

# The Effect of Childhood Starvation on Mental Health of Older Adults: Evidence From China

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## Research Article

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# Abstract

**Purpose:** Poverty and hunger are still severe problems faced by the world today, especially in developing countries. Starvation in childhood usually damaged mental health in later years. But, does this proposition apply China? The answer could not only verify the validity of the current research findings, but also provide certain significance for the intervention and formulation of global public health policy.

**Method:** This research was based on the data of the Chinese Longitudinal Healthy Longevity Survey data in 2018, and 1820 elderly people were investigated. The impact of childhood starvation on mental health in later years was investigated by the Ordinary Least Squares method. Moreover, the robustness tests conducted by replacing independent variable to severity of childhood starvation and dividing the samples to different age ranges. Furthermore, heterogeneity was also analyzed based on different gender, different domicile where they born, and different level of education.

**Results:** The childhood starvation was associated with less mental health scores in later life. The older who suffered from childhood starvation showed worsen mental health in later years, especially in the illiterate samples and the rural samples. However, there was no significant difference when considering different gender.

**Conclusions:** Childhood starvation worsened the mental health in later life, and the level of education and being born in urban had a mediating effect to the relationship. In order to reduce the negative impact of childhood starvation on mental health, anti-poverty strategies, such as providing assistance to children who are hungry, and developing early intervention programs for children's development, should be promoted around the world. Meanwhile, the local development, industrialization and modernization, as well as children's educational attainment should also be promoted while preventing child hunger.

## 1 Introduction

Although agricultural technology made remarkable progress in the world, hunger was still a serious issue faced by all human-beings. In 2020, there were as many as 720 million to 811 million people worldwide facing hunger, accounting for about 10% of the global population, and most of them were in the developing and undeveloped countries of Asia, Africa, Latin America (United Nations, 2021). To achieve the goal as stated by the United Nations by 2030 could be a huge challenge. Malnutrition or health shock in early years may bring continuous adverse effects on adult health, till the end of the life (Yao, 1999). In this paper, we investigated the long-term effects of childhood starvation on the mental health in their later life.

In recent years, the impact of life course on health attracted extensive attention from scholars in China and abroad. The relationship between the early experience of hunger and mental health in later years became a topic concerning with the emergence of poverty and hunger. Most studies found that early life experience was the basis for the development of people's whole life cycle. The seeds of many diseases in adulthood may have been planted decades ago (Warren, 2016). Malnutrition or health shock in early

years would bring continuous adverse effects on adult health (Neelsen and Stratmann, 2011), for example, the metalogenesis hypothesis proposed by Barker (1998) suggested a causal relationship between health in utero and later life. Walker et al. (2007) and Victoria et al. (2008), reviewing medical evidence from developing countries in Asia, Africa and South America, suggested that, similar to malnourished fetuses, malnutrition in the first 24 months of life in children was associated with increased blood glucose concentrations, elevated blood pressure, cognitive deficits and increased odds of psychosis. Guo and Zhao (2019) believed that famine increased the risk of cognitive impairment, depression and other mental disorders in old age. Shi et al. (2012) studied the long-term cumulative disadvantage on health. Both the number of early unfortunate experiences and the duration of the events formed a long-term accumulation, especially, the duration of early starvation experience had a significant negative relationship with adult health. Moreover, women's health was more vulnerable to famine (Huang and Phillips, 2013), and it was also possible that men's death choice to cope with health shock was more serious than women's, which led to the long-term health damage caused by famine not likely to be fully observed in men. Shi et al. (2012) also found that the health effects of the duration of early starvation tended to long in the 50-59 age group, followed by a declining trend in the 60-69 age group, with the inflection point occurring around age 60. In addition, the health risks associated with unfortunate experiences still existed and increasing levels of education and socio-economic status generally could not decrease the health risks that accumulated when experiencing starvation in childhood.

However, the conclusions were not consistent. He et al. (2020) conducted a cross-sectional study using a sample of community-dwelling adults aged 55 and above in Ningxia Province, Western China, and found that fetal famine was associated with a higher risk of depression in later life, compared with famine in adulthood. Moreover, Dermot (2012) used the Irish Famine data and found no evidence supported that hunger was associated with an increase in the incidence rate of mental disorders such as schizophrenia and depression. Based on the research of Shi (2011), Du and Huang (2020) subdivided the health status into depression tendency of older adults, focusing on the short-term accumulation effect of unfortunate experiences. Finally, they found that the impact of recent misfortune was more significant, which indicated the time accumulation effect was not obvious. The effect of early starvation on mental health in old age may not be as obvious as that of famine in old age. The reason for this may lie in different sample selection. Du and Huang (2020) only compared the impact of negative life events that older adults went through three years ago and one year ago, rather than tracking whether the sample suffered from famine in childhood. They did not consider the impact of starvation on depressive symptoms of older adults from the perspective of long-term life cycle.

