

## Research paper

## Depressive symptoms prevalence, associated family factors, and gender differences: A national cohort study of middle school students in China

Lu Ma<sup>a,#</sup>, Liwang Gao<sup>a,#</sup>, Dorothy T. Chiu<sup>b</sup>, Yixin Ding<sup>a</sup>, Weidong Wang<sup>c,\*</sup>, Youfa Wang<sup>a,d,\*\*</sup><sup>a</sup> Global Health Institute, School of Public Health, Xi'an Jiaotong University Health Science Center, Xi'an, Shaanxi, China<sup>b</sup> Community Health Sciences Division, School of Public Health, University of California Berkeley, Berkeley, CA, USA<sup>c</sup> Department of Sociology, School of Sociology and Population Studies, Renmin University of China, Beijing, China<sup>d</sup> Fisher Institute of Health and Well-Being, Department of Nutrition and Health Science, College of Health, Ball State University, Muncie, USA

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## ABSTRACT

**Background:** This study examined prevalence and change in depressive symptoms in Chinese adolescents, and roles of inter-parental (I-P) relationship and parent-child (P-C) relationships in its etiology and gender differences.**Methods:** Survey data on depressive symptoms, I-P relationship, and indicators of P-C relationships were collected in China Education Panel Survey (2013–2015) from a nationally representative sample of adolescents ( $n = 9,869$ ) at 7<sup>th</sup> (at baseline), 8<sup>th</sup> and 9<sup>th</sup> (follow-up) grades.**Results:** Prevalence of depressive symptoms was 17.9% in 7<sup>th</sup> graders and higher at 25.7% for 9<sup>th</sup> graders, more remarkably in girls. Better I-P relationship could reduce the risk of depressive symptoms among all (OR = 0.53, 95%CI: 0.48, 0.58), girls (OR = 0.61, 95%CI: 0.54, 0.69), and boys (OR = 0.54, 95%CI: 0.49, 0.61). Greater mother-child (M-C) and father-child (F-C) closeness were protective of depressive symptoms in all and girls (ORs = 0.94 to 0.96,  $p < 0.01$ ). More P-C interactions was associated with reduced risk of depressive symptoms among all (OR = 0.91, 95%CI: 0.89, 0.93), boys (OR = 0.91, 95%CI: 0.89, 0.94), and girls (OR = 0.93, 95%CI: 0.91, 0.96). Better I-P relationship increased M-C closeness, F-C closeness, and P-C interactions, which in turn reduced depressive symptoms risk (indirect effects:  $\beta = -0.03$ , 95% CI: -0.04, -0.03).**Limitations:** The brief depressive inventory was only able to capture higher depressive symptoms, not clinical depression.**Conclusions:** Depressive symptoms are prevalent in Chinese adolescents with increases from early to middle adolescence. I-P and P-C relationships reduce depressive symptoms risk. P-C relationships mediated associations between I-P relationship and depressive symptoms. Future interventions may target these family factors to reduce depression among Chinese adolescents.

## 1. Introduction

Adolescent mental health promotion is a public health priority (Vigo et al., 2016). In recent decades, the global prevalence of depressive symptoms in adolescents has increased rapidly (Mojtabai et al., 2016; Barker et al., 2019). This is concerning given depression's role in suicide and its facilitation of serious social and educational impairment (Thapar et al., 2012). Considering the rapid socioeconomic development in China, as well as its 2015 transition from the one-child policy to

a universal two-child policy (Zeng, Hesketh, 2016), unique insights into familial determinants and developmental trajectories of adolescent depression may be gained through mental health research among Chinese youth. However, no national-level work of this orientation has heretofore been conducted.

Inter-parental (I-P) and parent-child (P-C) relationships play important roles in shaping adolescent mental health (Li et al., 2017). I-P relationships are widely considered to be critical to adolescent mental health (Ying et al., 2018). For example, a recent systematic review

**Abbreviations:** I-P, Inter-parental; P-C, parent-child; M-C, mother-child; F-C, father-child; CEPS, the China Education Panel Survey; ORs, odds ratios; 95% CI, 95% confidence interval;  $\chi^2$ , chi-square; RMSEA, root-mean-square error of approximation; CFI, comparative fit index

\* Corresponding author.

\*\* Co-Corresponding author at: Global Health Institute, School of Public Health, Xi'an Jiaotong University Health Science Center, Xi'an, Shaanxi, China.

E-mail addresses: [wwd@ruc.edu.cn](mailto:wwd@ruc.edu.cn) (W. Wang), [yofawang@gmail.com](mailto:yofawang@gmail.com) (Y. Wang).

# Equal contributors.

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found that I-P relationships were associated with adolescent depressive symptoms (Yap et al., 2014). However, as most of the included studies were cross-sectional and conducted in Western contexts, the findings' temporality and generalizability to other settings are limited (Yap et al., 2014). Moreover, poor I-P relationships were observed to more adversely impact depressive symptoms in girls (Yap et al., 2014), highlighting the importance of gender-specific depression studies in adolescents.

