
5 involvement should be increased, and active participation should be encouraged to  
6 reduce the risk of depression in their children and to further promote the mental health  
7 of children and adolescents in China.

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10

## 11 **Introduction**

12 Mental health, especially mood disorders such as depression and anxiety in children  
13 and adolescents is acknowledged to be of considerable concern. The global  
14 prevalence of depression and anxiety among children and adolescents is estimated to  
15 be 13.4% (Bradshaw et al., 2021) With rapid economic and social development, the  
16 prevalence of mental health problems, such as depression and anxiety, among  
17 children and adolescents in China has also been on the rise. Some studies have  
18 reported that the prevalence of depression and anxiety among Chinese children and  
19 adolescents is 24.6% and 35.7%, respectively (Dong et al., 2023) while the prevalence  
20 among rural left-behind children is 51.5% and 57.6% (Cui et al., 2021) These  
21 emotional problems are highly correlated with a number of negative outcomes,

1 including learning difficulties, substance abuse, bullying, stigmatization, employment  
2 difficulties in adulthood, low incomes, self-harm, and suicide (Viswanathan et al.,  
3 2022; Viswanathan et al., 2022; Donato et al., 2021; Schlack et al., 2021). Thus,  
4 understanding and investigating the factors that influence depression and anxiety in  
5 children and adolescents is crucial and can provide excellent opportunities for early  
6 intervention and treatment.

7 Parenting theory (Del Barrio et al., 2016) and attachment theoretical frameworks  
8 (Peng et al., 2021) argue that the family environment is the primary place where  
9 people live and that family structure (Fritzell et al., 2019), parental mental health  
10 status (Raskin et al., 2015), family migration (Lu et al., 2020), parent–child  
11 relationships (Brouillard et al., 2018), parental education (Wille et al., 2008), and  
12 parenting styles (Fagan, 2022) are key influences on depression and anxiety in  
13 children and adolescents. Although there is a growing clarity of knowledge about how  
14 family contexts contribute to children and adolescents mental health, most of these  
15 studies have focused on the role of mothers, often ignoring the function of fathers’  
16 roles in family parenting involvement (Panter-Brick et al., 2014), and even studies on  
17 fathers have considered them as mediators of their children’s mental health (Ibrahim  
18 et al., 2017) or as emotion regulators (Shenaar-Golan et al., 2021) and have failed to  
19 recognize the unique and important roles of the father’s role in parenting involvement.  
20 Currently, the role of fathers has changed to become important participants in caring  
21 for family and raising children (Nettelbladt et al., 1980). Father involvement has been

1 defined as the emotional, cognitive and behavioral guidance and investment that  
2 fathers give to their children in order for them to be able to grow up in a healthy way  
3 (Coleman and Garfield, 2004), and it is a complex structure that includes three  
4 dimensions of accessibility, interaction and responsibility (Sarkadi et al., 2008), not  
5 only providing financial support but also the interaction, caring, support and attitudes  
6 toward their children, their reactions to their children's emotions, and their sense of  
7 security in their own roles (Opondo et al., 2017). In light of all this, understanding the  
8 role of father involvement in children and adolescents mental health during  
9 adolescence is critical (Dadds et al., 2018; Garcia et al., 2022). It has been noted that  
10 early father involvement can moderate children's susceptibility to mental health  
11 problems in adolescence and reduce the severity of mental health problems (Boyce et  
12 al., 2006), while father absence may lead to depression (Markowitz and Ryan, 2016),  
13 anxiety (Shenaar-Golan et al., 2021), and delinquency in children and adolescents  
14 (Culpin et al., 2013). The active involvement of fathers in parenting behaviors can  
15 significantly improve children's emotional cognitive and social development, such as  
16 depression and anxiety, and achieve better physical and mental health (Allport et al.,  
17 2018). The father-child relationship may also influence the motivation and efforts of  
18 children and adolescents to seek mental health services (Reeb and Conger, 2011).  
19 The relationship between father involvement in parenting behaviors and their  
20 children's mental health has also attracted widespread attention in China. Studies in  
21 Chinese populations have shown that children with active fathers have better mental

1 health (Jiang et al., 2023), and parental migration puts both migrant and left-behind  
2 children at greater risk for mental health problems (Lu et al., 2020). In addition,  
3 fathers' over-involvement in parenting increases children's anxiety (Leung, 2021).  
4 Unfortunately, despite the numerous studies conducted so far, most research exploring  
5 the relationship between father involvement and the mental health of children and  
6 adolescents within the context of Chinese culture still exhibits several shortcomings.  
7 First, although there have been a few studies on the impact of fathers' participation on  
8 children's mental health, most of the analyses have included paternal parenting as a  
9 covariate. Few studies have considered fathers' participation as an independent factor  
10 in the family parenting environment and specifically focused on the relationship  
11 between paternal parenting and children's mental health issues. Second, while the  
12 positive and negative effects of father involvement in children's mental health have  
13 been examined, the extent and level of father involvement have not been further  
14 analyzed. Third, previous studies have mostly combined children and adolescents in  
15 their analysis and did not separate these two differently represented groups, especially  
16 compared to urban areas, rural fathers tend to have lower educational levels, more  
17 unstable jobs, less parenting knowledge and skills, and spend less time with their  
18 families (Huang et al., 2015; Zhao et al., 2014). Therefore, there is a greater need to  
19 study the relationship between fathers' involvement and their children's mental health.  
20 To address this research gap, this study conducted an analysis of mental health data  
21 from rural children and adolescents in seven provinces of China, emphasizing the

1 relationship between fathers' parenting behaviors and the mental health of children  
2 and adolescents in rural China. Based on the scores from a questionnaire on fathers'  
3 involvement, the study stratified their participation in parenting and explored its  
4 impact as an independent variable on their children's depression and anxiety. This  
5 analysis aims to provide policy references for improving and enhancing the mental  
6 health of rural children and adolescents.

