

RESEARCH ARTICLE

A study of the effect of number of children on depression among rural older women: empirical evidence from China

Shuo Zhang¹, Hualei Yang², Zhiyun Li³, Siqing Zhang⁴ and Yuanyang Wu⁵

¹School of Sociology and Population Studies, Renmin University of China, Beijing, China, ²School of Public Administration, Zhongnan University of Economics and Law, Wuhan, China, ³School of Politics and Public Administration, Qingdao University, Qingdao, China, ⁴School of Government, Nanjing University, Nanjing, China and ⁵School of Medicine and Health Management, Tongji Medical School, Huazhong University of Science and Technology, Wuhan, China

Corresponding author: Hualei Yang; Email: home@zuel.edu.cn

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Abstract

The association between early reproductive events and health status in later life has always been of interest across disciplines. The purpose of this study was to investigate whether there was an association between the number of children born in the early years of elderly women and their depression in later life based on a sample of older women aged 65 years and above with at least one child in rural China. Data from the Chinese Longitudinal Healthy Longevity Survey in 2018, this study used the ordinary least square method to conduct empirical research. This study has found a significant correlation between an increase in the number of children and depression in older rural women. When considering the sex of the child, the number of daughters had a greater and more significant impact on depression. Number of children may exacerbate depression of older women through declining self-rated health and reduced social activity, while increased inter-generational support alleviated depression. The association between number of children born and depression also existed in urban older women, though not significant. Therefore, it is suggested to accelerate the improvement of supporting policies related to childbirth, developing a healthy and scientific fertility culture, and improving rural maternal and child health services. Women should be assisted in balancing their roles in the family and in society, and in particular in sharing the burden of caring for children. Targeted efforts to increase old-age protection for older people.

Keywords: number of children; Chinese rural women; depression; older people; CLHLS

Introduction

As an important life event in the life cycle, reproductive behaviours triggered not only individual physiological changes but also brought about changes in role-playing, social networks, and the environment they live in. This was closely linked to their health, a topic that has attracted a great deal of attention from scholars both nationally and internationally. Previous studies have found that parity can have both positive and negative effects on people's health (Parikh et al., 2010; Umberson et al., 2010; Huijts et al., 2011; Bai et al., 2017; Peters et al., 2017), with a large body of literature focusing on the psychological impacts of pregnancy and parity (Grundy et al., 2017; Djundeva et al., 2018; Li et al., 2019). In Chinese culture, more children and larger families were often considered to be a blessing (Lee et al., 2009). In China, with the development of urban and rural areas and the liberalisation of fertility controls, what was the association between number of children and parental well-being in later life, and whether it was in line with the relevant

international findings, needed to be further explored. Of course, this had important theoretical and practical implications for the institutional construction of population and health policies in various countries.

Reproductive behaviour and mental health in later years

A review of the relevant literature revealed inconsistent associations between the reproductive behaviour and mental health, which were complicated by factors such as physical functioning, socio-economics, and lifestyle (Ryan et al., 2008; Perquier et al., 2013; Tsai et al., 2017; Djundeva et al., 2018).

The event of childbearing brought the role of parents into a new life course and influenced by traditional culture, childbearing could improve the life satisfaction of older people (He, 2002). Some studies have found that older adults with no children and those with four or more children had poorer psychological status and were more likely to experience depressive symptoms and cognitive impairment than those with two children (Read & Grundy, 2017; Keenan & Grundy, 2018). On the one hand, in terms of group differences between having and not having children, depressive conditions may be worse among older people without children. However, the relevant research was not rich enough. On the other hand, in those groups of older people with children, an increased number of children may be associated with depression due to the realities of impaired physiological functioning, heavy family burdens, and unbalanced resource allocation. A study of a sample of older people in the UK found that deteriorating mental health was associated with having more children (Grundy & Read, 2015). In Eastern European countries, the association between an increased number of children and depression in later life also existed and was influenced by marital status and the country's economic development (Grundy et al., 2017).

However, there were studies that did not support this. Based on data from the E3N follow-up survey, the association was found between the larger number of children and lower risk of depression for French women (Perquier et al., 2013). This similar association was found in a sample of Taiwanese women in China (Tsai et al., 2017). One study selected 10 regions (five urban and five rural) and again found that more children were associated with better mental health of their mothers (Wang et al., 2019). In addition, there have been studies that have found no link between the number of children and depression in later life (Ryan et al., 2008). Some studies have also concluded that parenthood did not affect the life satisfaction of either fathers or mothers (Keizer et al., 2010). The association between number of children and fathers' mental health appeared to be a little weaker than that of mothers, and inconclusive. In general, the combination of motherhood and work roles made mothers more susceptible to the ongoing stress of childbearing compared to fathers, and having children or even more children increased mothers' negative emotions (Kim et al., 2015; Meier et al., 2016; Roeters et al., 2016). Other studies have further sought to support the above view (Savolainen et al., 2001; Meier et al., 2016).

Some scholars have also pointed out that the sex of children was an important variable when studying the relationship between reproductive behaviour and mental health. For mothers, having a son may consume more energy than having a daughter (Jasienska, 2009). As male foetuses grew faster in utero, they were larger at delivery (Marsal et al., 1996; Loos et al., 2001) and had a higher need for breastfeeding (Hinde, 2007). Number of sons was positively associated with the rate of inflammation in the mother's later years (Marttila et al., 2015). Epidemiological studies have shown that the number of sons was associated with shorter life expectancy (Helle & Lummaa, 2013).

Number of children and sex of children had different effects on the mental health of older people, suggesting that both biological and social effect mechanisms were possible.

Mechanism of biological effect

The impact of reproductive behaviour on the health of parents in later life was mainly realised through biological effects and social effects. Biological effects were manifested in the impact of biological scars or physical imprints produced during pregnancy on health in later life. Obviously, this was for the mothers. Social effects emphasised the impact of children support, family resource distribution, and parenting burden.

In terms of biological mechanism, reproductive behaviour affected the maternal organism differently (Jasienska, 2020), and poor physical health directly contributed to the onset of depression in later life (Fiske *et al.*, 2009). This was due to the trade-off between investing energy resources in reproduction and other metabolic functions (e.g. growth, somatic maintenance, and so on) (Kirkwood & Rose, 1991). If resources were limited, allocation to one function can only be at the expense of other functions (Zera & Harshman, 2001). One mechanism that allowed more resource energy to be allocated to reproduction was to reduce maternal basal metabolism (Peacock, 1991; Prentice *et al.*, 1995). A Chinese study chose hormone levels as mediating the link between high parity and depression in later life (Li *et al.*, 2019). Allocating resources for reproduction may make the supply to other metabolic functions inadequate, leading to impaired physiological function and increased risk of disease (Jasienska, 2009). This was consistent with the Disposable Soma Theory that reproduction competed with resources for organismal maintenance and that high parity was associated with health disadvantage (Kirkwood, 1977). In addition, unlike mothers with sons, mothers with daughters consumed relatively little energy during pregnancy and delivery (Galbarczyk & Jasienska, 2013).