According to attachment theory (Cowie, 2018), adolescents are less likely to experience depressive symptoms when they have high quality relationships with their parents; better P-C relationships may lead to higher perceived social support and self-esteem (Brumariu, Kerns, 2010). Nonetheless, to our knowledge, only one longitudinal study ( $n = 1,313$ ) has been documented in the literature, finding that mother-child (M-C) relationships predicted depressive symptoms in both Dutch male and female adolescents while father-child (F-C) relationships predicted depressive symptoms only for males (Branje et al., 2010). M-C relationships have generally received more attention than F-C relationships to date though paternal involvement during adolescence is, arguably, as similarly important for youth development. Examination into how M-C and F-C relationships may differentially impact adolescent depressive symptoms is warranted.

Two theories help explain how I-P relationships may affect adolescent mental health outcomes via P-C relationships. First, family systems theory suggests that conflict within certain family relationships can lead to conflict in other relationships and within the family as a whole, so affecting adolescent development (Cox, Paley, 2003). Second, per the spillover hypothesis, emotions from antagonistic I-P relationships can "spillover" onto P-C relationships, conferring negativity with adverse effects (Harold et al., 2016). Cross-sectional studies have found I-P relationships to affect adolescent mental health through P-C relationships (Braithwaite et al., 2015; Li et al., 2018), but the potential mediating role of P-C relationships linking I-P relationships to depressive symptoms have yet to be tested longitudinally.

This study aims to fill existing research gaps by using national cohort survey data from China for adolescents aged 12–16 years to examine: 1) prevalence and change of adolescent depressive symptoms between 2013 and 2015; 2) effects of I-P and P-C relationships on depressive symptoms; and 3) mediating roles of P-C relationships on the associations between I-P relationships and depressive symptoms. We hypothesized 1) positive I-P and P-C relationships would reduce the risk for depressive symptoms and 2) P-C relationships would mediate effects of I-P relationships on depressive symptoms.

## 2. Methods

### 2.1. Study design and participants

This research analyzed data from the China Education Panel Survey (CEPS)-middle school Cohort. The CEPS is a national longitudinal study designed to document attributes of developmental and educational experiences of adolescents in China (Li et al., 2017). In the 2013–14 academic year (baseline), a nationally representative sample of 7<sup>th</sup> graders were recruited using a stratified multistage sampling design. Counties (or equivalent administrative districts), schools, and classes comprised the primary, the secondary, and the tertiary sampling units, respectively. Primary sampling units were stratified by region and migrant population size, with oversampling of counties in Shanghai or with high migrant populations. Four schools were drawn from each sampled county using the probability proportional to size method. In the third stage, four classes were sampled from each school. All students in the sampled classes were asked to complete the self-administered Chinese language questionnaire. This survey was administered by local survey teams composed of CEPS-trained researchers from provincial universities or provincial institutes of social sciences. Survey weights were developed by the CEPS team to address the unequal probability of

selection (Li et al., 2017). More details regarding the CEPS-middle school cohort is available elsewhere (Wang, 2016).

Analyses examined data collected at 7<sup>th</sup> grade (baseline, the 2013–14 academic year), 8<sup>th</sup> grade, and 9<sup>th</sup> grade (2015–16 academic year) on students' and parents' demographics, students' relationships with their parents, and students' depressive symptoms. In the baseline 2013–2014 academic year, 10,338 students were approached and 52 declined to participate; the response rate was 99.4% ( $n = 10,279$ ;  $n = 5,310$  for boys,  $n = 4,773$  for girls,  $n = 196$  missing on gender). For analyses of depressive symptoms, only participants with complete depressive measure data were included:  $n = 9,869$  for 7<sup>th</sup> graders,  $n = 9,817$  for 8<sup>th</sup> graders, and  $n = 8,861$  for 9<sup>th</sup> graders.

The Ethnical Committee of Renmin University approved the study data collection. Written informed assent and consent were obtained from children and their parents.

### 2.2. Variables and measurements

#### 2.2.1. Outcome: Depressive symptoms

Depressive symptoms were assessed through a 4-item CEPS-constructed scale. Students were asked to rate the frequency of which feeling "blue", "unhappy", "life is meaningless", and "sad" were problematic for them during the past seven days using a 5-point Likert scale where "never" = 1 and "always" = 5. The average score of the four items was calculated as the scale score (range: 1.0 to 5.0), with higher values indicative of greater depressive symptoms (Li et al., 2018; Ge, 2017).

Because depressive symptoms in adolescents in China have not been fully elucidated, it was of interest to examine depressive symptoms in this population in more detail. Three methods were considered to identify students with "probable depression": 1) Students scoring  $\geq$  top 10% of baseline depressive symptoms score; 2) Students reporting "often" = 4 or "always" = 5 for any of the four items; and 3) Students reporting "often" = 4 or "always" = 5 for all four items. As this scale was unable to diagnose clinical depression, we refer to elevated symptoms levels as "probable depression" (Pereira et al., 2014). Both average score of depressive symptoms and "probable depression" (defined as participants scoring in the top 10%) were used as outcomes in mixed-effects models. Cronbach's  $\alpha$  of this scale was 0.81.

#### 2.2.2. Exposure variables

Inter-parental (I-P) relationships: Quality of I-P relationships were assessed by a 2-item scale constructed by the CEPS research team. Students were asked to rate if they agreed with the following statements (yes/no): "Currently, my parents often quarrel ("yes" = 1 and "no" = 2)", and "Currently, my parents have a good relationship ("yes" = 2 and "no" = 1)". Scores for the two items were summed and higher scores indicated better quality of I-P relationships. Cronbach's  $\alpha$  of this scale was 0.67 (Li et al., 2018).