In terms of the mechanisms between early hunger on mental health of older adults, there were two main explanations. One was the physiological effect, which focused on the generation of congenital mental diseases. The "fetal origin hypothesis" held that when intrauterine malnutrition occurs, nutrition would be supplied to the head first, while the heart, blood vessels and other organs or tissues would be stunted, thus affecting the health status of adults for a long time. Neurodevelopmental disorders may be "programmed" by early life stress exposure, which used epigenetic modification to alter the brain development (Tracy et al., 2010). Biological evidence showed that congenital nervous system

abnormalities were mainly related to neural tube defects (Lumey and Stein, 2011). More specifically, suffering from famine may lead to micronutrient and macronutrient deficiencies, increasing the risk of mental disorders. Protein malnutrition affected the development of hippocampus and other structures in the brain, as well as damaged the function of dopamine, serotonin and other neurotransmitters (Brown et al., 2000), laying a hidden danger for the child's future mental health. These biological conclusions provided the idea of the influence mechanism of "early experience of starvation led to nutritional deficiency and physiological function damage, thus inducing mental disease of older adults".

The second was the social effect, which focused on the influence of the later experience, suggesting that social support, experience accumulation and other factors were also related to depression in older adults. The social origins hypothesis suggested that early life misadventures had a persistent negative impact on health and the negative impact was not counteracted by any change in socio-economic status after childhood. Early life experiences and conditions actually reflected the characteristics of the family background, reflecting the low socio-economic status and lifestyle of the parents. Moreover, the theory of cumulative advantage, first proposed by Merton, provided the insights that the important events experienced by individuals in the course of life may have cumulative impact on the health of older adults (Cheng et al., 2020). The early famine experience led to the accumulation of disadvantages in such as education, employment opportunities and economic status, which eventually led to mental illness. Similarly, the stress process model suggested the occurrence of life events (such as famine) led to the change of chronic life stress (such as the decline of health level), and then caused the change of self-concept including sense of control and self-esteem, finally leading to the symptoms of depression (Merton, 1968).

In summary, many scholars have discussed the cumulative impact that early experiences of misfortune can have on their physical health in adulthood (Shi & Wu, 2018; Cheng & Phillips, 2013). However, less attention has been paid to the relationship between childhood starvation and mental health in later life, particularly in studies with Chinese samples. To fill these research gaps, this study was about to investigate the impact of individuals' childhood experiences of starvation on their mental health in later life, and to specifically analyse whether this impact differs across different types of older adult groups, in order to verify whether the impact relationship proposed by foreign scholars is appropriate for the actual situation in China.

On the basis of the foregoing, we put forward the two competing hypotheses as follows:

Hypothesis 1a: childhood starvation has no impact on the mental health in later life.

Hypothesis 1b: childhood starvation has a negative impact on mental health in later life.

Some studies have found that the impact of childhood starvation on the mental health in later life was different in terms of individual characteristics (24, 25). Therefore, the following hypothesis can be proposed:

Hypothesis 2: The impact of childhood starvation on the mental health in later life is heterogeneous in different groups.

## 2 Method

### 2.1 Data

The data of this study came from the Chinese Longitudinal Health Longevity Survey (CLHLS) in 2018, which was the earliest and longest social science survey in China (1998-2018). It was a follow-up survey of older adults initiated by the Research Center for healthy aging and development of Peking University and the National Development Research Institute, covering 23 provinces and autonomous regions in China. older adults aged 65 and above and adult aged 35-64 was the survey objects. The questionnaire was divided into two types: the questionnaire for the surviving interviewees and the questionnaire for the family members of the dead elderly. The contents of the first kind of questionnaire included the basic information of older adults and their families, sources of income and economic status, self-evaluation of health and quality of life, personality and psychological characteristics, disease treatment and lifestyle, etc. The second kind of questionnaire included the time of death, the cause of death and so on. The baseline survey was conducted in 1998, and eight follow-up surveys have been conducted before 2018. The latest follow-up survey (2017-2018) interviewed 15,874 elderly people aged 65 and above, and collected information of 2,226 elderly people who died during 2014-2018. Combined with the research content of this paper, older adults aged 65 and above were selected as the research objects. After excluding the variables and missing values that were not related to this study, the final sample number was 1,820.

### 2.2 Variables

#### 2.2.1 Dependent variable

The dependent variable was mental health, and was measured by the depressive symptoms scale in the 2018 CLHLS. According to the depressive symptoms scale in the 2018 CLHLS, there were nine questions about the mental status of last week, namely, Question b31 "Are you worried about some small things?", Question b32 "Is it difficult to concentrate when you are doing things now?", Question b33 "Are you feeling sad or depressed?", Question b34 "Do you think that the older you are, the less useful you are, and the hard work", Question b35 "Are you full of hope for future life? Are you full of hope for the future", Question b36 "Are you nervous and scared?", Question b37 "Do you feel as happy as you are when you are young?", Question b38 "Do you feel lonely?", Question b39 "Do you feel unable to continue your life?". The Cronbach's coefficient of the depressive symptoms scale is 0.936 indicating high degree of reliability. The five options of the nine questions are always, often, sometimes, rarely, never. They were assigned to 1, 2, 3, 4 and 5, respectively. Among them, the two questions reflected positive emotions, the two questions were processed in reverse order, resulting in a depression score of 9-45. The higher the score is, the less the depressive symptoms and the better the mental health is.

Figure A showed the distribution of mental health score. As shown by the overall distribution of mental health scores, the kernel density curve of the mental health scores of the older adults in China was a normal distribution, which indicated that the mental health of most people was near the mean value, and the difference of the mental health of the older people was small.

## **2.2.2 Independent variables**

The main independent variable of the study was childhood starvation, which was obtained from the question F6-6 "Did you often go to bed hungry as a child?" The ones who answered yes was assigned to "1", and those answered no were assigned to "0".