Specifically, the biological response to the reproduction can lead to an increased risk of coronary heart disease and obesity in later life (Lawlor *et al.*, 2003; Bastian *et al.*, 2005), and the repeated pregnancies may also affect lipid and glucose metabolism over time, leading to health problems such as obesity and atherosclerosis (Skilton *et al.*, 2009). Epidemiological studies have shown that pregnancy has a direct impact on women's health in the long term. Women with high parity had poorer health status (Kington *et al.*, 1997) and were also at higher risk of chronic diseases such as cardiovascular disease, endocrine disease, and certain cancers (Parikh *et al.*, 2010; Peters *et al.*, 2016).

In addition, birth interval has also been shown to be associated with maternal health. Short birth intervals meant that the mother had not yet effectively recovered from the previous act of childbearing, while they also faced a higher stress level from sleep deprivation, postnatal depression, and financial burdens. In the analytical framework of life course epidemiology, these stressful events exposed to mothers themselves had a cumulative impact on mental health in later life.

Mechanism of social effect

For social mechanism, social factors such as socio-economic resources, partnerships, and social networks were also associated with depression in the late-adulthood (Fiske *et al.*, 2009; Virtanen *et al.*, 2015). Pregnancy and parenting consumed parents' energy, while bringing some financial strain and crowding them out of their social roles (Grundy & Read, 2015). Social support theory suggested that individuals with more social support and close relationships had better health and lower mortality rates (Berkman & Syme, 1979; House *et al.*, 1988).

Both personal beliefs (Lehrer *et al.*, 1995; Giavazzi *et al.*, 2013) and cultural practises (Antecol, 2000; Fernandez, 2007; Almond *et al.*, 2013) had significant explanatory power for reproduction-related outcomes. In the context of traditional Chinese culture, the impact of having children on parents' health in later life showed different cultural effects. On the one hand, there were positive cultural effects. Specifically, due to the presence of upward inter-generational support provided by

children, older adults were able to obtain timely and adequate financial support, spiritual comfort, daily care services, and so on, which, in turn, were beneficial to their physical and psychological health. Inter-generational support in the late stages may have a greater impact on mothers' health in later life than the cost of reproduction itself (Thomas & Thomeer, 2019). On the other hand, there were negative effects. Chinese parents often took on the task of starting a family and career development for their children. The life and financial pressure may continue until old age. In the elderly stage, they still worried and cared for their children and even continued to work, thus enduring greater stress both physically and mentally. Thus, the impact of having children on parental health was multi-directional due to cultural effects. For example, in rural China, both the financial support of children on whom they relied in later life and the spiritual consolation that came from family emotions were effective in alleviating the mental stress of parents in later life. Studies have shown that parents with large families were more likely to have regular face-to-face contact than parents with no or few children and that this higher level of face-to-face contact in turn reduced the risk of depression (Grundy & Read, 2012; Tomassini et al., 2004).

Among other socio-economic and lifestyle factors, region influenced the relationship between parity and depression. In urban areas, more children had a significant protective effect against depression, but in rural areas, this protective effect disappeared for both men and women (Wang et al., 2019). This urban-rural difference may stem from different economic status and health levels (Tang, 2010). Previous studies have shown that older people in rural areas were at higher risk of depression than those in urban areas (Wen et al., 2019; Song, 2017).

In addition, many factors have an important moderating role in the association between reproductive behaviour and health in later life, such as marital status, socio-economic status of children (Yang et al., 2016), religious beliefs, reproductive culture, and so on. When discussing the health of older people in the context of Chinese society, grandchild care was a very important factor. On the one hand, grandchild care as an act of domestic labour created a physical burden on older adults and increased the risk of chronic disease (Minkler & Fuller-Thomson, 2005). Heavy caregiving also crowded out a great deal of older adults' time and energy, leaving them with fewer opportunities to exercise and go to the hospital for treatment (Baker & Silverstein, 2008), and thus they often did not have time to engage in self-health management (Burnette, 1999). In addition, grandchild care can also be directly detrimental to the mental health of older people, raising depression level (Whitley et al., 2001). Some studies have shown that intensive care made older adults' socialization narrow, which negatively affected mental health. On the other hand, caring for grandchildren can alleviate the loneliness and dreariness of older people and increase their enjoyment of life (Goodman & Silverstein, 2002). Some studies have found that grandchild care significantly reduced depression levels and increased life satisfaction and subjective well-being in older people (He et al., 2020).

Research contribution

The literature review indicated that most of the studies have been conducted in Western countries, while studies on Chinese samples were very few, especially for depression in older women. Considering that there were still a large number of farmers in China, it was of significance to select a sample of Chinese rural older people for this study. From data from the Chinese Longitudinal Healthy Longevity Survey (CLHLS) in 2018, this study selected rural older women who have experienced pregnancy (i.e. at least one child) as the sample to investigate the effects of the number of children on depression and attempted to analyse the transmission channels involved. The major contribution of this study was to explore the effects of the number of children born early in life on mothers' mental health in later life. Differences in the association between the sex of children and mothers' late-life depression were explored by introducing cultural factors. In particular, cutting through the social perspective, this study attempted to explore the mechanisms, including the social activity effect, the child-feeding effect, and the health effect.

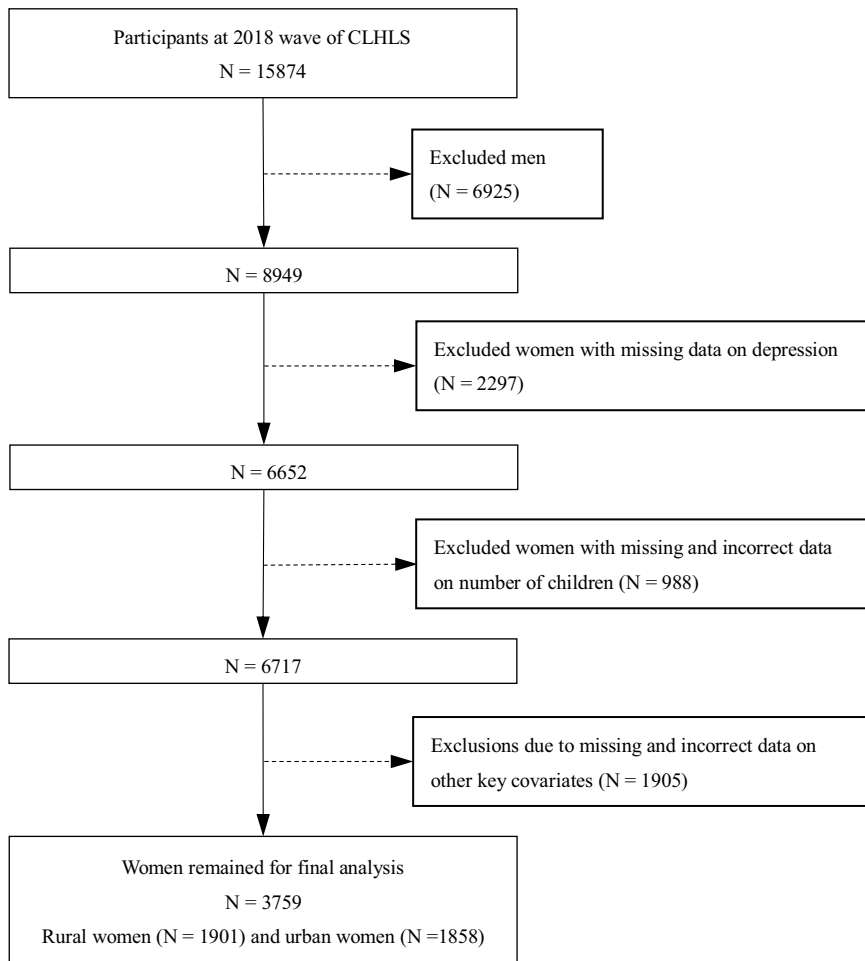


Figure 1. Flow Chart of the Study Population Selection Process.

