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Multigenerational Effects of Early-Life Hunger Experience on the socioeconomic status in
adulthood

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Multigenerational Effects of Early-Life Hunger Experience on the socioeconomic status in adulthood

Abstract

This paper examined whether and how early-life hunger experience leads to multigeneration disadvantage in socioeconomic status. We took the 1959–1961 Famine as a quasi-experimental design and performed a systematic analysis by constructing DID and high-dimensional fixed-effects models. The results show that early-life hunger experiences have a significant negative impact on labor market performance in adulthood. As the life period of experiencing hunger moves back, the experience of hunger has less and less of a negative impact on an individual's future occupational prestige and working hours. When it comes to the next generation, only father's hunger experiences reduce male offspring's income in adulthood.

Keywords: Multigenerational, early-life hunger experience, SES.

1. Introduction

The urgency and uncertainty of major public emergency shocks have brought significant challenges to the development of the global economy and the stability of human society (Yang et al., 2020). Experiencing these shocks, such as natural disasters, famines and public health events, has a comprehensive impact on the specific individual. If the shocks occur during a critical period of brain development, the detrimental effects of early adverse experiences are likely to be long-lasting (Nelson and Gabard-Durnam, 2020). It has been shown to undermine early skill formation and result in persistent disadvantages over the life course (Almond et al., 2010). Individuals' early experiences have long-lasting effects, with implications for accumulating human capital and various outcomes in adulthood (Barker, 2007; Almond et al., 2009; Fernald et al., 2011). Therefore, understanding the impact and mechanism of the persistence of childhood circumstances, wherein shocks and events experienced early in life (even in utero) may set an accumulation of disadvantages, is an important issue.

Famine is one of the most common exogenous shocks in the world today. According to The State of Food Security and Nutrition in the World 2021 report published by the United Nations, 720 million to 811 million people were hungry in 2020, increasing approximately 118 million (18%) compared with 2019. Although the degree of undernutrition has been rapidly reduced with rapid economic growth in the past few decades, the harm of hunger experience may continue for a long time and put people at a disadvantage for life. It affects the results of education, marriage, labor market performance, and the long-term well-being of individuals in the future (Chen and Zhou, 2007; Almond et al., 2009; Meng et al., 2009). A strong link between harmful early-life or in utero experience of shock and lowered later-life health and

economic outcomes has been found in several empirical studies (Beegle et al., 2010; Chamarbagwala and Morán, 2011). Whether the impact is positive or negative varies with scholars' different methods, perspectives, and databases. We seek to examine how early-life hunger experiences affect future socioeconomic status using nationally representative data from the 2005 and 2015 Chinese censuses.

We study how early-life hunger experiences, especially fetal and pre-three-year-old famine experiences affect future socioeconomic status by using a quasi-experimental design in which we use the Chinese Great Famine (1959–1961) as an adverse exogenous shock. Starvation was observed in Sichuan and Anhui provinces in the winter of 1958, and then it became widespread by the spring of 1959 (Shi, 2011). Following the idea of difference-in-difference, we build a fixed-effect model and find that early-life hunger experience has a significant potential impact on socioeconomic status in adulthood. We find that early experiences of hunger can affect an individual's socioeconomic status in adulthood, with a significant negative impact on labor market performance. As the period of life during which hunger is experienced moves back, the experience of hunger has less and less of a negative impact on an individual's future occupational prestige and working hours. Besides, we find that fathers' hunger experiences reduce male offspring's income and house size in adulthood.

Compared with the existing literature, this article makes two contributions to the literature. First, we systematically analyze the relationship between early experiences of hunger and future socioeconomic status in three dimensions: education, income, and occupation. We examine the impact of hunger experiences on an individual's future occupation based on the Chinese Career Prestige Classification Scale, adding evidence to relevant knowledge by using

a large sample of census data. With these results established, the next question is whether harmful early-life experiences might persist in the outcomes of a future generation. We explore the question of intergenerational persistence of early-life insults, extending previous work that used famine as a natural experiment (Almond, 2010) by adding multigenerational data.

The rest of the paper is organized as follows: Section 2 provides a literature review of the impact of early negative experiences brought about by exogenous shocks and backgrounds of the famine. Section 3 describes the data sources, sample, variables we used, and the empirical methodology. Section 4 presents the results and section 5 extend to intergeneration. Section 6 concludes with policy implications.

2. Background Literature

A fetus will change the physiological function and metabolic mode of the body to adapt to the environment of intrauterine malnutrition (Barker, 2007). This "procedural change" will cause permanent changes in the fetus's metabolism, tissues, and organs and produce long-term effects, leading to poor health performance in adulthood. (Lucas, 1998; Franke et al., 2018). A large amount of literature has documented associations between early-life insults and later-life outcomes, following the original Barker hypothesis (Almond and Mazumder, 2011; Rosales-Rueda, 2018).