- a Parent-Child (P-C) relationships: Quality of P-C relationships were measured by three subscales created by CEPS researchers. These scales have been used in previous studies on P-C relationships in Chinese adolescents.
- b Mother-child (M-C) and b.) Father-child (F-C) closeness were each measured by one global item: "How is your relationship with your mother/father?" Three options were provided: "[We are] not close" = 1, "[Our closeness is] average/general" = 2, "[We are] close" = 3. Higher scores indicate better quality relationships (Li et al., 2018; Ge, 2017).

Parent-child (P-C) interactions were assessed by a 6-item scale that measured how frequently adolescents did certain activities (e.g., eating dinner, watching TV) together with their parents. A 6-point Likert scale was used: "never" = 1, "once a year" = 2, "once a half year" = 3, "once a month" = 4, "once a week" = 5, or "more than once a week" = 6.

Responses for each item were summed and higher scores indicated more P-C interaction. The Cronbach's  $\alpha$  of this scale was 0.65 (Ge, 2017).

### 2.2.3. Covariates

Covariates included adolescent demographic and health factors: age (in years), gender, ethnicity (Han/non-Han), weight status, and single child status; and family characteristics included: highest parental educational attainment ( $\leq$  junior middle school, senior middle school/vocational schools,  $\geq$  college) and current household socioeconomic status (lower income, middle class, wealthy). These data were adolescent self-reported from 7<sup>th</sup> to 9<sup>th</sup> grade.

## 2.3. Statistical analysis

Descriptive statistics of adolescent and family characteristics were calculated for the survey sample. Chi-square tests (for categorical variables) and t-tests (for continuous variables) were conducted to test for any gender differences at baseline.

Mixed-effects models were fit using 7<sup>th</sup>, 8<sup>th</sup>, and 9<sup>th</sup> grades data to examine 1) change in adolescent depressive symptoms over time, adjusted for covariates and 2) effects of I-P and P-C relationships on depression. Effect sizes were presented either as beta coefficients with standard error or odds ratios (ORs) with a 95% confidence interval (95% CI). Gender-stratified analysis was conducted to examine gender differences on these associations. Both average score of depressive symptoms and “probable depression” were used as outcomes in mixed-effects models.

Path analyses were conducted to examine potential mediating effects of P-C relationships between I-P relationships and depressive symptoms, controlling for covariates. The mediation model used I-P relationships at 7<sup>th</sup> grade (baseline), P-C relationships at 8<sup>th</sup> grade (first follow-up), and depressive symptoms at 9<sup>th</sup> grade (second follow-up) as the independent variables, hypothesized mediators, and dependent variable, respectively. First, model fit and standardized path coefficients were examined to evaluate mediation models (Kline, 2015). All non-significant paths between specific covariates to dependent variable were dropped (Kaholokula et al., 2017). Acceptable model fit was determined as: 1) a chi-square ( $\chi^2$ ) value with a non-significant  $p$ -value; 2) a root-mean-square error of approximation (RMSEA) less than 0.08; 3) a comparative fit index (CFI) larger than 0.95; and 4) a Tucker-Lewis Index (TLI) larger than 0.95 (Hooper et al., 2008). Second, bootstrapping was used to test for indirect effects (Mallinckrodt et al., 2006). After bootstrapping ( $n=5,000$  replications), the significance of indirect effects was determined using 95% bias-corrected CIs, which were determined from the highest and lowest 2.5% of the indirect-effect estimates. An indirect effect was considered statistically significant if 95% CIs did not include zero (Hayes, 2009).

Analyses utilized Stata 14 (StataCorp, College Station, Texas) for mixed-effects modeling and Mplus 7.0 (Los Angeles, CA) for path analyses. Statistical significance was set at  $p < 0.05$ .

## 3. Results

### 3.1. Baseline characteristics of adolescents and their parents

Table 1 shows summary baseline characteristics for 10,083 adolescents (mean age: 13.1 years). Less than half (44.5%) were single children. Girls were more likely to report that their parents had a good relationship. No gender differences were observed for M-C closeness, but boys reported being closer with their father (greater F-C closeness vs. M-C closeness). Girls reported more frequent interactions with their parents than boys.

### 3.2. Change in prevalence of adolescent depressive symptoms with age

Table 2 shows change in depressive symptoms prevalence between 7<sup>th</sup> and 9<sup>th</sup> grade. Prevalence of “probable depression (defined as participants scoring  $\geq$  top 10% of baseline depressive symptoms score)” increased from 7<sup>th</sup> to 9<sup>th</sup> grade in analyses of all adolescents (17.9% to 25.7%), boys only (18.5% to 25.9%), and girls only (16.9% to 25.5%) (all  $p < 0.05$ ).

Fig. 1 shows change in proportions of adolescents reporting “seldom”, “sometimes”, and “always” for each of the four depressive symptoms. Between 7<sup>th</sup> to 9<sup>th</sup> grade, the proportion of girls reporting feeling “blue” “sometimes” or “always” increased (39.7% to 51.8%) as did those reporting the same for feeling “unhappy” (38.3% to 45.3%) ( $p < 0.05$ ). Changes among boys were not significant.