Method

Data

The data for this study were obtained from the 2018 CLHLS, which was a tracking survey of older people initiated by the Centre for Healthy Ageing and Development of Peking University and the National School of Development, and was the earliest and longest-running social science survey in China. This survey project conducted a baseline survey in 1998 and has been followed up eight times. It covered 23 provinces, municipalities, and autonomous regions across China. There were two types of questionnaires, one for surviving respondents and one for family members of the deceased. The former included basic information about older people and their families, financial status, cognitive function, and ability to perform daily activities. The latter focused on the death time and death cause of older people. This study mainly used the data provided by the surviving respondent questionnaire.

Combining the content and purpose of the study, older rural women aged 65 years and above with pregnancy experience (i.e. at least one child) were selected as main study population. Figure 1 illustrates the screening process for inclusion and exclusion of the study sample. After excluding irrelevant samples and missing values, a final sample of 3759 was obtained, including 1901 rural women and 1858 urban women (sample information was shown in Table 1). Figure 2 illustrates the distribution of the number of children in the urban and rural female samples.

Table 1. Descriptive Statistics for Variables in the Female Sample

Variable	Rural female (N = 1901)				Urban female (N = 1858)			
	Mean (%)	SD	Min	Max	Mean (%)	SD	Min	Max
Depression	22.83	6.10	10	46	22.93	6.10	10	48
Number of children	4	1.92	1	12	4	1.95	1	13
1–2	14%				17%			
3–4	41%				38%			
5–6	30%				32%			
7+	15%				13%			
Number of sons	2	1.34	0	9	2	1.32	0	8
Number of daughters	2	1.49	0	11	2	1.47	0	10
Birth cohort (year)	3.77	1.21	1	6	3.69	1.22	1	6
1901–1910	1%				1%			
1911–1920	18%				20%			
1921–1930	22%				23%			
1931–1940	27%				27%			
1941–1950	26%				23%			
1951–1960	6%				6%			
Education	1.37	0.65	1	4	1.49	0.75	1	4
Illiteracy	70%				64%			
Low education level	24%				26%			
Secondary education level	4%				7%			
High education level	2%				3%			
Reading	4.86	0.66	1	5	4.69	0.98	1	5
Always	2%				5%			
Often (at least once a week)	1%				2%			
Occasionally (at least once a month)	1%				1%			
Sometimes	1%				2%			
Never	95%				90%			
Married (1 = yes)	34%	0.47	0	1	32%	0.47	0	1
Drinking (1 = yes)	6%	0.23	0	1	7%	0.26	0	1
Living alone (1 = yes)	21%	0.41	0	1	19%	0.39	0	1
Living standard	2.98	0.60	1	5	2.91	0.61	1	5
Very well-off	2%				2%			
Well-off	13%				15%			
Fair	72%				73%			
Difficult	12%				9%			
Very difficult	1%				1%			

(Continued)

Table 1. (Continued)

Variable	Rural female (N = 1901)				Urban female (N = 1858)			
	Mean (%)	SD	Min	Max	Mean (%)	SD	Min	Max
Number of trips (ln)	0.75	0.23	0.69	4.13	0.78	0.28	0.69	3.09
Exercise (1 = Yes)	24%	0.43	0	1	31%	0.46	0	1
Pension insurance (1 = Yes)	34%	0.48	0	1	38%	0.49	0	1
Self-rated health	3.41	0.89	1	5	3.46	0.90	1	5
Very poor	1%				1%			
Poor	13%				13%			
Fair	40%				38%			
Good	36%				36%			
Excellent	10%				12%			
Social activity	1.41	0.89	0	3	1.41	0.88	0	3
Upward inter-generational support (ln)	6.19	2.90	0.69	11.33	5.97	3.19	0.69	12.21

Note: Social activities included visiting friends, watching TV, listening to radio, and playing cards and mahjong. Upward inter-generational support mainly refers to the financial support provided by sons, daughters-in-law, daughters, and sons-in-law.

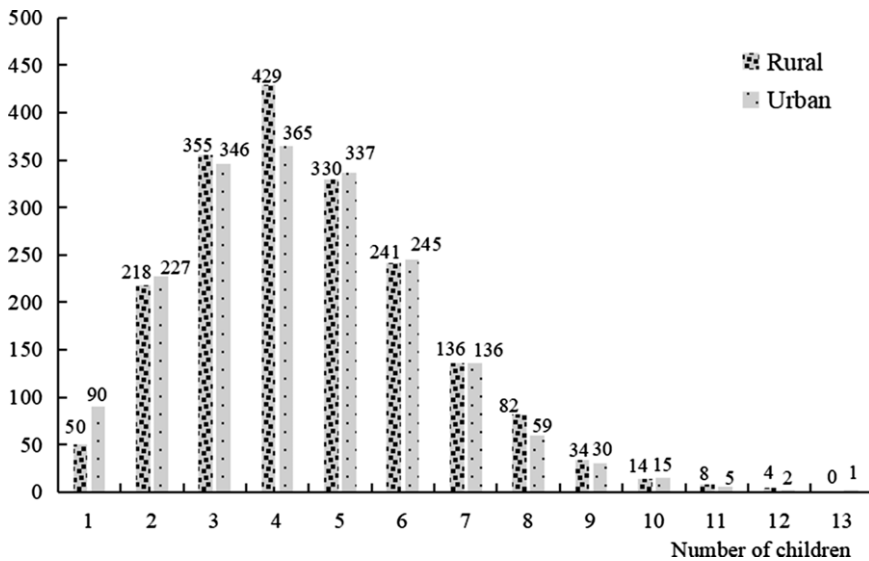


Figure 2. Distribution of the Number of Children of Urban and Rural Women.

In addition, to further test the representativeness of the study sample to the original database sample, we chose to compare the distribution of the number of children in the original database and the study sample. Figures 3 and 4 showed that this study sample was representative, and the study design was continued next.