## **2.2.3 Covariates**

According to the researches of Shi and Wu (2018) and He et al. (2020), we selected the individual characteristics, socio-economic characteristics of the respondents, and community service level variables as covariates. The variables for individual characteristics included gender, ethnic, domicile (born in urban areas=1, born in rural areas=0), years of education, marital status, activities of daily living (ADL), sleep quality and self-rated physical discomfort in the past two weeks (Wellness). The variables for socio-economic characteristics included the economic status of the respondent's family, financial support from the children.

The definitions of these variables and descriptive statistics of the sample were shown in Table 1.

Table 1  
Variable definition and descriptive statistics

<b>Variables</b>	<b>Definition of variables</b>	<b>Observations</b>	<b>Mean or %</b>	<b>Std. Dev.</b>
<i>Dependent variable</i>				
<i>Mental health</i>	Mental health score obtained from the nine negative emotional questions: in the 2018 CLHLS questionnaire, ranged from 9 to 45. The higher the score, the better the mental health.	3092	32.893	6.869
<i>Independent variables</i>				
<i>Childhood starvation</i>	Often went to bed hungry in childhood, measured by the question "Did you often go to bed hungry in childhood", yes = 1, no = 0	6257	74.4%	-
<i>Covariates</i>				
<i>Personal characteristics</i>				
<i>Gender</i>	Male = 1, Female = 0	7192	46.1%	-
<i>Ethnic</i>	Minority = 1, Han = 0	7192	9.2%	-
<i>Domicile</i>	Birth in urban places = 1, Birth in rural places = 0	6656	10.5%	-
<i>Education years</i>	Years of education, unit: year	7122	2.407	3.482
<i>Marital status</i>	Married without widows and not divorced = 1, Unmarried, divorced and widowed = 0	6986	40.2%	-
<i>ADL</i>	Activities of daily living, refers to tasks the individual finds relevant to perform to cover basic needs such as eating, staying clean and being appropriately dressed as well as more complex tasks relevant for independent living such as transportation, cooking, shopping, cleaning and washing. It is measured by the six questions in the questionnaire <sup>1</sup> , three options for each question, no need for help = 0 point, need a little = 0.5 point, complete need = 1 point. Add up the scores of the six questions, the lowest is 0, the highest is 6. The higher the score, the more disabled	7062	0.557	1.289
<i>Sleep</i>	Daily sleep time, unit: hour	3179	7.274	2.267
<i>Wellness</i>	Fell not well within the past two weeks, yes=1, no=0	6063	17.3%	-

Variables	Definition of variables	Observations	Mean or %	Std. Dev.
<i>Economic situation</i>				
<i>Income</i>	The total income of your family last year, unit:10 thousand yuan	2763	2.936	2.783
<i>Family support</i>				
<i>Financial support</i>	How much cash (including physical conversion) did your children give you in the past year, unit: 10 thousand yuan	6299	0.146	0.312
<i>Community service level variables</i>				
<i>Community service</i>	There are nine community services for older adults in your community, and then there are nine questions, there is one service = 1 point, there is no service = 0 point. After summing up the scores of the nine problems, the lowest group will get zero point and the highest value will get nine points. The higher the score, the higher the level of community service.	7000	1.575	1.897

<sup>1</sup>The six questions measuring ADL are: "Do you need help when bathing", "Do you need help getting dressed?", "Do you need help to go to the toilet", "Do you need help when moving around indoors", "Are you able to control your bowel movements", "Do you need help with eating".

## 2.3 Model

The Ordinary Least Squares (OLS) method was employed here for investigating the relation between childhood starvation and mental health of the older adults, considering that mental health in later life can hardly affect the experience of childhood starvation. The model was set as follows:

$$Mentalhealth_i = \alpha_0 + \alpha_1 Starvation_i + \alpha_2 X_i + \varepsilon_i \quad (1)$$

Among them,  $Mentalhealth_i$  represented the mental health status of the  $i$ th interviewee,  $Starvation_i$  was the independent variable, indicating whether the  $i$ th interviewee suffered from childhood starvation.  $X_i$  represented the covariates,  $\varepsilon_i$  was the random error term,  $\alpha_1$  was the coefficient to be estimated in this paper, which reflected the impact of childhood starvation on the mental health in later life.

## 3 Results

### 3.1 Descriptive statistics

Descriptive statistics of the sample were shown in Table 1. Among the sample collected, the older adults were in a good mental health ( $M = 32.89$ ,  $SD = 6.87$ ). Of the older adults, 74.4% ( $N = 6257$ ) experienced starvation as a child, 46.1% ( $N = 7192$ ) were male, 9.2% ( $N = 7192$ ) were minority, 10.5% ( $N = 6656$ ) were born in urban, 40.2% ( $N = 6986$ ) were in marriage, 17.3% ( $N = 6063$ ) felt not well within the last two week. Their sleep time was appropriate ( $M = 7.27$ ,  $SD = 2.26$ ). The mean household income was 2.936. However, The older adults had very low level of education ( $M = 2.41$ ,  $SD = 3.48$ ), and most of them needed a little help in their daily life ( $M = 0.56$ ,  $SD = 1.29$ ), got little financial support from children ( $M = 0.15$ ,  $SD = 0.31$ ), and level of community services for the older was low ( $M = 1.57$ ,  $SD = 1.89$ ).