Studies from neuroscience and biological science have shown that experiences early in life may have profound effects on the brain and mental and neurological health. There is evidence that children who experience adversity such as biological hazards (e.g., malnutrition, environmental toxins, chronic infections) or psychological hazards (abuse, violence) early in life have an increased risk of atypical variation in their brain structure (Fox et al., 2010),

delayed development of certain life traits (Lewis and Maurer, 2005), and reduced plasticity (Daw et al., 1991). Then economists who studied fetal origins were keenly aware of the strong cross-sectional association between health and educational attainment, employment, and wages (Futoshi, 2006; Zhou, 2015). There is an increasing number of economic studies on the effect of early-life adverse experiences on a range of outcomes, including human capital (Beegle et al., 2010; Chamarbagwala and Morán, 2011), income and labor market outcomes (Almond et al., 2007; Almond & Mazumder, 2011). Research about the impact of early famine experiences on later-life outcomes can also be divided into health and socioeconomic aspects.

From one hand, early-life hunger experience puts an individual at a disadvantage in persistent health. Hunger experience, which leads directly to malnutrition, affects the growth and development of individuals in many aspects, such as brain, cognition (Maluccio et al., 2006; He et al., 2018), and may even alter the epigenetic and intergenerational transmission of certain traits (Lewis and Maurer, 2005). In empirical studies, most scholars have demonstrated that hunger experiences have adverse health impacts on people in fetal (Chen and Zhou, 2007), early childhood, or childhood (Meng and Qian, 2009). However, some scholars have argued that early hunger experiences do not necessarily have a significant negative impact on physical health (Ma, 2011). The impact of early experiences of hunger on mental health is mainly through the psychological trauma left behind. Psychologists believe that human actions are based on memories of past knowledge and experiences (Freud, 1915). The tragic memories of severe hunger can leave people with eternal psychological trauma, which may give individuals a conservative personality and preference, resulting in a lack of leisure and social interaction, which in turn leads to psychological depression in individuals (Lin and Zhou, 2019). Those

who experience severe famine in the first part of their lives are at increased risk of developing antisocial personality disorder (Neugebauer et al., 1999), and those who are pregnant and born during the famine have the highest risk of developing schizophrenia in mid-adulthood (Sperber, 2017).

On the other hand, early experience of hunger affects people's socioeconomic behavior and socioeconomic status. The fact that only those households which store more food can survive better in times of famine makes children with hunger experiences realize the importance of saving for survival early than others. Even though they are no longer in danger of hunger as adults, they still behave to increase their savings (Cheng, 2011). Besides, the experience of hunger induces people to develop a stronger risk aversion, discouraging farmers from engaging in risky non-farm employment, reducing the likelihood of abandoning farming to enter non-farm sectors, and discouraging them from increasing their income (Wang, 2015). In addition, some empirical research has shown that famine experience will reduce the length of an individual's years of education (Almond et al., 2010) and high school completion (Shi, 2011), and it will also have a huge negative impact on employment (Cheng et al., 2021) and marriage (Brandt et al., 2008). The working hours and income of individuals who experienced famine also significantly decrease. (Chen and Zhou, 2007). However, some scholars think that it makes people more risk-taking (Haushofer and Fehr, 2014). They also find that exposure to adversity increases the likelihood of becoming an entrepreneur (Miller and Le Breton-Miller, 2017; De Blasio et al., 2018; Yi et al., 2022) by making individuals more self-reliant (Bonanno, 2004), resourceful and effective in handling failures (Baker and Nelson, 2005), and more risk-tolerant (Yi et al., 2022).

There are several pathways that exist for the intergenerational transmission of the early-life hunger experience. Through socioeconomic channels, education (Cook et al., 2019) and income (Lo, 2020) can be passed between generations. From a biological perspective, exposure to exogenous shocks during fetal life can cause the expression or alteration of certain genes. Scholars have attempted to identify gene-environment (or g-by-e) interactions (Werner, 1989; Currie and Moretti, 2007). Epigenetics suggests that traits that do not depend on DNA sequence can also be stably inherited. For example, the offspring of mice inherit their father's fear memory (Dias and Ressler, 2014), and starvation induces the expression of small RNAs in a proportion of the target genes of hydrophilic nematodes that are nutrient metabolism-related genes and can be intergenerationally inherited into the third generation of hydrophilic nematodes, allowing them to live longer. (Rechavi et al., 2014). Epigenetic inheritance largely determines when, where, and how genes are expressed and is mainly achieved through mechanisms such as DNA methylation, post-translational histone modification, chromatin remodeling, RNA editing, and small RNA regulation (Bird, 2007).