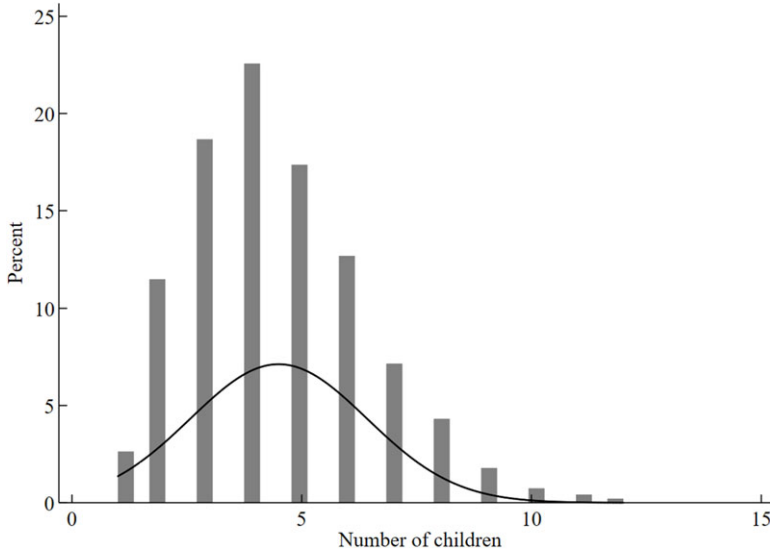


Figure 3. Distribution of the Number of Children in the Study Sample.

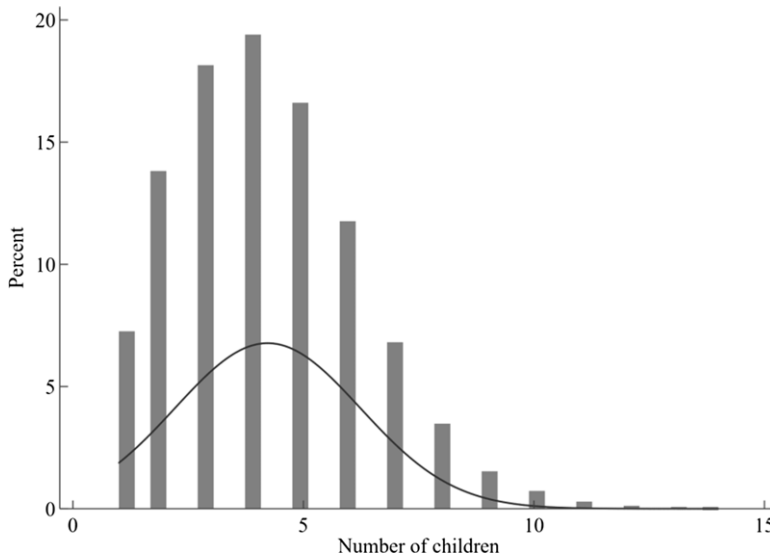


Figure 4. Distribution of the Number of Children in the Original Database.

Variable design

Dependent variable

In the study, the dependent variable was the level of depression. The impact of the number of children on depression in rural older women was mainly in the areas of emotional state, loneliness, and sleep quality. In the 2018 CLHLS, participants were asked the related questions that measured an individual’s depression level, including ‘are you worried about some small things?’, ‘are you feeling sad or depressed?’, ‘are you full of hope for future life?’, ‘do you feel lonely?’, and so on. These questions made up the Center for Epidemiological Studies Depression scale that contained ten items (CES-D10). The CES-D scale, developed by Radloff (1977), contained 20 items and was widely used to measure depressive symptoms in individuals. Here, the brief form containing three

negative items and seven positive items used in this study had the same reliability and validity for the measurement of depressive symptoms in the Chinese population (Zhang & Li, 2011; Ren *et al.*, 2014; Feng *et al.*, 2016).

Referring to existing literature (Lei *et al.*, 2014; Zhang *et al.*, 2015; Zhou *et al.*, 2018), each response under the negative item was assigned an integer between 1 and 5, and the response under the positive item was reverse-assigned a value. Finally, the scores were summed to obtain the individual's depression score, with a range of 10–48. Higher scores represented more severe depression and poorer physiological health of the participants.

Independent variable

The independent variable was the number of children and did not include adopted children, using the question 'how many children have you had in your lifetime (including those who have died)?'. It was important to clarify that the number of children in this study referred to the number of pregnancies that occurred early in the sample of older women and that have been delivered normally that is equivalent to going through the full course of pregnancy. Data from this study showed 86% of respondents who answered that they have six children or less, which was in line with the reality of the situation. Also, number of sons and daughters were added to the analysis to further explore the association between sex of children and depression level.

Mediating variable

In exploring the transmission channels through which the number of children affected with depression level, this study specifically selected three different channels for in-depth exploration: health effect, social effect, and feedback effect.

The first was the health channel, choosing self-reported health to test. Self-reported health was one of the commonly used indicators to measure the health status of the population. It was a comprehensive evaluation of people's subjective feelings and objective health information about their physical, psychological, and social adaptation, which could reflect their health status in an intuitive and comprehensive way (Zhang & Fu, 2022). In the questionnaire, the responses to the question 'how do you feel about your own health now?' were assigned a value between 1 and 5, with higher value indicating poorer self-rated health of participants. The second was the social channel, choosing social activities to test. Participants were asked to answer the question 'do you currently do or participate in the following activities?', including 'series, interact with friends' 'play cards/mah-jongg', and 'watch TV or listen to radio'. If the response was to participate, it was assigned a value of 1, otherwise it was assigned a value of 0. Social activity status was obtained by summing all responses and had a value range of 0–3. Higher value indicated a greater variety of activities participated in. The third was the feedback channel, choosing upward inter-generational support to test, mainly referring to financial support. Participants were asked 'how much did you receive from your son(s) or daughter(s)-in-law last year?' and 'how much did you receive from your daughter(s) or son(s)-in-law last year?'. Responses were logarithmically processed to measure the support provided by the children.

Control variables

Referring to the studies of other scholars (Galbarczyk *et al.*, 2019; Grundy *et al.*, 2019; Wang *et al.*, 2019; Yang *et al.*, 2021), birth cohort, education, reading, married, drinking, living alone, living standard, number of trips, exercise, and pension insurance were selected as control variables from multiple perspectives, including individual characteristics, lifestyle, and family status. The specific definitions and assignments of variables are shown in Appendix Table A1.

Model Setting

Based on the specifics of this study, we set up the following models. Here, models were estimated and analysed in this study using Stata 15.0 software.

Ordinary least square

In this study, the depression score was treated as a continuous variable (Lei et al., 2014; Zhou et al., 2018). Therefore, the ordinary least square (OLS) was used to estimate the association between number of children and depression. The specific model was set up as follows:

$$\text{Depression}_{it} = \alpha_0 + \alpha_1 \text{Num}_{it} + \alpha_2 X_{it} + \varepsilon_{it}, \quad (1)$$

where Depression_{it} denoted the participant's depression score; Num_{it} denoted number of children born to the participant, including the total number of children, number of sons, and number of daughters; α_1 was the core coefficient to be estimated in the study; X_{it} were other control variables; α_2 indicated the coefficients of a set of control variables, respectively; α_0 denoted the constant term; and ε_{it} denoted the random error term.