7

## 8 **Methods**

### 9 **Data sources**

10 This was an observational study based on a public mental health database of Chinese  
11 rural children (Fang et al., 2022). Of note, this mental health database is a subset of  
12 the Chinese National Mental Health Database (<https://cmhr.psych.cn/m/>), which is an  
13 open, freely accessible dataset. This dataset is a questionnaire survey of mental health  
14 problems and related influencing factors among children and adolescents aged 5-16  
15 years old in rural China using a convenience sampling methodology, and the inclusion  
16 criteria for the survey are students in grades 1-6 of elementary school in rural China.  
17 In general, researchers carried out a questionnaire survey between March 2021 and  
18 May 2021 for 16 rural elementary schools in 7 provinces in China, including Anhui,  
19 Gansu, Guangdong, Heilongjiang, Hubei, Hunan, and Sichuan province.  
20 A total of 2,498 out of 3,025 distributed questionnaires were included for the final  
21 analysis after excluding extreme values, large scale omissions and questionnaire with

1 invalid responses. Figure 1 shows the flow chart for selection of study population. A  
2 total of 785 students completed both CDI and FIQ survey, while 815 students  
3 completed both GAD-7 and FIQ survey. These two population are the main study  
4 populations for the current study.

## 5 **Measurement tools**

6 **Father involvement:** The survey used the Father Involvement Questionnaire (FIQ) to  
7 measure the level of fathers' parenting involvement (WU et al., 2015), which has 22  
8 questions on a 5-point Likert scale from 0 (never) to 4 (always), with scores for all  
9 questions summed up and scores ranging from 0-88, and higher scores indicating  
10 higher levels of involvement in parenting by fathers. The FIQ is organized around the  
11 three dimensions of accessibility, interaction and responsibility, there are 9 items for  
12 accessibility, 7 items for interaction, and 6 items for responsibility (Appendix). The  
13 reliability and validity of the FIQ have been tested (WU et al., 2015), and the internal  
14 consistency coefficient in this survey was 0.94. For the purpose of research and  
15 analysis, FIQ scores were categorized into four groups according to quartiles: low,  
16 middle-low, middle-high, and high.

17 **Depression levels:** Depressive symptoms in rural children and adolescents in the last  
18 two weeks were assessed using the Child Depression Inventory (CDI) (Kovacs, 1985),  
19 a 27-question scale using a 3-point Likert scale from 0 to 2, where each option  
20 consists of statements describing varying degrees of depressive symptoms: 0 points  
21 for "general reaction", 1 point for "major depressive symptoms", and 2 points for



1 "severe depressive symptoms", and scores for all the questions were summed up,  
2 which range from 0 to 54 points, with higher scores indicating higher levels of  
3 depression. A score of 0-19 is considered low risk for depression and a score higher  
4 than 19 is considered high risk for depression. The internal consistency coefficient for  
5 this scale in this survey was 0.84.

6 **Anxiety symptoms:** Anxiety symptoms in children and adolescents were measured  
7 over a two-week period using the Generalized Anxiety Disorder 7-item (GAD-7)  
8 (Spitzer et al., 2006). The GAD-7 is set up with seven questions, each scored on a  
9 4-point Likert scale from 0 (not at all) to 3 (almost every day), and all question scores  
10 are summed for a range of scores from 0-21, which are categorized into four  
11 dimensions based on the scores: no anxiety (0-4 points), mild anxiety (5-9 points),  
12 moderate anxiety (10-14 points), and severe anxiety (15-21 points). Higher scores  
13 indicate higher levels of anxiety in individuals. The internal consistency coefficient of  
14 the scale was 0.81 in this survey.

15 **Background information:** The survey also synchronized the collection of basic  
16 background information such as gender, age, family situation, and parents' education  
17 level of the participants.

### 18 **Statistical analysis**

19 First, background characteristics of the children and adolescents were described, using  
20 frequencies and percentages to describe categorical variables. Depression and anxiety  
21 scores were found to be nonnormally distributed by normality tests, and the median

1 and interquartile range [IQR] were used to describe the depression and anxiety risk  
2 scores of the different subgroups.

3 Second, Spearman correlation analyses were conducted to test the relationship  
4 between children and adolescents depression scores and anxiety scores and father  
5 involvement. To improve the robustness of the results, we used logistic regression to  
6 validate the effect of the level of father involvement on mental health problems by  
7 incorporating relevant covariates based on a univariate model and 2 separate  
8 multivariate models constructed for depression and anxiety risk;

9 Finally, restricted cubic spline plots with 3 knots were drawn, using the median FIQ  
10 score of 38 as a reference, to analyze the dose-response relationship between fathers'  
11 parenting investment and the risk of depression and anxiety risk among children and  
12 adolescents. Restricted cubic spline plots were constructed for the relationship  
13 between fathers' parenting investment and depression risk scores as well as anxiety  
14 risk scores, respectively.

15 SPSS 27.0 (SPSS Inc., Chicago IL, USA) was used for descriptive statistics,  
16 Spearman correlation analysis, and logistic regression analysis. The rms package of  
17 R4.2.3 software was used for restricted cubic spline analysis. All statistical analyses  
18 were performed using two-sided tests with a test level of  $\alpha = 0.05$ .

## 19 **Ethics**

20 The data used in the study are open access data, which have been cleaned and do not  
21 involve any personally identifiable information or privacy, so there are no ethical

1 issues with the study.

2

### 3 **Results**

4 Of 2498 valid questionnaires, 1277 (51.1%) were female and 49 (2%) did not report  
5 gender; age ranged from 5-16 years ( $M = 10.67, SD = 1.71$ ) and 301 (12%) did not  
6 report age; 51.2% and 58.8% reported living with a biological father or mother,  
7 respectively; 67.2% reported a harmonious parental relationship; more than one-third  
8 had a parent with a middle school education level or lower; 11.1% reported having no  
9 siblings; the median and interquartile range of depression risk scores was 13 (9-19),  
10 the median and interquartile range of anxiety risk scores was 6 (3-10), and the median  
11 and interquartile range of father involvement scores was interquartile spacing of 38  
12 (23-52). Detailed background information about the participants is presented in Table  
13 1.

14 The depression and anxiety risk scores were skewed by the normality test. The  
15 association of background information with depression risk and anxiety risk was  
16 analyzed using the rank sum test, which showed that rural children and adolescents  
17 depression risk and anxiety risk were significantly different on factors related to age,  
18 parental relationship, and biological parent's companionship (Supplemental table). A  
19 Spearman correlation analysis was conducted to examine the relationship between  
20 paternal parenting investment and the scores of depression and anxiety among rural  
21 children and adolescents, testing the association between paternal parenting

1 investment and the risk of depression and anxiety risk. Fig. 2 illustrates the results of  
2 Spearman's correlation analysis, with father involvement having a significant  
3 negative association with both depression scores ( $r = -0.38$ ,  $p < 0.001$ ) and anxiety  
4 scores ( $r = -0.18$ ,  $p < 0.001$ ).