## 3.2 Basic regression results

The basic regression results were shown in Table 2. Model 1 only included the dependent variable and the main independent variable. Model 2 added the personal characteristics variable on the basis of model 1. Model 3 added the economic situation variable on the basis of model 2. Model 4 added the family support variable on the basis of model 3, and model 5 added the community service level variable on the basis of model 4.

From model 5, it can be seen that the experience of childhood starvation significantly decreased the mental health score in later years. Compared to individuals who did not experience childhood starvation, older people who experienced childhood starvation had worse mental health and the scores decreased by 0.670. The mental health of minorities was significantly worse. Compared with the individuals born in rural areas, the mental health of individuals born in urban areas was significantly better. Compared with divorced, unmarried and widowed individuals, the mental health of married and current spouse was significantly better. Compared with illiterate, non-illiterate individuals was in higher mental health. The poorer the self-care ability was, the worse the mental health. The longer the sleep duration was, the better the mental health. The higher the level of service provided by the community, the better the individual mental health would be.

Gender, individual income level and children's financial support level had no significant impact on the mental health of older adults. However, men were healthier than women. The higher the income and financial support level of their children were, the higher their mental health was.

Table 2  
Basic regression results

	(1)	(2)	(3)	(4)	(5)
<i>Starvation</i>	-1.015 <sup>***</sup>	-0.615 <sup>**</sup>	-0.641 <sup>*</sup>	-0.675 <sup>*</sup>	-0.670 <sup>*</sup>
	(-3.39)	(-2.05)	(-1.93)	(-1.95)	(-1.94)
<i>Gender</i>		-0.075	0.055	-0.029	-0.009
		(-0.25)	(0.17)	(-0.08)	(-0.03)
<i>Ethnic</i>		-1.302 <sup>***</sup>	-1.022 <sup>**</sup>	-1.018 <sup>*</sup>	-0.885
		(-2.88)	(-2.04)	(-1.86)	(-1.61)
<i>Domicile</i>		0.799 <sup>*</sup>	1.162 <sup>**</sup>	1.108 <sup>*</sup>	1.039 <sup>*</sup>
		(1.69)	(2.09)	(1.90)	(1.79)
<i>Marital status</i>		1.430 <sup>***</sup>	1.514 <sup>***</sup>	1.358 <sup>***</sup>	1.387 <sup>***</sup>
		(5.00)	(4.80)	(4.12)	(4.20)
<i>Education years</i>		0.286 <sup>***</sup>	0.261 <sup>***</sup>	0.299 <sup>***</sup>	0.291 <sup>***</sup>
		(7.03)	(5.46)	(6.01)	(5.87)
<i>ADL</i>		-1.810 <sup>***</sup>	-2.057 <sup>***</sup>	-2.042 <sup>***</sup>	-2.054 <sup>***</sup>
		(-6.39)	(-6.68)	(-6.14)	(-6.19)
<i>Sleep</i>		0.371 <sup>***</sup>	0.440 <sup>***</sup>	0.513 <sup>***</sup>	0.502 <sup>***</sup>
		(6.25)	(6.68)	(7.38)	(7.22)
<i>Wellness</i>		-0.535	-0.943 <sup>**</sup>	-1.027 <sup>**</sup>	-1.070 <sup>**</sup>
		(-1.43)	(-2.26)	(-2.38)	(-2.48)
<i>Income</i>			-0.000	0.000	0.000
			(-0.05)	(0.46)	(0.40)
<i>Financial support</i>				0.000 <sup>*</sup>	0.000 <sup>*</sup>
				(1.93)	(1.90)
<i>Community service</i>					0.237 <sup>***</sup>

Note: *t* statistics in parentheses; \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

	(1)	(2)	(3)	(4)	(5)
					(2.67)
<i>Constant</i>	33.638***	29.362***	28.789***	28.184***	27.946***
	(131.44)	(53.55)	(46.46)	(43.45)	(42.10)
<i>Observations</i>	2678	2494	1998	1835	1820
<i>R</i> <sup>2</sup>	0.004	0.084	0.093	0.105	0.108
Note: <i>t</i> statistics in parentheses; * <i>p</i> < 0.1, ** <i>p</i> < 0.05, *** <i>p</i> < 0.01.					

## 3.3 Robustness test results

### 3.3.1 Effects of severity of childhood starvation on mental health in later life

The childhood starvation data we used was based on personal memories, there may be subjective biases. Therefore, referring to the research of Shi (2011), we analyzed the effect of the severity of childhood starvation which was measure by the abnormal mortality of various provinces during the great famine in China as a robustness test of the benchmark regression. China experienced a great famine from 1959 to 1961. Abnormal mortality was the difference between normal mortality and expected normal mortality. The specific calculation method was as follows:

$$Death_{y,n} = death_{rate}_{y,n} - \left\{ Ave(death_{rate}_{1954-1958,n}) + \left[ Ave(death_{rate}_{1962-1966,n}) - Ave(death_{rate}_{1954-1958,n}) \right] \times \frac{(y-1958)}{(1962-1958)} \right\} \quad (2)$$

The estimated mortality was calculated by the finite difference method using the mortality of each province in the five years before and after the great famine in China (1959-1961). In the calculation,  $death_{rate}_{(year1-year2,n)}$  represented the mean mortality rate between year1 and year2 in *n* provinces. The mortality data of all provinces were from the compilation of statistical data of 55 years of new China.