### 3.3. Longitudinal analyses: Effects of I-P and P-C relationships on depressive symptoms between 7<sup>th</sup> and 9<sup>th</sup> grade

#### 3.3.1. Depressive symptoms scores during 7<sup>th</sup> and 9<sup>th</sup> grade as a continuous outcome

After adjusting for covariates and indicators of P-C relationships, better quality of I-P relationships was independently associated with lower average depressive symptom scores in analyses of all students ( $\beta = -0.13$ ,  $p < 0.001$ ), boys ( $\beta = -0.11$ ,  $p < 0.001$ ), and girls ( $\beta = -0.14$ ,  $p < 0.001$ ).

After adjusting for covariates and I-P relationships, higher degree of M-C closeness was independently associated with lower depressive symptoms scores among all adolescents ( $\beta = -0.01$ ,  $p < 0.001$ ), boys ( $\beta = -0.01$ ,  $p < 0.01$ ), and girls ( $\beta = -0.01$ ,  $p < 0.001$ ). Higher F-C closeness was independently associated with lower depressive symptoms scores among all adolescents ( $\beta = -0.01$ ,  $p < 0.001$ ), boys ( $\beta = -0.01$ ,  $p < 0.001$ ), and girls ( $\beta = -0.01$ ,  $p < 0.001$ ). More frequent P-C interactions were also independently associated with lower depressive symptoms scores among all adolescents ( $\beta = -0.02$ ,  $p < 0.001$ ), boys ( $\beta = -0.02$ ,  $p < 0.001$ ), and girls ( $\beta = -0.02$ ,  $p < 0.001$ ) (Table 3).

#### 3.3.2. Having “probable depression” during 7<sup>th</sup> and 9<sup>th</sup> grade as a binary outcome

Table 4 shows effects of I-P relationships and indicators of P-C relationships on probable depression (defined as students scoring  $\geq$  top 10% of baseline depressive symptoms score). After adjusting for covariates and indicators of P-C relationships, I-P relationship quality was independently associated with reduced risk of probable depression among all adolescents (OR = 0.53, 95%CI: 0.48, 0.58), boys (OR = 0.61, 95%CI: 0.54, 0.69), and girls (OR = 0.54, 95%CI: 0.49, 0.61) (Table 4).

After adjusting for covariates and I-P relationships, greater M-C closeness was independently associated with reduced risk of probable depression among all adolescents (OR = 0.96, 95%CI: 0.93, 0.98) and girls (OR = 0.94, 95%CI: 0.91, 0.97). Greater F-C closeness was also independently associated with reduced probable depression risk among all adolescents (OR = 0.94, 95%CI: 0.91, 0.96) and girls (OR = 0.94, 95%CI: 0.90, 0.97). More P-C interaction was independently associated with reduced probable depression risk as well among all adolescents (OR = 0.91, 95%CI: 0.89, 0.93), boys (OR = 0.91, 95%CI: 0.89, 0.94), and girls (OR = 0.93, 95%CI: 0.91, 0.96) (Table 4).

### 3.4. Path analyses: Indirect effects of I-P relationships on depressive symptoms through indicators of P-C relationships

Table 5 and Supplemental Figure 1 show indirect effects of I-P relationship quality at 7<sup>th</sup> grade (baseline) on continuous depressive symptom scores in 9<sup>th</sup> grade through indicators of P-C relationships at 8<sup>th</sup> grade, controlling for gender, highest parental education, and depressive symptoms at baseline. Bootstrapping revealed total indirect effects of I-P relationship on depressive symptoms scores via P-C relationships to be significant: ( $\beta = -0.03$ , 95% CI: -0.04, -0.03) (Model fit:

**Table 1**Summary characteristics of adolescents in China at baseline (7<sup>th</sup> grade, 2013–14 academic year) (Mean (SD) or %).

Characteristic	All (n = 10,279 <sup>c</sup> )	Boys (n = 5,310)	Girls (n = 4,773)	P-value for gender differences <sup>a</sup>
Age (years)	13.1 ± 0.7	13.1 ± 0.7	13.0 ± 0.7	<0.001
Ethnicity				0.115
Han	91.8	92.1	91.7	
Non-Han	8.2	7.9	8.3	
Overweight or obesity <sup>b</sup>	23.4	28.7	17.8	<0.001
Single child status				<0.001
Yes	44.5	47.1	42.2	
No	55.5	52.9	57.8	
Highest parental educational attainment				0.150
≤ Junior middle school	55.1	50.1	49.5	
Senior middle school/vocational schools	29.6	30.2	29.2	
≥ College	20.3	19.7	21.3	
Current household socioeconomic status				<0.001
Lower income	20.2	21.0	18.8	
Middle class	71.1	69.3	73.6	
Wealthy	8.7	9.8	7.6	
Inter-parental relationships items				
Frequent parental discord (yes, %)	9.7	9.9	9.4	0.390
Good inter-parental relationship (yes, %)	84.2	83.6	85.3	0.020
Indicators of parent-child relationships:				
Mother-child closeness				0.205
Not close	2.6	2.6	2.5	
Average closeness	21.6	22.3	20.9	
Close	75.8	75.1	76.6	
Father-child closeness				<0.001
Not close	3.9	3.4	4.3	
Average closeness	30.6	29.4	32.3	
Close	65.5	68.2	63.4	
Parent-child interactions (Frequency rating of activities) <sup>c</sup>	10.4 ± 3.2	10.3 ± 3.3	10.5 ± 3.2	0.005

<sup>a</sup> P-value was based on Chi-square tests for categorical variables and t-tests for continuous variables across gender;<sup>b</sup> Total sample size was 10,279, but 196 had missing gender data. So, the total number of boys and girls analyzed was 10,083;<sup>c</sup> Total possible score on the frequency rating scale ranged from 3 (least frequent) to 18 (most frequent).