5 Subsequently, logistic regression analyses were performed on 785 individuals who  
6 completed both the CDI and the FIQ to validate the relationship between depression  
7 risk and father involvement in rural children and adolescents. The variance inflation  
8 factor for each variable is less than 7.5 ( $VIF = 1.013 \sim 1.626$ ), suggesting that there is  
9 no large covariance between the variables. The results of the logistic regression  
10 analysis showed that the aspects of parental relationship, biological father's  
11 companionship, biological mother's companionship and father's level of involvement  
12 were significantly related to the depression risk score in the univariate analysis.

13 To investigate the impact of father involvement, a multifactorial model.1 was  
14 constructed by incorporating statistically significant factors from the univariate  
15 analysis as independent variables in the multifactorial analysis. After adjusting for  
16 moderators, the results showed that among rural children and adolescents, higher  
17 levels of father involvement predicted a lower risk of depression compared to low  
18 levels. Using the lowest quartile group of the FIQ quartiles as the reference, the *OR*  
19 (95% *CI*) for the other three groups, from low to high, were 0.929 (0.595 ~ 1.451),  
20 0.599 (0.369 ~ 0.972), and 0.268 (0.149 ~ 0.483), respectively, *P* for trend  $\leq 0.001$ .

21 Subsequently, a multivariate model.2 was constructed utilizing all factors as

1 independent variables, showing that fathers with higher levels of involvement faced a  
2 lower risk of depression than fathers with lower levels of involvement in parenting.  
3 Using the lowest quartile group after grouping the FIQ quartiles as a reference, the  
4 *OR* (95% *CI*) of the other three groups, from low to high, were 0.799 (0.442 ~ 1.444),  
5 0.787 (0.428 ~ 1.447) and 0.303 (0.144 ~ 0.636), *P* for trend = 0.013 (Table 2). This  
6 suggests that more positive father involvement is a protective factor in children and  
7 adolescents depression problems.

8 Additionally, logistic regression analyses were conducted on 815 individuals who  
9 completed both the GAD-7 and the FIQ to validate the relationship between anxiety  
10 risk and father involvement in rural children and adolescents. The variance inflation  
11 factor for each variable is less than 7.5 (*VIF* = 1.012 ~ 1.628), suggesting that there is  
12 no large covariance between the variables. Consistent with the analysis of depression  
13 risk, univariate and multivariate analyses were performed to establish the respective  
14 multivariate models.1 and multivariate models.2. Regarding anxiety risk scores, only  
15 the highest level of father involvement in the univariate model (*OR* = 0.387, 95% *CI*:  
16 0.259~0.577) and multivariate model 1 (*OR* = 0.570, 95% *CI*: 0.363~0.896) was  
17 associated with lower anxiety risk among children and adolescents. The association  
18 between other levels of father involvement and anxiety risk in children and  
19 adolescents was not statistically significant (Table 3).

20 Finally, restricted cubic splines were plotted at 3 knots, demonstrating the quantitative  
21 validity of the relationship between father involvement and the depression risk score

1 (Figure 3) as well as the anxiety risk score (Figure 4) among rural children and  
2 adolescents, respectively. Overall, the risk of depression and anxiety risk both tended  
3 to decrease gradually as father involvement increased. Although medium-low levels  
4 of father involvement did not show a statistically significant relationship with  
5 depression risk and anxiety risk, the red trend and red areas in the graph indicate that  
6 medium-high levels of father involvement significantly reduce children and  
7 adolescents depression risk, particularly for anxiety. Father involvement also exerted  
8 a significant protective effect on the anxiety risk of children and adolescents once the  
9 score exceeded 38.

10

## 11 **Discussion**

12 In the past four decades, with drastic social transformation, rapid economic  
13 development, and the impact of East–West cultural exchanges, Chinese children and  
14 adolescents are at a higher risk of mental health problems, especially those in rural  
15 areas of China, who face lower socioeconomic status, poorer education, more  
16 backward growth environments, fewer parental companions, and higher symptoms of  
17 depression and anxiety, which urgently need more attention and research (Fellmeth et  
18 al., 2018; Tang et al., 2018). To the best of our knowledge, this is one of the few to  
19 discuss father involvement and the mental health of children and adolescents in rural  
20 China. A nationally representative survey was utilized to conduct secondary analyses  
21 of data collected from children and adolescents aged 5-16 years attending 16 rural

1 elementary schools across seven provinces in China. The aim of these analyses was to  
2 reveal the association between Chinese father involvement and their children's risk of  
3 depression and levels of anxiety. The study found that father involvement has a  
4 protective effect on the mental health problems such as depression and anxiety among  
5 rural children and adolescents.

6 Considering conditions such as economic and social status, family composition,  
7 parenting styles, and cultural background, previous studies have emphasized the role  
8 of mothers (Wu et al., 2022; Briscoe et al., 2019), and the influence of fathers on their  
9 children's mental health tends to be a factor that is easily overlooked (Jeong et al.,  
10 2021). Although evidence suggests that positive father involvement can have a unique  
11 and lasting impact on the development of children and adolescents mental health and  
12 the treatment of mental health problems, research on involvement still lags behind  
13 that of mothers, and more attention needs to be paid to the relationship between father  
14 involvement and children and adolescents mental health problems in the current  
15 setting, especially when designing and implementing intervention programs  
16 (Gonzalez et al., 2023).

17 The current study evaluates the level of father involvement investment from three  
18 dimensions: interactivity, accessibility, and responsibility (WU et al., 2015) and  
19 divided father involvement into four levels: low, medium-low, medium-high and high  
20 based on the scores. The results showed that the level of father involvement was  
21 significant in both the risk of depression and anxiety scores of the children and

1 adolescents. The higher the level of father involvement is, the lower the risk of  
2 depression and anxiety in the children. This is similar to the findings of other  
3 researchers (Suh et al., 2016; Yap et al., 2014), whose studies also suggest that among  
4 the family environment factors, greater father input and involvement and better  
5 father-child parenting are protective factors for children and adolescents mental  
6 health.

7 Attachment theory suggests that fathers play an irreplaceable role in children's  
8 development and that the father-child relationship is relevant to the mental health and  
9 emotional development of children and adolescents (Peng et al., 2021). The analysis  
10 revealed that the higher the father involvement, the better the children and adolescents  
11 psychological adjustment and the lower the risk of depression, along with the  
12 increasing level of father involvement, the children's risk of depression is decreasing,  
13 and father involvement is a protective factor for children and adolescents depression.  
14 This is consistent with previous findings that more positive father involvement is  
15 effective in preventing psychological distress in children and adolescents (Flouri,  
16 2008) and can enhance resilience and frustration tolerance (Liu et al., 2023), thereby  
17 reducing the risk of depression and promoting good mental health status.