The regression results were shown in Table 3. The results showed that the more serious the famine in the area where the older people were born, the more depressive symptoms the older adults had. This suggested childhood starvation had a negative impact to the mental health of the older adults, supporting the basic results.

Table 3  
Effects of severity of childhood starvation on mental health in later life

	(1)	(2)	(3)	(4)	(5)
<i>Severity of starvation</i>	-0.138***	-0.115***	-0.110***	-0.106**	-0.106**
	(-4.47)	(-4.35)	(-3.83)	(-2.48)	(-2.43)
<i>Gender</i>		-0.190	-0.051	-0.087	-0.058
		(-0.60)	(-0.14)	(-0.23)	(-0.15)
<i>Ethnic</i>		-1.147**	-1.127*	-1.122*	-1.100*
		(-2.15)	(-1.89)	(-1.73)	(-1.69)
<i>Domicile</i>		0.856*	1.093*	1.125*	1.086*
		(1.74)	(1.85)	(1.81)	(1.75)
<i>Marital status</i>		1.495***	1.725***	1.566***	1.601***
		(4.89)	(5.00)	(4.33)	(4.41)
<i>Education years</i>		-1.856***	-2.118***	-2.174***	-2.185***
		(-6.39)	(-6.55)	(-6.27)	(-6.30)
<i>ADL</i>		0.383***	0.444***	0.517***	0.507***
		(6.08)	(6.26)	(6.90)	(6.75)
<i>Sleep</i>		0.270***	0.240***	0.273***	0.266***
		(6.29)	(4.63)	(5.07)	(4.94)
<i>Wellness</i>		-0.865**	-1.320***	-1.340***	-1.411***
		(-2.20)	(-2.98)	(-2.93)	(-3.07)
<i>Income</i>			0.091	0.117*	0.112*
			(1.51)	(1.88)	(1.80)
<i>Financial support</i>				0.003	0.003
				(1.18)	(1.15)
<i>Community service</i>					0.086
					(0.91)

Note: *t* statistics in parentheses; \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

	(1)	(2)	(3)	(4)	(5)
<i>Constant</i>	33.727***	29.145***	28.077***	27.425***	27.396***
	(149.23)	(52.39)	(43.64)	(40.36)	(38.68)
<i>Observations</i>	2,485	2,152	1,704	1,556	1,541
$R^2$	0.005	0.083	0.095	0.108	0.109
Note: <i>t</i> statistics in parentheses; * $p < 0.1$ , ** $p < 0.05$ , *** $p < 0.01$ .					

### 3.3.2 Effect of childhood starvation on mental health of the older adults in different age groups

In order to further ensure the robustness of the conclusion, the influence of childhood starvation on the mental health of older adults in different age groups were investigated. Meanwhile, considering the small number of samples under the age of 70 and over the age of 100, the samples were divided into three groups: the samples whose age was less than or equal to 80, the samples whose age was more than 80 and less than or equal to 90, and the samples whose age was more than 90. The results were reported in Table 4. It can be found from Table 4 that in the three groups of samples, childhood starvation worsened the mental health of the older adults. Overall, all regressions produced similar results, suggesting the basic results were robust.

Table 4  
Effect of childhood starvation on mental health of the older adults in different age groups

	(1)	(2)	(3)
	Age≤80	80<Age≤90	90<Age
<i>Starvation</i>	-0.278 <sup>***</sup>	-0.585 <sup>*</sup>	-2.766 <sup>***</sup>
	(2.53)	(-1.86)	(-2.78)
<i>Gender</i>	-0.281	0.353	0.774
	(-0.59)	(0.62)	(0.84)
<i>Ethnic</i>	-1.100	-0.998 <sup>*</sup>	0.231
	(-1.40)	(-1.74)	(0.16)
<i>Domicile</i>	0.855	1.316	-0.199
	(1.12)	(1.46)	(-0.10)
<i>Marital status</i>	0.428	1.496 <sup>***</sup>	0.369
	(0.85)	(2.86)	(0.36)
<i>Education years</i>	0.270 <sup>***</sup>	0.167 <sup>*</sup>	0.325 <sup>*</sup>
	(4.33)	(1.92)	(1.76)
<i>ADL</i>	-2.656 <sup>***</sup>	-2.432 <sup>***</sup>	-0.932
	(-3.67)	(-4.60)	(-1.47)
<i>Sleep</i>	0.520 <sup>***</sup>	0.537 <sup>***</sup>	0.407 <sup>**</sup>
	(5.04)	(4.83)	(2.46)
<i>Wellness</i>	-1.596 <sup>***</sup>	-0.782	-1.330
	(-2.61)	(-1.13)	(-1.18)
<i>Income</i>	0.000 <sup>***</sup>	-0.000	-0.000
	(2.91)	(-1.40)	(-0.22)
<i>Financial support</i>	0.000 <sup>**</sup>	0.000	0.000
	(2.10)	(0.68)	(0.67)

Note: *t* statistics in parentheses; \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

	(1)	(2)	(3)
<i>Community service</i>	0.273**	0.032	0.579**
	(2.16)	(0.23)	(2.51)
<i>Constant</i>	28.035***	28.479***	28.805***
	(28.33)	(27.07)	(17.48)
<i>Observations</i>	742	710	368
$R^2$	0.122	0.105	0.086
Note: <i>t</i> statistics in parentheses; * $p < 0.1$ , ** $p < 0.05$ , *** $p < 0.01$ .			