Mediating mechanism

The possible mediating effects in Equation (1) were tested by referring to the practises of other scholars (Judd & Kenny, 1981; Baron & Kenny, 1986; Wen et al., 2004; Lv & Liu, 2020). First, all selected mediating variables were put into the same model to make a preliminary judgement on their transmission effects. Then, number of children was regressed on each of the mediating variables separately. Finally, the relative contribution of each channel was obtained. Based on this, the following models were established.

$$M_i = \beta_0 + \beta_1 \text{Num}_{it} + \theta_{it} + \omega_{it}, \quad (2)$$

$$\text{Depression}_{it} = \gamma_0 + \gamma_1 \text{Num}_{it} + \gamma_2 M_i + \gamma_3 X_{it} + \delta_{it}, \quad (3)$$

where M_i denoted the mediating variables, including self-reported health, social activity, and upward inter-generational support; β_1 was the coefficient of the effect of number of children on mediating variables; β_0 and γ_0 were the constant terms of Equations (2) and (3), respectively; θ_{it} denoted the control variables; γ_1 denoted the coefficient of effect of number of children on depression after the inclusion of mediating variables, indicating the direct effect after accounting for mediating effects; and γ_2 denoted the coefficient of the effect of mediating variables on depression after the including of number of children. γ_3 also indicated the coefficients of a set of control variables, respectively. Both Equations (2) and (3) were estimated using OLS model. In the decomposition of the mediating effect, Equation (2) was substituted into Equation (3) to obtain Equation (4).

$$\text{Depression}_{it} = \gamma_0 + \gamma_2 \beta_0 + (\gamma_1 + \gamma_2 \beta_1) \text{Num}_{it} + \gamma_2 \theta_{it} + \gamma_3 X_{it} + \varepsilon'_{it}, \quad (4)$$

where γ_1 denoted the direct effect of number of children on depression and $\gamma_2 \beta_1$ denoted the indirect effect of number of children on depression through mediating variables. It can be seen that the relative contribution of each transmission channel was as follows:

$$\sigma_1 = \frac{\gamma_1}{\gamma_1 + \gamma_2 \beta_1}, \quad (5)$$

$$\sigma_2 = \frac{\gamma_2 \beta_1}{\gamma_1 + \gamma_2 \beta_1}. \quad (6)$$

Results

Basic descriptive analysis

Table 1 presents the descriptive results of the variables for the female sample. In this study, there were 1901 rural women and 1858 urban women, accounting for approximately half each. Depression scores ranged from 10 to 46 among rural women and 10 to 48 among urban women. The mean value of the former was 22.83 and the latter was 22.93, indicating that the average depression level would be a little higher in the urban female group. For number of children, the mean value was 4 for both rural and urban women, with the maximum value of 12 for rural female sample and 13 for urban female sample, which was consistent with the family structure in our national context. Specifically, the sample of women with three to four children had the highest percentage in both rural (41%) and urban areas (38%), followed by five to six children (30% and 32%, respectively). The mean value for both number of sons and daughters was about 2.

According to the birth cohorts, it could be found that 1921–1930, 1931–1940, and 1941–1950 birth cohorts had higher percentages of samples. The mean age of the rural and urban female samples was 85 and 86 years, respectively. 70% of rural women and 62% of urban women were in a state of illiteracy, meaning they had no education, and the vast majority said they did not usually read. About one-third of the samples was married with a spouse status. Most samples considered their standard of living to be average compared to other local people. Less than one-third of samples exercised regularly. The vast majority do not have pension insurance.

Baseline regression results

Regression analyses were conducted based on a sample of rural older women who had children, and the results are shown in Table 2.

The results of Model 1 showed a coefficient of 0.272 ($p < 0.01$) for a number of children before the inclusion of control variables, indicating that an increase in the number of children led to higher depression scores. Adding the control variables to the model to obtain Model 2, it was found that the regression coefficient for number of children decreased to 0.177 ($p < 0.05$) and still passed the significance test, indicating that an increase in the number of children does lead to poorer health and increased levels of depression. Specifically, each additional child was associated with an increase in depression score of 0.177 units. Further, in Model 3, the number of children was treated as four groups. When the one to two children groups were used as the reference group, the regression coefficients for three to four, five to six, and seven or more children were all positive, and the coefficient was especially larger and more significant for the seven and more children group, suggesting that older women with more children would show higher depression level.

Models 4 and 5 showed the association between number of sons or daughters and depression level. In addition, to try to avoid bias in the effect of sex of child on the regression results, when exploring the association between number of sons on depression level, the number of daughters was simultaneously controlled, and vice versa. Model 4 demonstrated that an increase in the number of sons or daughters was significantly associated with increased levels of depression in rural older women. After adding the control variables, Model 5 indicated that the regression coefficient for the number of sons was 0.135, although insignificant, while the coefficient for the number of daughters was 0.208 ($p < 0.05$) and passed the significance test. It could be found that an increase in the number of sons or daughters could be detrimental to the mental health of rural older women and aggravate their depression levels. By comparing the absolute value and significance of the coefficients, it was clear that the positive association between number of daughters and depression levels was stronger. In other words, an increase in number of daughters may lead to a higher level of depression.

Table 2. Estimates of the Effect of Number of Children on Depression in Rural Older Women

Variable	Model 1	Model 2	Model 3	Model 4	Model 5
	Depression	Depression	Depression	Depression	Depression
Number of children	0.272*** (0.072)	0.177** (0.074)			
Ref:1-2					
3-4			0.598 (0.415)		
5-6			0.526 (0.445)		
7+			1.179** (0.524)		
Number of sons				0.246** (0.104)	0.135 (0.105)
Number of daughters				0.293*** (0.094)	0.208** (0.093)
Birth cohort		-0.132 (0.145)	-0.147 (0.146)		-0.137 (0.146)
Education		0.058 (0.231)	0.040 (0.232)		0.054 (0.232)
Reading		0.306 (0.209)	0.301 (0.209)		0.304 (0.209)
Married		-0.406 (0.364)	-0.424 (0.365)		-0.400 (0.365)
Drinking		-1.710*** (0.580)	-1.699*** (0.580)		-1.714*** (0.580)
Living alone		0.832** (0.354)	0.814** (0.355)		0.853** (0.356)
Living standard		-2.313*** (0.227)	-2.314*** (0.227)		-2.309*** (0.227)
Number of trips		-1.925*** (0.594)	-1.887*** (0.595)		-1.922*** (0.594)
Exercise		-1.224*** (0.321)	-1.228*** (0.321)		-1.229*** (0.321)
Pension insurance		-0.492* (0.285)	-0.498* (0.286)		-0.484* (0.286)

(Continued)

Table 2. (Continued)

Variable	Model 1	Model 2	Model 3	Model 4	Model 5
	Depression	Depression	Depression	Depression	Depression
Constant term	21.602*** (0.354)	16.042*** (1.495)	16.346*** (1.492)	21.618*** (0.357)	16.107*** (1.500)
<i>N</i>	1901	1901	1901	1901	1901
<i>R</i> ²	0.007	0.097	0.097	0.007	0.097

Note: Older rural women with at least one child were used as study population; the ordinary least square (OLS) is used to estimate above models; *, **, or *** indicated a significance level at 10%, 5%, and 1%, respectively; standard errors are reported in parentheses.