\*: p &lt; 0.05; \*\*: p &lt; 0.01; \*\*\*: p &lt; 0.001.

$\chi^2_{(2)} = 5.41$ ,  $p = 0.07$ , RMSEA = 0.014, CFI = 0.99, TLI = 0.99). Better I-P relationships were associated with greater M-C closeness, F-C closeness, and more P-C interactions ( $\beta$ s ranged from 0.13 to 1.10,  $p < 0.001$ ), which, in turn, were associated with lower depressive symptoms scores ( $\beta$ s ranged from -0.09 to -0.02,  $p < 0.001$ ). Better I-P relationships were also directly associated with lower depressive symptom scores ( $\beta = -0.16$ ,  $p < 0.001$ ).

#### 4. Discussion

Using nationally representative data, we established the first large-scale estimates of “probable depression” among adolescents in China. The prevalence was high and increasing over time with children's age. It was 17.9% in 7<sup>th</sup> graders with an increase to 25.7% for 9<sup>th</sup> graders; changes were more remarkable for girls (16.9% to 25.5% vs 18.5% to 25.9% in boys). The gender difference in depression prevalence change is likely attributable to significant increases in feeling unhappy, blue, and that life is meaningless observed in girls but not in boys. Our findings are similar to other research on adolescent depression. A meta-analysis of regional Chinese studies published before 2018 reported a considerably high pooled prevalence of depressive symptoms (24.3%) among secondary school students (Tang et al., 2019). Though, different screening scales and cutoffs were used, precluding direct comparisons with our study (Tang et al., 2019). Similarly, recent epidemiological research in American adolescents found prevalence of depressive symptoms to be 17.3% among those aged 12–17 years with incidence rising sharply after puberty and at the end of adolescence, particularly in girls as well (Thapar et al., 2012; Kouros et al., 2016).

Consistent with our hypotheses, better I-P relationships were associated with less depressive symptoms in adolescents. These results support a possible causal relationship between I-P relationships and depressive symptoms. The relationship between parents is core to

family solidarity and a primary influence on adolescents' long-term mental health (Ying et al., 2017; Harold et al., 2016; Smith et al., 2019). Parents who exhibit greater discord may elevate their children's depressive risk. Previous reviews have found children of all ages to be affected by destructive I-P conflicts (Harold et al., 2016). In China, negative I-P relationships may become more common as pressures associated with work and rapid societal changes weigh more heavily onto parents (Li et al., 2018). I-P relationships may prove a promising target in future interventions to reduce adolescent depressive risk (Harold et al., 2016).

Regarding P-C relationships, increased M-C and F-C closeness could also reduce adolescent depressive symptoms risk. Attachment theory posits P-C relationships to be vital for adolescent mental health as adolescents with better P-C relationships may possess greater social-support and self-esteem to combat depression (Brumariu, Kerns, 2010; Brumariu, 2015). Here, interestingly, both M-C closeness and F-C closeness showed significant associations with depressive symptoms for all adolescents, but reductions in probable depression risk with both M-C and F-C closeness were observed only in girls, not boys. Previous studies also reported that girls appear to be more affected by parental closeness (Branje et al., 2010; Meadows et al., 2006; O'Gara et al., 2019). These results highlight the important need to account for and distinguish F-C and M-C relationships and gender differences in adolescent mental health.

Frequency of P-C interactions was also associated with reduced risk of depressive symptoms for all adolescents, boys, and girls, respectively, demonstrating the potential of such to improve adolescent mental health. More P-C interactions may foster higher levels of parental care, warmth and support, and minimize parental indifference (Xu et al., 2018; Greenberg, Lippold, 2013). Considering China's transition from its one-child policy to a universal two-child policy in 2015, Chinese parents should be sure to maintain frequent interactions with their first



**Table 2**  
Change in prevalence (%) and means ( $\pm$  SD) of depressive symptoms in Chinese adolescents from 7<sup>th</sup> grade (2013) to 9<sup>th</sup> grade (2015).

	2013 (Baseline, 7 <sup>th</sup> Grade, n = 9,869)			2014 (First Follow-up, 8 <sup>th</sup> Grade, n = 9,817)			2015 (Second Follow-up, 9 <sup>th</sup> Grade, n = 8,861)			P-value <sup>a</sup>	P-value <sup>b</sup>	P-value <sup>c</sup>
	Total	Boys	Girls	Total	Boys	Girls	Total	Boys	Girls			
1) Probable depression ( $\geq$ Top 10% of baseline depressive symptoms score)	17.9	18.5	16.9	28.5	28.9	27.9	25.7	25.9	25.5	<0.001	0.007	0.006
2) Children reporting > 3 on any depression item	16.7	17.2	15.6	18.7	17.8	19.5	18.1	17.1	19.1	<0.001	0.104	<0.001
3) Children reporting > 3 on all depression items	2.2	2.6	1.7	4.5	4.8	4.1	5.1	5.6	4.7	<0.001	0.002	0.003
4) Depressive symptoms score (mean, SD) <sup>d</sup>	1.4 $\pm$ 0.5	1.4 $\pm$ 0.5	1.4 $\pm$ 0.5	1.4 $\pm$ 0.6	1.4 $\pm$ 0.6	1.5 $\pm$ 0.6	1.5 $\pm$ 0.6	1.5 $\pm$ 0.6	1.5 $\pm$ 0.6	<0.001	0.004	0.020

<sup>a</sup> P-value for the change of depression among all adolescents from 2013 to 2015;

<sup>b</sup> P-value for the change of depression among girls from 2013 to 2015;

<sup>c</sup> P-value for the change of depression among boys from 2013 to 2015;

<sup>d</sup> Possible mean score on the depressive symptoms scale ranged from 1–5.