18 The association between anxiety risk and the degree of father involvement is  
19 somewhat inconsistent in the data analysis. Only the highest level of father  
20 involvement in the univariate model and multivariate model. 1 showed a protective  
21 effect on the anxiety risk of children and adolescents. The dimensions of parenting



1 behavior and the level of involvement have both positive and negative effects on the  
2 mental health of children and adolescents (Weitkamp and Seiffge-Krenke, 2019).  
3 Despite the evidence from previous studies that the active involvement of fathers  
4 significantly lowers children and adolescents anxiety symptoms (Ibrahim et al., 2017;  
5 Yap et al., 2014), it has also been suggested that excessive parenting behaviors by  
6 fathers increase children's anxiety risk (Jiang et al., 2023), which seems to be  
7 confirmed by our results, and that fathers' excessive involvement in parenting  
8 behavior may be perceived by children in adolescence as a restriction on the  
9 individual's pursuit of freedom and independence, leading to tensions and conflicts in  
10 the parent-child relationship, which may affect psychological well-being (Peng et al.,  
11 2021). However, explaining such behaviors should be done with some caution,  
12 especially in rural Chinese families, where the interaction mechanism between  
13 excessive father-child involvement in parenting behaviors and children's tensions and  
14 conflicts is unclear.

15 What is clear, however, is that father involvement is a modifiable factor in the family  
16 environment (Coleman et al., 2004; Tang et al., 2018; Gonzalez et al., 2023). The  
17 present study demonstrates that father involvement is an important influence on  
18 children's mental health; it is thus important to emphasize the role of fathers in the  
19 family environment, in addition to the maintenance of a family atmosphere and the  
20 creation of good family relationships, in the mental health of children and adolescents  
21 in rural areas. The findings provide a new perspective on interventions for children

1 and adolescents mental health, High levels of father involvement predict lower risk of  
2 depression and anxiety in their children, suggesting that interventions to promote  
3 children and adolescents mental health can be made from the fathers' perspective,  
4 which provides a basis for more targeted public health policies, prevention strategies  
5 and interventions to promote children and adolescents mental health issues.

6

### 7 **Limitations and future research**

8 This study has several limitations. First, the data used in this study were collected  
9 through non-random sampling methods, consequently, there may be sampling bias.  
10 Second, these findings were derived from self-reported data. Although this is a  
11 common methodology used in research on children and adolescents mental health  
12 issues, there is still the possibility of individual self-perceived bias; for instance,  
13 individuals with poorer mental health may report lower levels of father involvement,  
14 leading to differences in results. Future research should combine multiple reporting  
15 sources, including parent-reported scales, teacher-reported scales, and structured  
16 interviews for a comprehensive analysis. Thirdly, the study did not include relevant  
17 variables related to the mother, thus there was no way to analyze the relationship  
18 between other family variables characteristics, such as motherhood, and the FQI.  
19 Fourth, although FQI is a continuous scoring questionnaire divided into three  
20 dimensions, current evidence does not support analyzing the three dimensions as  
21 independent variables. Future studies should aim to obtain more evidence for each

1 dimension. Finally, as this study is based on cross-sectional survey data, it is not  
2 possible to establish a control group in the traditional sense to measure differences.

3

#### 4 **Conclusion**

5 Despite the limitations mentioned above, as one of the few studies on father  
6 involvement and children and adolescents mental health problems in rural China, The  
7 findings validate the correlation between father involvement and children's risk of  
8 depression and anxiety, establishing that different levels of father involvement predict  
9 depression and anxiety in children and adolescents. The present study offers a novel  
10 perspective on intervention policies addressing children and adolescents mental health  
11 issues. Policy makers, educational authorities, healthcare professionals, and families  
12 can encourage father's participation, enhance the level of fathers' parenting investment,  
13 and thereby protect and promote the mental health of children and adolescents.

14

15

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20 Material preparation and data collection were performed by JJ and TXW. Data  
21 analysis was performed by TXW and LZP. The first draft of the manuscript was

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9 **Conflict of Interest Statement:** None

10 **Ethics statement:** The data used in the study is open access data, which has been  
11 cleaned and does not involve any personally identifiable information or privacy, so  
12 there are no ethical issues with the study.

13 **Data Availability Statement:** The data used in this study is open and publicly  
14 available, free of charge. And data and materials are available at the following  
15 <https://doi.org/10.57760/sciencedb.j00001.00464>. The analytic Code is available from  
16 the first author. The analyses presented here were not preregistered.

17 **Abbreviations:** CDI = Child Depression Inventory, GAD -7= Generalized Anxiety  
18 Disorder 7-item, FIQ=Father Involvement Questionnaire, IQR= interquartile range.

19 **Consent for publication:** Not Applicable.

20

21

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1

2 **Table 1.** Background information and depression, anxiety and FIQ scores of the study

3 population.

Variable	N	%	n <sub>1</sub>	%	n <sub>2</sub>	%
<b>Gender</b>						
Male	1172	46.9	357	45.5	369	45.3
Female	1277	51.1	414	52.7	433	53.1
Not reported	49	2.0	14	1.8	13	1.6
<b>Age</b>						
5-9	534	21.4	2	0.3	2	0.2
10-11	877	35.1	149	19.0	151	18.5
12-16	786	31.5	615	78.3	642	78.8
Not reported	301	12.0	19	2.4	20	2.5
<b>Accompanied by biological father</b>						
Yes	1278	51.2	449	57.2	466	57.2
No	1147	45.9	327	41.7	336	41.2
Not reported	73	2.9	9	1.1	13	1.6
<b>Accompanied by biological mother</b>						
Yes	1470	58.8	517	65.9	538	66.0
No	953	38.2	259	33.0	264	32.4
Not reported	75	3.0	9	1.1	13	1.6
<b>Parental relations</b>						
Harmony	1567	62.7	559	71.2	579	71.0
General disharmony	539	21.6	133	16.9	136	16.7
Not reported	303	12.1	79	10.1	83	10.2
Not reported	89	3.6	14	1.8	17	2.1
<b>Father's education level</b>						
Lower secondary and below	897	36.0	409	51.6	418	51.3
High school/vocational high school/secondary school/college	444	17.7	156	19.9	162	19.9
University and above	181	7.2	30	3.8	32	3.9
Not reported	976	39.1	194	24.7	203	24.9
<b>Mother's education level</b>						
Lower secondary and below	885	35.4	405	51.6	422	51.8
High school/vocational high school/secondary school/college	432	17.3	156	19.9	157	19.3
University and above	218	8.7	32	4.1	34	4.2
Not reported	96.3	38.6	192	24.5	202	24.8
<b>One-child</b>						