### 3.4 Heterogeneity analysis

In order to further investigate the influence of gender, domicile and level of education on the relationship, heterogeneity analysis was performed. Table 5 reported the results. It can be seen from Table 5 that gender had no significant effect on the relationship. Childhood starvation did not damage mental health in the urban samples, while obviously worsened the mental health in the rural samples. In the illiterate group, childhood starvation significantly damages mental health in later years. However, in the non-illiterate group, childhood starvation had no significant effect.

Table 5  
Heterogeneity analysis

	Gender		Domicile		Education	
	Male	Female	Urban	Rural	Illiterate	Non illiterate
<i>Starvation</i>	-0.634	-0.664	1.993**	-0.953***	-0.994*	-0.538
	(-1.34)	(-1.32)	(2.02)	(-2.60)	(-1.83)	(-1.22)
<i>Gender</i>	-	-	-0.351	-0.025	-0.025	0.028
	-	-	(-0.34)	(-0.07)	(-0.05)	(0.06)
<i>Ethnic</i>	-0.038	-1.603**	-0.095	-0.924	-1.047	-0.716
	(-0.05)	(-2.03)	(-0.04)	(-1.62)	(-1.26)	(-0.99)
<i>Domicile</i>	1.306*	0.605	-	-	0.929	1.353**
	(1.67)	(0.68)	-	-	(0.89)	(2.00)
<i>Marital status</i>	1.282***	1.531***	3.690***	1.207***	1.745***	0.961**
	(2.68)	(3.33)	(3.54)	(3.47)	(3.61)	(2.13)
<i>Education years</i>	0.273***	0.311***	0.294***	0.292***	-	-
	(4.58)	(3.49)	(2.71)	(5.34)	-	-
<i>ADL</i>	-0.916*	-2.672***	-1.075	-2.226***	-2.248***	-1.596***
	(-1.66)	(-6.33)	(-1.61)	(-5.96)	(-5.27)	(-2.85)
<i>Sleep</i>	0.394***	0.613***	0.521**	0.498***	0.548***	0.426***
	(4.07)	(6.15)	(2.24)	(6.85)	(5.47)	(4.40)
<i>Wellness</i>	-1.666**	-0.629	-1.717	-1.018**	-0.429	-2.049***
	(-2.46)	(-1.11)	(-1.27)	(-2.24)	(-0.71)	(-3.27)
<i>Income</i>	0.000	-0.000	-0.000	0.000	-0.000	0.000*
	(1.01)	(-0.29)	(-0.45)	(0.53)	(-0.82)	(1.69)
<i>Financial support</i>	0.000	0.000*	0.000	0.000*	0.000	0.000
	(0.88)	(1.81)	(0.38)	(1.72)	(1.33)	(1.16)

Note: *t* statistics in parentheses; \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ ; The *p*-value is used to test the significance of the difference in starvation coefficient between groups, which is obtained by 1000 times of self-sampling (Boot-strap).

	Gender		Domicile		Education	
<i>Community service</i>	0.216*	0.240*	0.252	0.256***	0.203	0.259**
	(1.78)	(1.85)	(0.98)	(2.72)	(1.53)	(2.18)
<i>Constant</i>	28.681***	27.208***	26.353***	28.252***	27.747***	30.155***
	(29.37)	(29.17)	(12.27)	(40.59)	(28.99)	(31.93)
<i>Observations</i>	898	922	141	1679	896	939
$R^2$	0.079	0.121	0.256	0.100	0.084	0.064
<i>p</i> -value	0.500		0.000***		0.074*	
Note: <i>t</i> statistics in parentheses; * $p < 0.1$ , ** $p < 0.05$ , *** $p < 0.01$ ; The <i>p</i> -value is used to test the significance of the difference in starvation coefficient between groups, which is obtained by 1000 times of self-sampling (Boot-strap).						

## 4 Discussion

The increasingly severe aging situation has brought more attention to the mental health of older adults. Scholars tried to clarify factors of mental health. Through the related literature, we found that the unfortunate events in the early years have an important impact on the mental health of the older adults, and the experience of childhood starvations should be considered.

After controlling individual characteristics, socio-economic characteristics, and community characteristics, we used the OLS model to explore the relationship between the childhood starvation and mental health in later life. Moreover, we conducted the robustness tests by examining the impact of the severity of starvation and dividing the samples to different age ranges. Childhood starvation worsened the mental health in later life, which supported the Hypothesis 1b and rejected the Hypothesis 1a. This study also showed that the effects in sub-groups were heterogeneous, which supported Hypothesis 2. Specifically, childhood starvation did not significantly damage mental health in the urban samples, while had a significantly negative impact in the rural samples. In the illiterate group, childhood starvation significantly damaged mental health in later years. However, in the non-illiterate group, childhood starvation had no significant effect.