\*:  $p < 0.05$ ; \*\*:  $p < 0.01$ ; \*\*\*:  $p < 0.001$ .

child after arrival of a sibling. As adults may struggle against the fast-paced demands of work and life in modernizing societies such as China and other developing countries, our findings stress the importance for parents not to compromise positive interactions with their children.

Lastly, our findings support that I-P relationships quality not only affects adolescent depressive symptoms directly, but also indirectly through indicators of P-C relationships. Better I-P relationships increased M-C closeness, F-C closeness, and frequency of P-C interactions, which, in turn, reduced risk of depressive symptoms. These findings, supported by the family systems theory and spillover hypothesis (Cox, Paley, 2003; Harold et al., 2016), were also consistent with previous cross-sectional studies that found associations between more I-P conflicts with less P-C closeness and interactions and more child depression (Ying et al., 2018; Braithwaite et al., 2015; Li et al., 2018). Recommendations to improve P-C relationships for adolescent depression risk reduction could be fruitful.

The study has several key strengths. First, it is the first nationally representative cohort study to examine the prevalence and change in depressive symptoms among adolescents in China. Second, availability of longitudinal data allowed for the establishment of temporal associations between family dynamics and adolescent depressive symptoms. Third, the breadth of the CEPS survey allowed for the construction and evaluation of a novel and integrative conceptual framework that begins to delineate the complex roles of family in adolescent depression in China, with potential relevance for other developing countries.

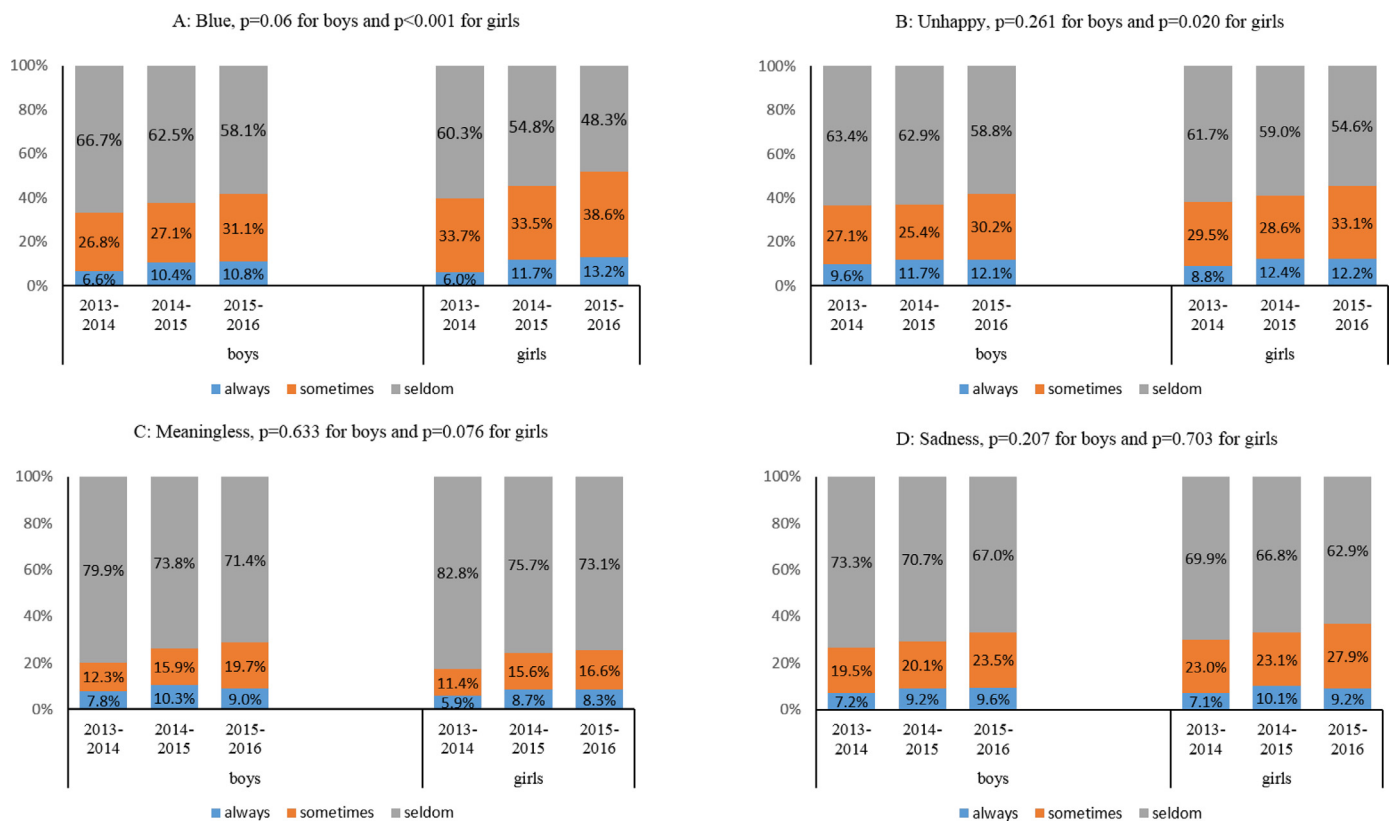
Our findings have some important implications for national policy makers, program managers, and non-governmental organizations working in Chinese adolescent mental health. Attention needs to be paid to the high and increasing prevalence of depressive symptoms among young Chinese adolescents. I-P and P-C relationships may be promising targets for intervention aiming to reduce depressive risk. The importance of including fathers in such interventions should also not be overlooked.