Yes	278	11.1	103	13.1	106	13.0
No	2117	84.7	670	85.4	693	85.0
No reported	103	4.1	12	1.5	16	2.0
<b>Depression risk</b>						
Yes	571	22.9	199	25.4	198	24.3
No	1761	70.5	586	74.6	583	71.5
Not reported	166	6.6	0	0	34	4.2
<b>Depression score (median [IQR])</b>	13[9-19]		13[9-20]		13[9-20]	
<b>Anxiety level</b>						
No	729	29.2	346	44.1	364	44.7
Mild	617	24.7	243	31.0	250	30.7
Moderate	376	15.1	144	18.3	153	18.8
Severe	90	3.6	48	6.1	48	5.9
Not reported	686	27.5	4	0.5	0	0
<b>Anxiety score (median [IQR])</b>	6[3-10]		5[2-9]		5[2-9]	
<b>FIQ score (median [IQR])</b>	38[23-52]		38[23-53]		38[23-53]	

- 1 *Note: Data are from “A mental health database of rural children”. Categorical variables are given as*
- 2 *n and %, and continuous variables are given as the median ([IQR]). where N is information on 2498*
- 3 *individuals, n<sub>1</sub> indicates information on 785 individuals who completed the CDI and FIQ, and n<sub>2</sub>*
- 4 *indicates information on 815 individuals who completed the GAD-7 and FIQ. CDI = Child Depression*
- 5 *Inventory, GAD -7= Generalized Anxiety Disorder 7-item, FIQ=Father Involvement Questionnaire.*
- 6 *IQR= interquartile range.*

**Table 2.** Logistic regression model of the relationship between depression risk scores and background information such as FIQ score.

Variable	Univariate analysis		Multivariable analysis model 1		Multivariable analysis model 2		VIF
	OR (95% CI)	P	OR (95% CI)	P	OR (95% CI)	P	
<b>Gender</b>		0.928				0.022	1.039
Male	1.000 (reference)				1.000 (reference)		
Female	0.991 (0.819, 1.200)				1.696 (1.079, 2.665)		
<b>Age</b>		0.377				0.274	1.013
5-10	1.000 (reference)				1.000 (reference)		
11-16	1.097 (0.893, 1.347)				0.357 (0.056, 2.263)		
<b>Parental relations</b>		<0.001		<0.001		<0.001	1.156
Harmony	1.000 (reference)		1.000 (reference)		1.000 (reference)		
General	2.345 (1.867, 2.945)		2.401 (1.564, 3.687)		3.764 (2.169, 6.531)		
disharmony	4.101 (3.113, 5.403)		2.917 (1.723, 4.937)		3.649 (1.853, 7.187)	0.341	1.626
<b>Accompanied by biological father</b>		<0.001		0.091			
No	1.000 (reference)		1.000 (reference)		1.000 (reference)		
Yes	0.706 (0.583, 0.856)		0.698 (0.459, 1.060)		0.767 (0.444, 1.324)	0.950	1.615
<b>Accompanied by biological mother</b>		0.004		0.889			
No	1.000 (reference)		1.000 (reference)		1.000 (reference)		
Yes	0.754 (0.621, 0.916)		1.031 (0.670, 1.587)		1.019 (0.571, 1.818)	0.336	1.151
<b>One-child</b>		0.058				0.162	
No	1.000 (reference)				1.000 (reference)		
Yes	0.730 (0.527, 1.010)				1.606 (0.826, 3.119)		
<b>Father's education level</b>		0.871				0.383	1.545



Lower secondary and below	1.000 (reference)			1.000 (reference)		
High school/vocational high school/secondary school/college	0.928 (0.702, 1.227)			1.468 (0.821, 2.626)		
University and above	0.983 (0.667, 1.449)			1.673 (0.501, 5.584)		
<b>Mother's education level</b>		0.282			0.174	1.555
Lower secondary and below	1.000 (reference)			1.000 (reference)		
High school/vocational high school/secondary school/college	0.793 (0.596, 1.055)			0.583 (0.319, 1.066)		
University and above	0.930 (0.650, 1.333)			0.495 (0.139, 1.757)		
<b>FIQ score</b>		<0.001		<0.001	0.013	1.199
Low	1.000 (reference)		1.000 (reference)	1.000 (reference)		
Medium-low	0.723 (0.478, 1.092)		0.929 (0.595, 1.451)	0.799 (0.442, 1.444)		
Medium-high	0.425 (0.270, 0.667)		0.599 (0.369, 0.972)	0.787 (0.428, 1.447)		
High	0.166 (0.095, 0.288)		0.268 (0.149, 0.483)	0.303 (0.144, 0.636)		