### 4.1 childhood starvation worsened the mental health in later life

Childhood starvation worsened the mental health in later life. The severer the childhood starvation was, the more depressive symptoms, and the worse the mental health in later life. This was in line with the

findings of the previous studies, revealing an inverse correlation between childhood misadventures and individuals' mental health in later life (Guo and Zhao, 2019; Liu et al., 2020; Almond et al., 2007; Guo and Hao, 2020). Possible reasons for this negative impact were as follows. The early experience of starvation had a certain impact on the physical health of survivors, and may change their behavior in society. The dual effects of physiology and society increased the risk of mental illness in older adults. First, people who suffered from starvation in childhood would always bear in mind the pain caused by starvation, develop simple living habits in adulthood, and even have retaliatory material desire rebound. They generally paid more attention to material security, and were more willing to suffer unfortunate experiences in order to have a higher material level, thus forming a more conservative behavior characteristic. Compared with those who did not experience starvation in their early life, they would choose less social entertainment activities (such as audio-visual activities, hobbies, games, fitness exercises), ignore the improvement of their own happiness, and focus on how to meet their basic needs in life (Barker,1990; Abel and Frohlich.2012). However, the absence of pressure release, emotional pouring and physical and mental healing resulted in the accumulation of negative emotions such as stress and depression, which affected their mental health (Lin and Zhou,2019). Second, early starvation may make it more difficult for individuals to integrate into the society, thus reducing the emotional support, decreasing the sense of well-being and increasing the risk of depression in old age. From an individual point of view, the starvation experience reduced one's social motivation, making themselves more inclined to believe in religions(Du and Liang, 2018). All these factors may lead to the formation of a more introverted personality, which was not conducive to seeking social support to cure childhood trauma. From the perspective of living environment, starvation may make family ties no longer close. The indifference of family relationship, neglect of parents' care or even the abuse can significantly reduce the individual's mental health and subjective well-being (McEwen and Teresa, 1999). Third, the social environment was also one of the important factors affecting the individual's mental status. Growing up in an unstable environment, such as hunger, would reduce the opportunities for individuals to receive positive and correct guidance. As adults, they may show excessive worry about social security and employment situation. The lack of sense of security was more likely to lead to a negative attitude towards things and worsened the mental health of older adults.

## **4.2 Childhood starvation significantly improve mental health in urban samples**

We also found that childhood starvation significantly improved mental health in urban samples, which was different from the effect of the older people born in rural areas. A large number of existing studies proved that the mental status of urban residents was generally better than that of rural residents, especially when suffering from major natural disasters (such as famine). Farmers always faced the hunger directly. With a low income, once the harvest was not good, the whole family lost the source of income, thus the spiritual impact was more likely to be seriously. On the contrary, urban residents usually have a more stable source of income, and the childhood starvation would be a memory and inspire them to fighter for better life. Moreover, with the development and industrialization in China over the past years, the urban population had more opportunities to create a better life, and the unfortunate childhood

experiences often inspired urban residents to seize these opportunities and live a better life. The quality of life of urban older adults improved much more than that of rural older adults. The positive effects on mental health from income improvement offset the negative effects of childhood starvation on the mental health of older adults (Wen and Cheng, 2017). Thus, for urban older adults, childhood starvation significantly enhanced mental health.

## **4.3 Education weaken the negative impact of early starvation on the mental health of older adults**

We found that the level of education weakened the negative impact of early starvation on the mental health in older adults. Many studies have shown that there was a positive relationship between individual education level and mental health (Nie and Feng, 2015; Wang and Peng,2020). First, people with higher level of education tended to have better jobs and higher incomes, and they had more access to medical resources and living conditions, leading to better health status (Moen,1999; Cutler,2010 ). Second, educated older adults showed higher self-control in poor health behaviors, such as smoking and alcohol abuse, and were more active in good habits such as eating a balanced diet, exercising, and leisure activities. Moreover, the cognitive enrichment hypothesis suggested that education was an important factor in building the mental resources of a society. Highly educated people have more comprehensive cognition about individuals, tended to be more positive-minded, and better able to use social support networks to relieve their mental stress (Ye and Liang, 2017; Berkman,1995; Mazzonna,2014; Adler et al.,1994 ). Taken together, the positive effects of education on a person's mental and physical health made the negative effects on mental health different for people with different levels of education who face the experience of childhood starvation. That is, education weakened the negative effects of early starvation on the mental health of older adults. However, some studies also found that the number and duration of early life misadventures had a steady negative effect on health when education was low. The influence of the number and duration of early life misadventures did not diminish with increasing years of education, i.e., the negative effects of early life misadventures persisted even after the change of social class over the life course<sup>12</sup>. This may be because they focused on the self-rated health of older adults, while we focus on the mental health of older adults.

## **5 Conclusions**

This study investigated the impact of the childhood starvation on mental health in later life among Chinese older people and examined whether the effects were heterogeneous in sub-groups. The results showed childhood starvation worsened the mental health in later life, and a higher level of education had a mediating effect. However, there was a positive correlation between childhood starvation and the mental health in later life among urban residents. In order to reduce the negative impact of childhood starvation, the research continued to promote anti-poverty strategies around the world, provided assistance to children who are hungry, and developed early intervention programs for children's development. Meanwhile, the local development, industrialization and modernization, as well as children's educational attainment should be promoted while preventing child hunger.