This study also has some study limitations. The depressive inventory used was a brief instrument only able to capture the burden of certain depressive symptoms, not provide a clinical depression diagnosis. However, significant depressive symptoms is strongly predictive of clinical depression, and this scale was validated for use among adolescents in China (Li et al., 2018), and had a high Cronbach's alpha. Also, assessments of I-P and P-C relationships were all child reported. While parental assessments may have differed, it is arguable that child perceptions may be more relevant for research of child symptomatology (Yap et al., 2014). Last, given limited data, it was not possible to examine potential confounding by parental mental health, social support, and peer-relationships. Also, reverse causality where adolescent depressive symptoms may impact I-P and P-C relationships were not examined here and cannot be ruled out. More comprehensive studies are needed.

In conclusion, we found that depressive symptoms were prevalent nationally among adolescents in China. These rates increased from early- to middle- adolescence, especially in girls. Better inter-parental and parent-child relationships appear protective of depressive symptoms, especially for girls. Associations between inter-parental relationships and depressive symptoms appear to be mediated by parent-child relationships. Efforts are needed to address depression in China's youth. Intervention programs to improve inter-parental and parent-child relationships, such as through psychoeducation and parenting skills training, may help to improve mental health among adolescents.

#### Author statement

Contributors: WDW and YFW conceptualized the study. LM led the paper writing and revising with the contributions from DTC, WDW, YFW, and YXD. LWG cleaned, analyzed, and visualized the data with the contribution from LM. All authors read and approved the final draft for submission.



**Fig. 1.** Change in proportions (%) of Chinese adolescents reporting the degree (often/always, sometimes, never/seldom) to which the following feelings were problematic for them during the past 7 days: (A) feeling blue, (B) feeling unhappy, (C) feeling that life is meaningless, and (D) feeling sad from 7<sup>th</sup> (2013-14) to 9<sup>th</sup> (2015-16) grade.

P-values reflect the significance of change among boys and girls for each symptom from 7<sup>th</sup> grade to 9<sup>th</sup> grade;  $n=9,869$  in 2013-14,  $n=9,817$  in 2014-15, and  $n=8,861$  in 2015-16.

**Table 3**

Longitudinal analyses: Effects of inter-parental and parent-child relationships on depressive symptoms in Chinese adolescents.

	Model 1 (Beta, SE) <sup>a</sup>			Model 2 (Beta, SE) <sup>b</sup>		
	All	Boys	Girls	All	Boys	Girls
Inter-parental relationship	-0.15 (0.01) ***	-0.14 (0.01) ***	-0.16 (0.01) ***	-0.13(0.01)***	-0.11(0.01)***	-0.14(0.01)***
Mother-child closeness	-0.18(0.01)***	-0.17(0.01)***	-0.18(0.01)***	-0.01(0.00)***	-0.01(0.00)**	-0.01(0.00)***
Father-child closeness	-0.16(0.01)***	-0.17(0.01)***	-0.15(0.01)***	-0.01(0.00)***	-0.01(0.00)***	-0.01(0.00)***
Parent-child interactions	-0.02(0.00)***	-0.02(0.002)***	-0.02(0.002)***	-0.02(0.00)***	-0.02(0.00)***	-0.02(0.00)***

Variable definition: Inter-parental relationships: scores ranged from 2-4, higher score indicate higher quality of inter-parental relationship; Parent-child relationships: Closeness: Not close = 1, average/general closeness = 2, close = 3; Frequency of parent-child interactions: never = 1, once a year = 2, once a half year = 3, once a month = 4, once a week = 5, more than once a week = 6. The dependent variable was the mean score of the four depression symptom items (range: 1-5).

The sample size was  $n=9,869$  in 2013-14,  $n=9,817$  in 2014-15, and  $n=8,861$  in 2015-16.

<sup>a</sup>Independent variables in Model 1 included each of the four variables (inter-parental relationships, mother-child closeness, father-child closeness, and frequency of parent-child interactions) with covariates (age, gender, ethnicity, single child status, highest parental education, current household socioeconomic status, and baseline depressive symptoms).

<sup>b</sup>Independent variables in Model 2 included all four variables: inter-parental relationships, mother-child closeness, father-child closeness, and frequency of parent-child interactions) and covariates (age, gender, ethnicity, single child status, highest parental education, current household socioeconomic status, and baseline depressive symptoms).

\*:  $p<0.05$ ; \*\*:  $p<0.01$ ; \*\*\*:  $p<0.001$ .