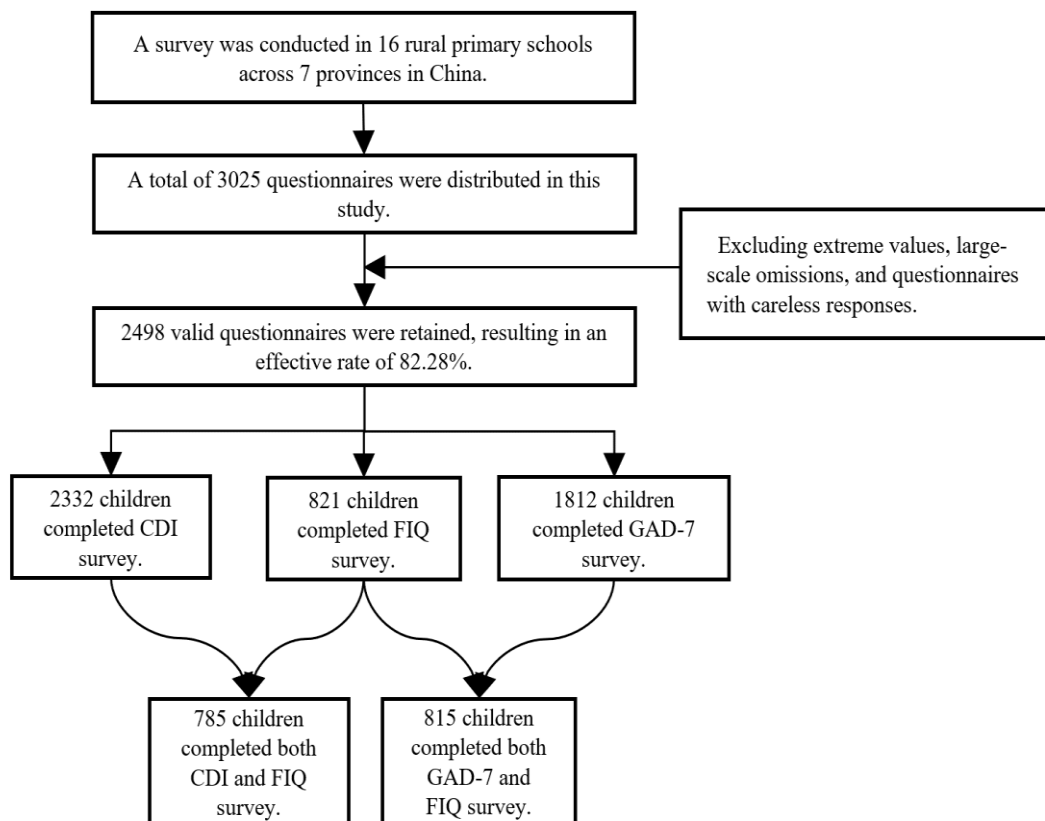
*Note: Data are from "A mental health database of rural children". A logistic regression analysis of the relationship between the background characteristics of the children and adolescents and the risk of depression was conducted, and a multivariate model was constructed based on univariate analysis. The variables included in model 1 were parental relationship, whether the biological father was accompanied, whether the biological mother was accompanied and the level of father involvement. The variables included in Model 2 were gender, age, parental relationship, whether the biological father was accompanied, whether the biological mother was accompanied, whether the stepfather was accompanied, whether the stepmother was accompanied, whether the child was an only child, the father's education level, the mother's education level and the level of father involvement.  $P \leq 0.05$  was considered significant. FIQ= Father Involvement Questionnaire.*

**Table 3.** Logistic regression model of the relationship between anxiety risk scores and background information such as FIQ score.

Variable	Univariate analysis		Multivariable analysis model 1		Multivariable analysis model 2		VIF
	OR (95% CI)	P	OR (95% CI)	P	OR (95% CI)	P	
<b>Gender</b>		0.033		0.102		0.034	1.036
Male	1.000 (reference)		1.000 (reference)		1.000 (reference)		
Female	1.229 (1.017, 1.486)		1.283 (0.952, 1.728)		1.493 (1.03, 2.165)		
<b>Age</b>		0.010		0.085		0.220	1.012
5-10	1.000 (reference)		1.000 (reference)		1.000 (reference)		
11-16	0.753 (0.607, 0.935)		0.157 (0.019, 1.292)		0.245 (0.026, 2.327)		
<b>Parental relations</b>		<0.001		<0.001		<0.001	1.164
Harmony	1.000 (reference)		1.000 (reference)		1.000 (reference)		
General disharmony	2.308 (1.785, 2.984)		2.564 (1.643, 4.002)		4.277 (2.346, 7.796)		
disharmony	2.265 (1.586, 3.236)		2.044 (1.192, 3.507)		3.22 (1.588, 6.528)		
<b>Accompanied by biological father</b>		0.005		0.049		0.224	1.628
No	1.000 (reference)		1.000 (reference)		1.000 (reference)		
Yes	0.760 (0.627, 0.921)		0.690 (0.477, 0.999)		0.744 (0.462, 1.199)		
<b>Accompanied by biological mother</b>		0.007		0.353		0.888	1.619
No	1.000 (reference)		1.000 (reference)		1.000 (reference)		
Yes	0.757 (0.619, 0.925)		1.201 (0.816, 1.768)		1.038 (0.622, 1.731)		
<b>One-child</b>		0.163				0.625	1.034
No	1.000 (reference)				1.000 (reference)		
Yes	0.808 (0.600, 1.090)				0.869 (0.494, 1.528)		
<b>Father's education level</b>		0.978				0.764	1.551

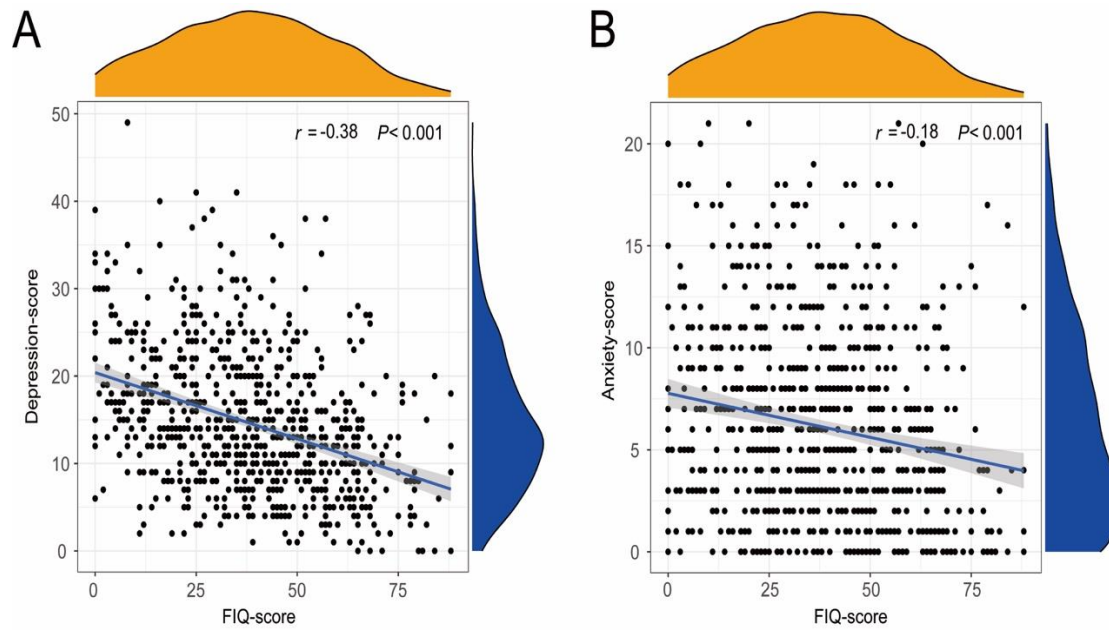
Lower secondary and below	1.000 (reference)			1.000 (reference)		
High school/vocational high school/secondary school/college	1.012 (0.783, 1.307)			0.852 (0.527, 1.377)		
University and above	0.967 (0.654, 1.43)			0.776 (0.289, 2.084)		
<b>Mother's education level</b>		0.899			0.865	1.560
Lower secondary and below	1.000 (reference)			1.000 (reference)		
High school/vocational high school/secondary school/college	1.065 (0.816, 1.389)			1.019 (0.628, 1.655)		
University and above	1.020 (0.709, 1.468)			0.775 (0.281, 2.137)		
<b>FIQ score</b>		<0.001		0.036	0.080	1.201
Low	1.000 reference)		1.000 (reference)	1.000 (reference)		
Medium-low	0.777 (0.522, 1.158)		0.962 (0.623, 1.484)	1.096 (0.622, 1.930)		
Medium-high	0.683 (0.457, 1.019)		0.938 (0.604, 1.458)	1.338 (0.763, 2.346)		
High	0.387 (0.259, 0.577)		0.570 (0.363, 0.896)	0.703 (0.396, 1.247)		