The results in Table 2 showed that most control variables were significantly associated with depression level. For living arrangement, there was a stronger association between living alone and depression level in older women. Family support theory suggested that older adults who lived with their children received more support in all areas, which enhanced physical and mental health. One study using Chinese older adults found that living alone worsened their mental health and significantly increased their depression levels (Jiang & Sun, 2022). Similar findings have been found in foreign studies, for example, a study of older adults in Singapore showed that older adults who lived alone and had poor social networks had higher depression levels than those who lived with their children (Chan et al., 2011). Older women with the lower standard of living may feel higher depression level compared to other locals. Self-assessment of the standard of living was often done with reference to their income level and household economic status, among others. In a study by O'Neil et al. (2005), 40% of residents reported that their health was affected to some extent by economic problems and that they had mental health problems such as depression and anxiety. It was found that high-income earners had more positive emotions, while low-income earners had more negative emotions (Bradburn, 1969). Further, the effect of income was relative. Easterlin (1974) found that subjective perceptions of economic level played a greater role than income itself. In addition, compared to those not having pension insurance, the association between having pension insurance and lower level of depression in older women was stronger. In 2012, China's social pension insurance achieved full system coverage. Taking China's New Rural Social Pension Insurance policy as an example, many existing studies have found that the pension income under this policy has reduced poverty and increased subjective well-being to some extent and that older people in poorer health were more affected by the policy (Pei & Pillai, 1999; Zhang & Chen, 2014; Zurlo et al., 2014). It was found that this pension insurance significantly increased the financial independence of older rural people. Similarly, Galiani et al. (2016) found that the Mexican pension system improved the mental health of older adults and reduced depression values.

Mediating effect analysis

Combined with the above analysis, after referring to other studies (Wen et al., 2004; Lv & Liu, 2020), this study sought to explore the mediating transmission mechanisms between number of children and depression level in rural older women, as shown in Tables 3–5 of the specific results.

In Table 3, Model 6 reported the results of estimating the effect of the number of children on depression level when the control variables were added to the model but mediating variables were not included. Model 7 was obtained by adding mediating variables, and it was found that the regression coefficient of the number of children decreased from 0.175 to 0.073, although the latter was not significant. From this, it could be found that indirect channels through self-reported health status, social activity status, and inter-generational support of children could explain to a greater extent the effect of the number of children on depression. Specifically, self-reported health,

Table 3. Estimation Results of Mediating Effect

Variable	Model 6	Model 7
	Depression	Depression
Number of children	0.175*** (0.074)	0.073 (0.068)
Mediating variable		
Self-rated health		-2.802*** (0.142)
Social activity		-0.516*** (0.157)
Upward inter-generational support		-0.120*** (0.043)
Control variables	Yes	Yes
<i>N</i>	1901	1901
<i>R</i> ²	0.098	0.262

Note: Older rural women with at least one child were used as study population; birth cohort, education, reading, married, drinking, living alone, living standard, number of trips, exercise, and pension insurance are under control; *, **, or *** indicated a significance level at 10%, 5%, and 1%, respectively; standard errors are reported in parentheses.

Table 4. Regression Estimates of number of Children on the Mediating Variables

Variable	Model 8	Model 9	Model 10
	Self-rated health	Social activity	Upward inter-generational support
Number of children	-0.043*** (0.011)	-0.012 (0.010)	0.198*** (0.036)
Control variables	Yes	Yes	Yes
<i>N</i>	1901	1901	1901
<i>R</i> ²	0.081	0.241	0.041

Note: Older rural women with at least one child were used as study population; birth cohort, education, reading, married, drinking, living alone, living standard, number of trips, exercise, and pension insurance are under control; *, **, or *** indicated a significance level at 10%, 5%, and 1%, respectively; standard errors are reported in parentheses.

social activity, and upward inter-generational support were all significantly associated with depression levels in older women ($p < 0.01$). Poorer self-reported health, fewer social activities, and less inter-generational support from children were significantly associated with higher depression scores, that was, they showed higher depression levels.

Table 4 reports the estimation results of the effect of the number of children on mediating variables. Model 8 demonstrated the regression coefficient of -0.043 ($p < 0.01$) for a number of children, indicating a significant negative association between number of children and self-reported health. In Model 9, the coefficient of the number of children was 0.012 , indicating a negative but insignificant association between number of children and social activities. The results of Model 10 showed a coefficient of 0.198 ($p < 0.01$) for a number of children, indicating that the number of children showed a significant positive association with inter-generational support.

Table 5. Results of Effect Decomposition

	Rural older woman	Relative contribution /%
Direct effect	0.073	42%
Indirect effect		
Self-rated health	0.120*** (3.853)	68%
Social activity	0.006 (1.166)	3%
Upward inter-generational support	-0.024*** (-2.511)	-13%

Note: Older rural women with at least one child were used as study population; *, **, or *** indicated a significance level at 10%, 5%, and 1%, respectively; the Z-sobel statistic is reported in parentheses.

To ensure the reliability of mediating effect test results, this study used the Bootstrap sampling method to test the mediating effect, which was a coefficient product test, and the specific Z-statistics were reported in parentheses in Table 5. In addition, Table 5 reported the results of specific effect decomposition.

The results showed that the $|Z|$ for both self-reported health and upward inter-generational support were greater than 1.65, indicating that the number of children had a significant effect on their depression levels through these two channels among the study population. However, the $|Z|$ for social activity was less than 1.65, indicating that the mediating effect of this variable was not significant in this study. Considering that the social activities in this study only included three categories: hanging out with friends, playing cards and mahjong, and watching TV and listening to the radio, it did not define this variable more comprehensively, which in turn may have influenced the test results. Not surprisingly, 58% of the effects of the number of children on depression were generated through mediating variables, with the rest showing a direct effect. Specifically, poorer self-reported health and fewer social activities exacerbated the depression level, with relative contributions of 68% and 3%, respectively. More financial support from children reduced the level of depression with a relative contribution of -13%.

Further analysis

Through a review of relevant literature, the association between number of children and depression level in older women may show differences in urban and rural samples (Dew & Wilcox, 2011; Wang *et al.*, 2019; Yang *et al.*, 2021). Therefore, the study population was replaced with urban older women with children for further analysis in an attempt to explore the urban-rural differences. Also, to ensure the completeness and reliability of the regression results, a simple comparative analysis was conducted by analysing the full women sample and urban women sample. The specific results are shown in Tables 6 and 7, respectively.

The regression results for the full sample of females are shown in Table 6. It was not difficult to find that the regression results for the full sample and rural female sample remained consistent. In other words, there was a significant association between an increase in the number of children and an increase in depression score, i.e., more children increased the depression level in older women. According to Model 13, when one to two children groups were used as the reference group, it was found that women with three to four, five to six, or seven or more children had higher depression scores. By comparing the magnitude of the coefficient values, the higher the number of children (especially seven and above), the higher level of depression in older women. For the sex of children, an increase in number of either sons or daughters was significantly associated with higher levels of depression. The coefficient size and significance results suggested a greater exacerbating effect of number of daughters on depression in older women.