There were limitations in this study. Though we did a robustness test by replacing the independent variable to the severity of the famine in the childhood, childhood starvation information was obtained from the older adults with memories of their youth, which was rather subjective. However, most of existing datasets were not suitable for our study. Moreover, we controlled variables on individual characteristics, socio-economic characteristics, and community characteristics, but some unobserved variables might be omitted. For example, personality and sociability were not controlled.

## **Declarations**

### **Ethics approval and consent to participate**

The CLHLS study was approved by the research ethics committee of Peking University (permission# IRB00001052–13074), and all participants or their proxy respondents provided written informed consent after thoroughly explaining the research contents and results involved. All participants expressed informed consent to participate in the study. The study was conducted according to the guidelines of Declaration of Helsinki and all methods were carried out in accordance with Declaration of Helsinki.

### **Consent for publication**

Not applicable.

### **Availability of data and materials**

The datasets generated and/or analysed during the current study are not publicly available due limitations of data use, but are available from the corresponding author on reasonable request.

### **Competing interests**

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

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### **Authors' contributions**

XL and YHL conceived this research. YHL was responsible for the methodology. YLXZ conducted software analyses. ZS and CYL conducted necessary validations. WYY conducted a formal analysis and managed the investigation. ZS and ZWL gathered resources, curated all data, wrote/prepared the original draft, and were responsible for project administration. XL, WYY and ZWL reviewed and edited the manuscript, were responsible for visualization. YHL supervised the project, and acquired funding. All authors contributed to the article and approved the submitted version.

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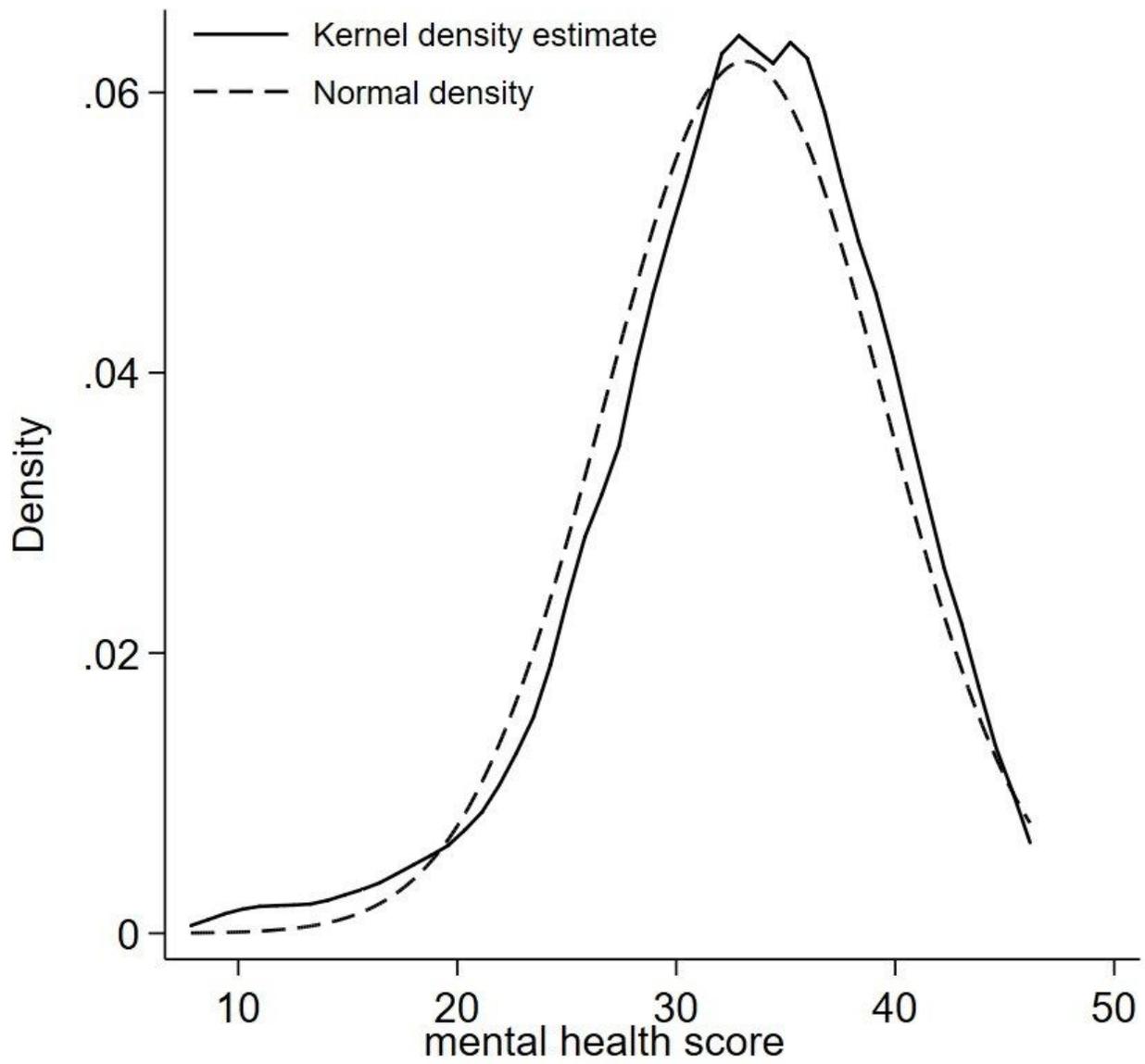
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## Figures



**Figure 1**

Kernel density of mental health scores