*Note: Data are from "A mental health database of rural children". A logistic regression analysis of the relationship between the background characteristics of the children and adolescents and their levels of anxiety was conducted, and a multivariate model was constructed based on a univariate analysis. The variables included in Model 1 for analysis were gender, age, parental relationship, whether the biological father was accompanied, whether the biological mother was accompanied and the level of father involvement. The variables included in Model 2 were sex, age, parental relationship, whether the child was accompanied by a biological father, whether the child was accompanied by a biological mother, whether the child was accompanied by a stepfather, whether the child was accompanied by a stepmother, whether the child was an only child, the father's education level, the mother's education level and the level of father involvement.  $P \leq 0.05$  was considered significant. FIQ= Father Involvement Questionnaire.*



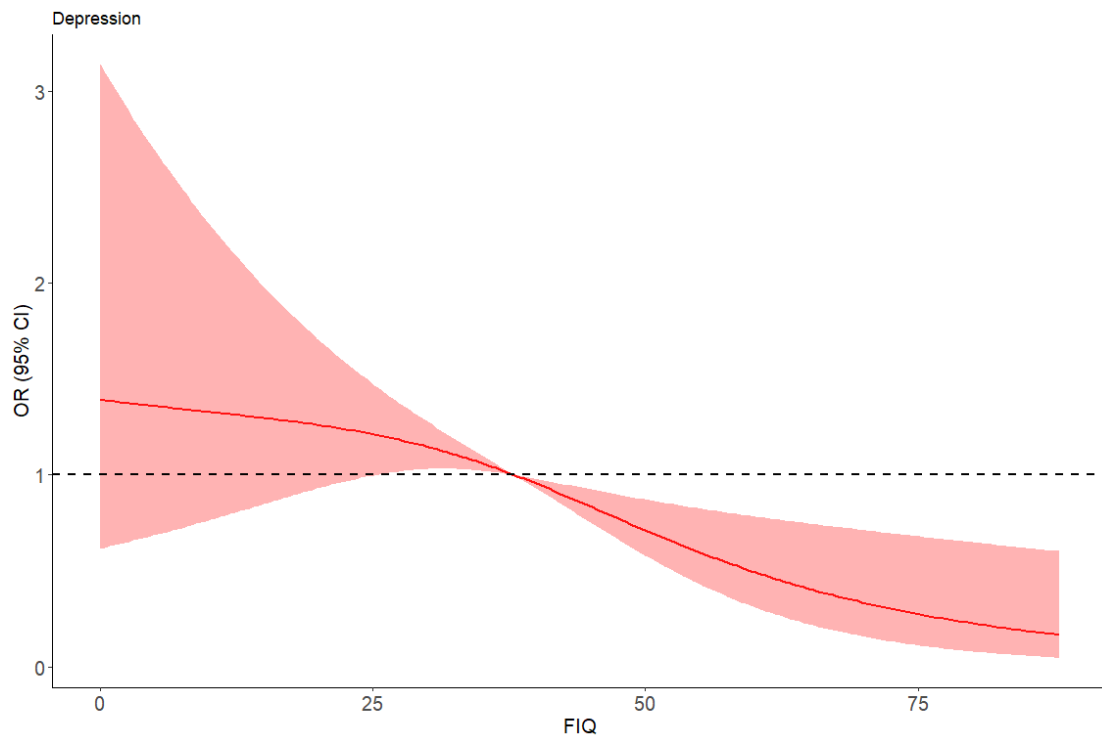
**Figure 1.** Flowchart of recruitment of study participants.

*A total of 2332 completed the Child Depression Inventory (CDI), 1812 completed the Generalized Anxiety Disorder 7-item (GAD-7), 821 completed the Father Involvement Questionnaire (FIQ), 785 completed the Child Depression Inventory (CDI) and Father Involvement Questionnaire (FIQ), 815 completed the Generalized Anxiety Disorder 7-item (GAD-7) and Father Involvement Questionnaire (FIQ).*