Table 6. Estimates of the Effect of Number of Children on Depression in Total Older Women

Variable	Model 11	Model 12	Model 13	Model 14	Model 15
	Depression	Depression	Depression	Depression	Depression
Number of children	0.196*** (0.051)	0.104** (0.053)			
Ref:1-2					
3-4			0.626** (0.287)		
5-6			0.677** (0.308)		
7+			0.847** (0.369)		
Number of sons				0.164** (0.075)	0.061 (0.075)
Number of daughters				0.222*** (0.067)	0.138** (0.066)
Control variables		Yes	Yes		Yes
<i>N</i>	3759	3759	3759	3759	3759
<i>R</i> ²	0.004	0.096	0.096	0.004	0.096

Note: Total older women with at least one child were used as study population; the OLS is used to estimate above models; birth cohort, education, reading, married, drinking, living alone, living standard, number of trips, exercise, and pension insurance are under control; *, **, or *** indicated a significance level at 10%, 5%, and 1%, respectively; standard errors are reported in parentheses.

Table 7 presents the regression results in the urban women sample with children as the study population. In Model 17, the regression coefficient of the number of children was positive, indicating that there was an association between more children and an increase in depression level among older urban women, which was consistent with the results for the rural women sample. There were two differences worth noting. One of them was shown in Model 18. It was found that when the one to two children groups were used as a reference, the coefficients for all other child subgroups were positive, but older urban women with five to six children may show higher depression level, followed by the group with three to four children. Another point was expressed in terms of sex of children. Model 19 showed an association between an increased number of either sons or daughters and increased depression in urban older women, which was consistent with the results for the rural women sample. When control variables were added, Model 20 showed that the coefficient on number of sons became negative, but its absolute value was smaller. This suggested that the effect of increasing number of sons on depression in older urban women was different across settings. Context-specific analysis was required.

Discussion

More children significantly associated with depression in older rural women

In rural China, for older women with children, an increase in the number of children significantly exacerbated their depression levels. In the group of women with children, compared with one to two children, having more children was often associated with more severe depressive conditions. It was consistent with most existing research results.

Table 7. Estimates of the Effect of Number of Children on Depression in Urban Older Women

Variable	Model 16	Model 17	Model 18	Model 19	Model 20
	Depression	Depression	Depression	Depression	Depression
Number of children	0.122*	0.041			
	(0.073)	(0.075)			
Ref:1–2					
3–4			0.714*		
			(0.398)		
5–6			0.871**		
			(0.428)		
7+			0.553		
			(0.522)		
Number of sons				0.084	–0.008
				(0.107)	(0.107)
Number of daughters				0.152	0.079
				(0.096)	(0.095)
Control variables		Yes	Yes		Yes
<i>N</i>	1858	1858	1858	1858	1858
<i>R</i> ²	0.002	0.102	0.104	0.002	0.102

Note: Older urban women with at least one child were used as study population; the OLS is used to estimate above models; birth cohort, education, reading, married, drinking, living alone, living standard, number of trips, exercise, and pension insurance are under control; *, **, or *** indicated a significance level at 10%, 5%, and 1%, respectively; standard errors are reported in parentheses.

On the one hand, this was due to the existence of the trade-off between reproduction and health. Specifically, women had limited resources in their bodies, and when allocating energy resources to reproduction, this inevitably reduced the supply of energy for their other metabolic functions (Peacock, 1991; Prentice et al., 1995; Jasienska, 2009). The Disposable Somatic Theory suggests that reproduction competes with resources to sustain organismal growth and that high parity can cause health problems (Kirkwood, 1977). Most studies have found that as the number of children increased, women may be at increased risk of cancer and chronic diseases, including stomach, brain, and cervical cancers, as well as heart disease and diabetes (Parikh et al., 2010; Peters et al., 2016; Bai et al., 2017; Peters et al., 2017). The presence of depressive symptoms was associated with certain physical health disadvantages, and the cumulative health disadvantages associated with high parity can lead to a high incidence of depression in later life.

On the other hand, the different family divisions of labour tended to make Chinese women take on more family caregiving responsibilities, leading to a lack of social support, which hindered career development and reduced personal leisure and consumption. Mirowsky (1988) noted that women who had difficulties in caring for their children had higher levels of depression. However, older people could also receive more financial support, spiritual comfort, and daily care from more children in their later years, which increased their subjective well-being and thus benefited their mental health (Mu & Xie 2014; Zhang et al., 2018). Thus, from a social point of view, the impact of the number of children on mothers' mental health in later life is multi-directional and varies across regions and groups.

In the context of Chinese society, especially in rural areas, grandchild care and traditional cultural practises (supporting parents, respecting older people, and so on) were important

factors that had to be taken into account. Specifically, grandchild care could increase the physical burden on older people, increase the risk of chronic disease, and take up time and energy. Grandchild care can also be directly detrimental to the mental health of them, increasing levels of depression. At the same time, grandchildren care could alleviate the loneliness and dreariness of old age and add to the enjoyment of life. In order to raise more children, parents were under greater life and financial pressure and expended more energy. At the same time, adult children often fulfil their obligation to support their parents by providing them with financial support and daily care.

It needed to be made clear that reproductive behaviours such as the number of children were only one of the influences on mothers' mental health in later life. In addition to the above, healthy habits, adequate security in old age, and a rich life in old age all have an impact.

Differences in the association between sex of children and depression in older rural women

An increase in the number of daughters significantly exacerbated depression among older rural women, while the worsening effect of an increase in the number of sons on depression was much smaller and the result was not significant.

When discussing the sex of children and health in old age in the context of Chinese rural society, among all the influencing factors, traditional cultural customs cannot be ignored.

In terms of having daughters, the positive cultural effects were mainly manifested in the excellent traditional culture of respecting older people, and children have the obligation to support their parents. In other words, older people would receive financial support, spiritual comfort, and daily care services from their children, which were beneficial to their physical and mental health. Negative cultural effects were more often seen in the traditional concept of reproduction that favours sons over daughters, especially in rural areas of China. Under the influence of this fertility culture, a family would choose to continue to have children until they had a son, which meant more daughters. A family was keen to have more sons than daughters. More daughters meant that the mother may be under more pressure to bear children, which in turn was detrimental to her physical and mental health. With the combination of these different effects, in the sample of rural elderly women in this study, the negative cultural effect of daughters outweighed the positive effect, indicating that the more daughters there are, the more depression in later life will worsen. Thus, to some extent, the positive feedback effects of daughters were much smaller than the negative effects such as impaired physical health and reduced social support.

In terms of having sons, in addition to the positive cultural effects mentioned above, under the influence of traditional concept of having more children and more blessings and preferring sons to daughters in rural China, having sons directly increased older people's sense of well-being. In addition, family care remained the choice of the vast majority of older people. In the social context of the time, daughters left their families through marriage when they reached adulthood, and sons were often the main source of financial support and spiritual comfort for parents in their later years (Yang, 2019). As a result, under the concept of raising sons for old age, sons usually took on the responsibility of caring for them, and parents preferred to have more sons to ensure their old age (Ebenstein & Leung, 2010). The negative effect was mainly manifested in the fact that Chinese parents often took on the task of family and career for their children, especially sons. Life and financial pressure continued into old age. They still worked hard for their children in the old age and even continued to work, resulting in significant physical and mental stress. Based on this, the positive feedback effects of sons were somewhat offset by negative effects such as impaired physical health and reduced social support. In summary, compared to sons, daughters had a greater negative effect on the health of mothers.