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## CRediT authorship contribution statement

**Lu Ma:** Validation, Visualization, Writing - original draft, Writing - review & editing. **Liwang Gao:** Data curation, Formal analysis, Software, Visualization. **Dorothy T. Chiu:** Writing - original draft, Writing - review & editing. **Yixin Ding:** Software, Visualization. **Weidong Wang:** Conceptualization, Funding acquisition, Investigation, Methodology, Project administration, Resources, Supervision, Validation. **Youfa Wang:** Conceptualization, Funding acquisition, Methodology, Resources, Supervision, Validation, Writing - review &

**Table 4**Longitudinal analyses: Associations between inter-parental and parent-child relationships with “probable depression” in Chinese adolescents during 7<sup>th</sup> and 9<sup>th</sup> grade.

	Model 1 (OR, 95%CI) <sup>a</sup>			Model 2 (OR, 95%CI) <sup>b</sup>		
	All	Boys	Girls	All	Boys	Girls
Inter-parental relationships	0.47(0.43,0.51)***	0.55(0.49,0.61)***	0.40(0.36,0.45)***	0.53(0.48,0.58)***	0.61(0.54,0.69)***	0.54(0.49,0.61)***
Mother-child closeness	0.41 (0.38,0.45)***	0.47 (0.41,0.53)***	0.36 (0.31,0.42)***	0.96(0.93,0.98)**	0.98(0.94,1.02)	0.94(0.91,0.97)***
Father-child closeness	0.43 (0.40,0.47)***	0.44 (0.39,0.50)***	0.42 (0.37,0.48)***	0.94(0.91,0.96)***	0.95(0.91,1.00)	0.94(0.90,0.97)***
Parent-child interactions	0.88 (0.86,0.90)***	0.90 (0.88,0.92)***	0.86 (0.84,0.89)***	0.91(0.89,0.93)***	0.91(0.89,0.94)***	0.93(0.91,0.96)***

Variable definition: Inter-parental relationship: scores ranged from 2-4, higher score indicate higher quality of inter-parental relationship; Parent-child relationships: Closeness: Not close = 1, average/general closeness = 2, close = 3; Frequency of parent-child interactions: never = 1, once a year = 2, once a half year = 3, once a month = 4, once a week = 5, more than once a week = 6. Having probable depression was a binary variable, defined as students scoring  $\geq$  top 10% of baseline depressive symptoms score.

The sample size was n = 9,869 in 2013-14, n = 9,817 in 2014-15, and n = 8,861 in 2015-16.

<sup>a</sup> Independent variables in Model 1 included each of the four variables (inter-parental relationships, mother-child closeness, father-child closeness, and frequency of parent-child interactions) with covariates (age, gender, ethnicity, single child status, highest parental education, current household socioeconomic status, and baseline depressive symptoms).

<sup>b</sup> Independent variables in Model 2 included all four variables inter-parental relationships, mother-child closeness, father-child closeness, and frequency of parent-child interactions) and covariates (age, gender, ethnicity, single child status, highest parental education, current household socioeconomic status, and baseline depressive symptoms).

\*:  $p < 0.05$ ; \*\*:  $p < 0.01$ ; \*\*\*:  $p < 0.001$ .

**Table 5**

Bootstrap analysis of the indirect effects of inter-parental relationships (at baseline) on depressive symptoms (second follow-up) through parent-child relationships (first follow-up) in Chinese adolescents

	All		Boys	Girls	
	$\beta$	95%CI	$\beta$	$\beta$	95%CI
Total effects	-0.12	(-0.14, -0.09)	-0.12	-0.12	(-0.14, -0.09)
Total indirect effects	-0.03	(-0.04, -0.03)	-0.03	-0.03	(-0.04, -0.03)
Specific indirect effects					
Mother-child closeness	-0.01	(-0.02, -0.01)	-0.004	-0.01	(-0.01, -0.01)
Father-child closeness	-0.02	(-0.02, -0.01)	-0.02	-0.02	(-0.02, -0.01)
Parent-child interactions	-0.01	(-0.02, -0.01)	-0.01	-0.01	(-0.01, -0.01)

Variable definition: Inter-parental relationship: scores ranged from 2-4, higher score indicate higher quality of inter-parental relationship; Parent-child relationship: Closeness: Not close = 1, average/general closeness = 2, close = 3; frequency of parent-child interactions: never = 1, once a year = 2, once a half year = 3, once a month = 4, once a week = 5, more than once a week = 6. The dependent variable was the mean score of the four depression symptom items (range: 1-5).

Path analyses were conducted to examine the indirect effects of inter-parental relationships at baseline on continuous depression scores in 9<sup>th</sup> grade through P-C relationships scores in 8<sup>th</sup> grade, controlling for gender, highest parental educational attainment, and depressive symptoms at baseline.

The sample size was n = 10,279 in 2013, n = 9,449 in 2014, and n = 8,232 in 2015.

Numbers in bold indicate statistical significance at  $p < 0.05$ .

editing.

## Declaration of Competing Interests

None declared. The funding source had no role in the design of this study and will not have any role during its execution, analyses, interpretation of the data, or decision to submit results.

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## Supplementary materials

Supplementary material associated with this article can be found, in the online version, at [doi:10.1016/j.jad.2020.05.128](https://doi.org/10.1016/j.jad.2020.05.128).

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