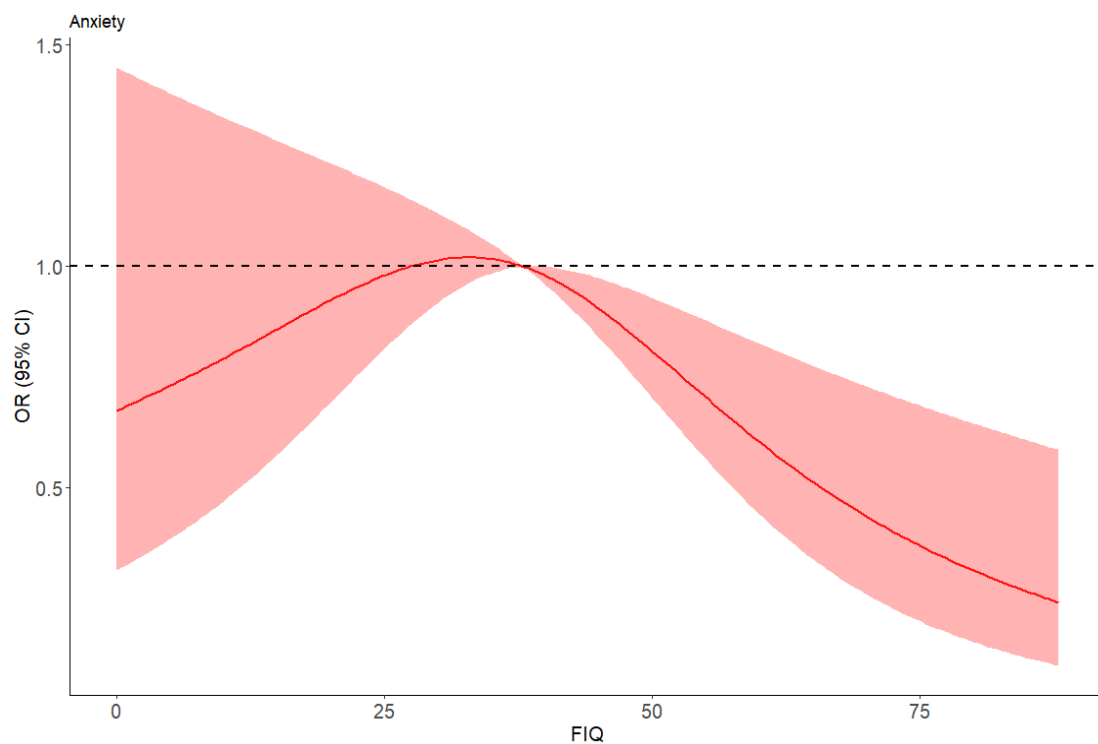
**Figure 2.** Spearman's correlation analysis for father involvement and depression and anxiety scores among Chinese rural children and adolescents.

*A is the relationship between depression scores and father involvement, B is the relationship between anxiety scores and father involvement. FIQ=Father Involvement Questionnaire.*



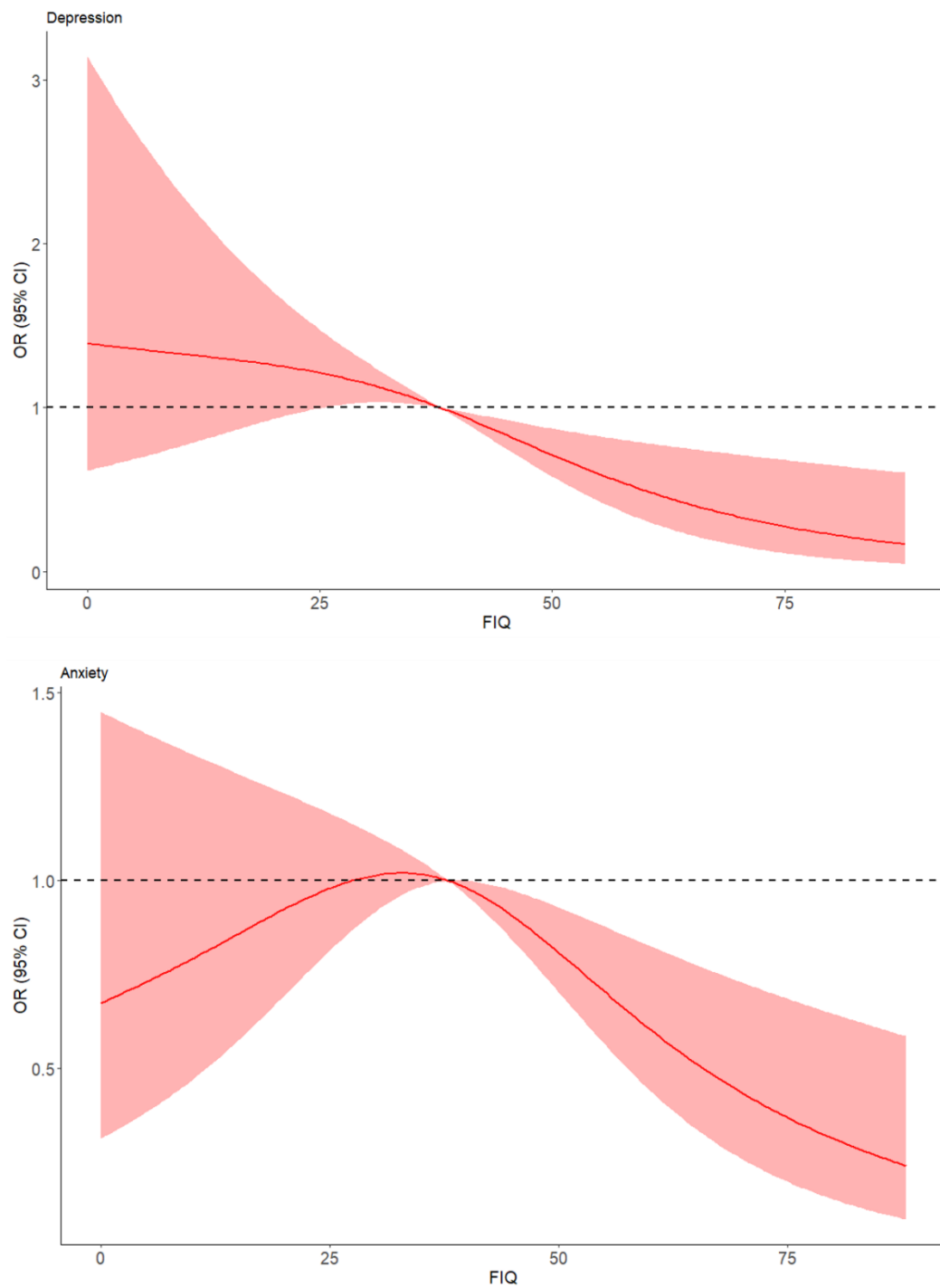
**Figure 3.** Quantitative-effective relationship between FIQ score and risk of depression.

*The red line in the graph indicates the trend of the fit between the FIQ score and the risk of depression, and the red area indicates the 95% CI of the fitted curve. FIQ= Father Involvement Questionnaire.*



**Figure 4.** Quantitative-effective relationship between FIQ score and risk of anxiety.

*The red line in the graph indicates the trend of the fit between the FIQ score and risk of anxiety, and the red area indicates the 95% CI of the fitted curve. FIQ= Father Involvement Questionnaire.*



The risk of depression and anxiety both tended to decrease gradually as father involvement increased. The red trend and red areas in the graph indicate that the highest levels of father involvement significantly reduce children and adolescents depression risk, especially in terms of anxiety.