Number of children was associated with depression in older rural women through both biological and socio-economic mechanisms

First, an increase in the number of children decreased self-rated health, which in turn increased depression levels. This was consistent with the Disposable Soma Theory, where high parity led to poor physiological health (Kirkwood, 1977), accumulating a poor health base for the onset of depression. As the reasons for poor self-rated health, there were bound to be other relevant factors in addition to the accumulation of physical health disadvantages that may have resulted from early reproductive events. Specifically, the increased stress of life associated with raising more children may continue into later life, and grandchildren care may affect their physical and mental health, and so on. This study did not explore the specific reasons in detail. Thus, in terms of the biological effect mechanism, the larger the number of children born, the greater the negative impact on the physical health of mothers, and thus on the mental health in later life.

Second, more children exacerbated depression by reducing the mother's social activities. This was because more children bring with them a greater burden of nurturing and caregiving, crowding out personal leisure time, and leading to reduced social participation. At the same time, long-term family roles would affect other social roles, thus limiting access to social support, which led to depression.

Finally, more children brought with it an increase in inter-generational support in later life, an effect that inhibited the onset of depression in older women. In rural China, older people often choose family care. They could receive more financial support, spiritual comfort, and daily care from a larger number of children, which reduced the stress of later life and thus contributed to physical and mental health.

Negative association between number of children and depression of older urban women

There was also a correlation, although not significant, between the increase in the number of children born and depression in older urban women.

This may be due to the dual urban–rural structure in China, which has led to an imbalance in development between urban and rural areas, as reflected in differences in the economic level, social development, public health service, and so on. In terms of physiological factors, most urban women were mandated to enrol in maternity insurance, which provided them with basic reproductive health care. This has, to a certain extent, improved the accessibility of health-care services, thereby ensuring the maintenance of better physiological health. In terms of social factors, regional development may bring high-economic income and available childcare services. The former can to some extent alleviate the pressure of raising children in daily life. The latter was conducive to weakening the crowding-out effect of taking care of children on the personal development of mothers, thereby having more time and energy for social participation and obtaining more social support. This will all be beneficial to their health in later years. In addition, economic development inevitably led to higher health consciousness as well. This was consistent with Maslow's Hierarchy of Needs theory. There was no doubt about the influence of scientific and correct health concept on individual health, such as exercising, eating a balanced diet, and seeking timely medical treatment. Therefore, under the combined influence of various factors, compared to rural older women, more children may exacerbate depression in urban older women, but this impact was smaller and not significant.

Conclusion

The traditional notion of 'more children and more blessings' has always been deeply rooted, and a large family with more children was often regarded as a symbol of happiness. In China's current rapidly developing society, the link between more children and health in later life deserves a serious answer.

Based on data from the 2018 CLHLS, older women with children were included in the study. It was found that there was a significant adverse effect of the number of children on depression in rural older women. This effect was also present in the urban mother samples, though not significant. There were differences in the association between the sex of children and maternal depression in later life. The worsening effect of an increased number of daughters on depression was stronger compared to sons. The direct effect of the number of children exacerbating depression levels accounted for approximately 42%. In terms of indirect effects, self-rated health and social activity explained about 68% and 3% of the exacerbating effects of depression, respectively, and upward inter-generational support explained approximately 13% of the reducing effect of depression.

In order to cope with aging, China has now begun to adjust its fertility policy. However, while relaxing fertility control, the potential impact of reproductive behaviour on women, as the direct bearers of fertility, deserves in-depth study. In this study, the test of relationship between the number of children born early in life and mothers' mental health in later life illustrated its importance.

On the one hand, it is recommended to accelerate the improvement of supporting policies related to fertility and develop a healthy and scientific fertility culture. Strengthen policy supply in public services, improve maternal and child health services in rural areas, and improve women's reproductive health. On the other hand, it is recommended that a sound family development support programme be gradually established. Women should be helped to balance their family and social roles and minimise role conflicts, and in particular, the pressure of caring for children should be shared appropriately. At the same time, targeted efforts have been made to increase old-age protection for older people.

There were many limitations to this study. First, there is insufficient control for confounding variables. In addition to the confounding factors such as individuals and families, low socio-economic status, health status before having children, fertility, and other social policies should be taken into account. Second, this study is not theoretically explanatory enough in terms of regional differences. Factors such as religious beliefs, social development, and traditional culture are all important reasons for the heterogeneity of its findings. Finally, there are few measures of reproductive behaviour and health in later life. This study only focuses on the number of children and child sex and does not take into account information such as age at childbearing and birth interval. At the same time, this study measures mental health only by depression, which may have also overlooked other important health information.

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Appendix

Table A1. Variable Definition and Assignment

Variable	Variable definition
Depression	Continuous variable (10–48), calculated from the 10 items The higher the value, the higher the level of depression
Number of children	‘Number of children ever born (including deceased)’ Continuous variable (1–13)
Number of sons	‘Number of male children ever born’ Continuous variable (0–9)
Number of daughters	‘Number of children – Number of sons’ Continuous variable (0–11)
Birth cohort	‘Validated birth year’ 1 = 1901–1910, 2 = 1911–1920, 3 = 1921–1930, 4 = 1931–1940, 5 = 1941–1950, 6 = 1951–1960
Education	‘Years of schooling’ 1 = 0 year; 2 = 1–6 years; 3 = 7–12 years; 4 = 13 years and over
Reading	‘Reading or not at present?’ 1 = always, 2 = often (at least once a week), 3 = occasionally (at least once a month), 4 = sometimes, 5 = never
Drinking	‘Drink or not at present?’ 0 = no, 1 = yes
Living alone	‘Who do you currently live with?’ 1 = living alone, 0 = not living alone
Living standard	‘How do you rate your economic status compared with other local people?’ 1 = very difficult, 2 = difficult, 3 = fair, 4 = well-off, 5 = very well-off
Married	‘Current marital status’ 0 = others, 1 = married
Number of trips	‘How many trips have you taken in the last two years?’ Continuous variable (logarithmic processing)
Exercise	‘Exercise or not at present (referring to purposeful fitness activities such as walking, ball games, running, etc.)?’ 0 = no, 1 = yes
Pension insurance	‘Are you covered by pension insurance?’ 0 = no, 1 = yes
Self-rated health	‘How do you feel about your own health now?’ 1 = very poor, 2 = poor, 3 = fair, 4 = good, 5 = excellent
Social activity	‘Are you currently engaged in/participating in any of the following activities?’ Continuous variable (0–3) The higher the value, the greater the variety of activities
Upward inter-generational support	‘How much did you receive from your son(s) or daughter(s)-in-law last year?’ ‘How much did you receive from your daughter(s) or son(s)-in-law last year?’ Continuous variable (logarithmic processing)

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