Existing studies have mainly looked at the impact on socioeconomic status from the perspective of income or education level (Almond, 2010; Shi, 2011) or exclusively at the impact of early life experiences on later career choices (Miller and Le Breton-Miller, 2017). Besides, current research mostly examines the multigenerational effects of in utero exposures in human populations (Cook et al., 2019), and less research has been done on the effects of experiencing shocks in early childhood. Thus, there is a lack of research on the multidimensional and multifaceted impact on socioeconomic status. The interplay of what is 'innate' to the individual at birth and acquired factors from the environment is currently little

research as there is limited multigenerational data linking mothers and offspring. We can also find disagreement among scholars in the section on the impact of early hunger experiences on risk preference, occupation, and income. In this paper, we try to add to these studies by examining the multigenerational impact of hunger in early childhood on one's socioeconomic status later in life.

3. Data and Empirical Methodology

3.1 Data and sample

Data used in this paper come from a 400,367 observations sample from the Sixth National Census of 2005 and 2015 of the National Bureau of Statistics of China, covering 31 provinces¹. The sample collection adopts the stratified multi-stage whole group probability ratio sampling method. The unified purchasing and marketing policy, which prioritizes food supply to the cities in times of famine, made the impact of starvation on urban residents much less pronounced than on rural residents (Lin and Yang, 2000). Nonetheless, families with middle and low socioeconomic status were almost equally affected by the famine from 1959 to 1961, and families with high socioeconomic status were not spared (Cui, 2020). In addition, children's educational attainments were disrupted by the 1966-1976 disruption (Giles et al., 2008). Since a great deal of the brain's ultimate structure and capacity is shaped early in life before the age of 3 (Fox et al., 2010) and the first 1,000 days are so critical in development (Requejo, 2015), the final sample of the first generation used in this paper includes individuals born between January 1954 and December 1962. Since the average age of the first childbearing for women

¹ Chongqing was a city in Sichuan province until 1997, and Hainan was part of Guangdong province until 1988, so Chongqing and Hainan are treated as part of Sichuan and Guangdong provinces, respectively. Removal of Tibetan-born individuals due to limitations in mortality data; Tibetan-born individuals make up 0.75% of the total sample, and removing the Tibetan sample should not cause selection problems.

of childbearing age is 24, the sample of the second generation includes individuals born between January 1977 and December 1986.

3.2 Descriptive statistics

The measurement of hunger intensity is generated from provincial excess mortality in different years, and the data comes from the China Compendium of Statistics: 1949–2004. Following Shi (2011), we define the excess death rate (EDR) in 1959–1961 as the deviation of provincial mortality rates from the provincial projection of mortality. The estimated excess death rate (EDR) for each province from 1959 to 1961 is shown in table 1. We can see that the highest average excess death rate appeared in 1960, which is consistent with the famine pattern, that is, the most severe famine happened in 1960, and the famine was coming to its end in 1961.

Table 1. The estimated excess death rate for provinces in the famine (Unit: 1%)

Province	Year		
	1959	1960	1961
Sichuan	3.403	4.111	1.660
Anhui	0.512	5.828	-0.096
Henan	2.459	2.877	0.031
Guizhou	0.603	3.758	0.813
Qinghai	0.509	2.982	0.145
Gansu	0.449	2.882	-0.055
Guangxi	0.517	1.811	0.906
Shandong	0.603	1.173	0.683
Hunan	0.014	1.717	0.591
Fujian	0.263	1.110	0.667

Liaoning	0.343	0.332	0.951
Jiangsu	0.374	0.802	0.350
Hubei	0.342	1.053	-0.116
Yunnan	0.228	1.155	-0.198
Guangdong	0.160	0.630	0.250
Hebei	0.129	0.522	0.345
Xinjiang	0.514	0.286	-0.032
Ningxia	0.426	0.282	0.008
Jilin	0.399	0.047	0.226
Jiangxi	0.067	0.457	0.077
Tianjin	0.121	0.213	0.226
Heilongjiang	0.277	0.087	0.188
Beijing	0.143	0.097	0.282
Zhejiang	0.072	0.254	0.116
Shaanxi	0.039	0.210	0.041
Shanghai	0.111	0.035	0.130
Shanxi	0.172	0.088	-0.306
Neimenggu	-0.013	-0.113	-0.114

The intensity of hunger experienced by an individual can be measured by the severity of the famine in the location, which can be expressed as the product of the excess mortality rate in the individual's province and the duration of the hunger experience. We calculate hunger intensity experienced by cohorts born in province j in month m of year t and experiencing hunger in different years using equation 1, consistent with the method used in “Famine, fertility, and fortune in china” (Shi, 2011). For example, an individual born in November 1959 spent ten

months of the first year of life in the famine.

$$FI_{jmt} = \sum_{z=1959}^{1961} \frac{(\text{months spent in year } z)_{mt}}{12} \times EDR_{jz} \quad (1)$$

We investigate the effects of the hunger experience on three types of SES variables. The first type is about education, measured by years of schooling and an indicator of whether the individual completed high school. The second type is wealth, including annual household income per capita, the average number of rooms per capita, and the average housing areas per capita. The third type is labor market performance, including the number of workdays from October 25 to October 31 in 2005 and occupational prestige score. The occupations were classified and assigned values with reference to the “Chinese Occupational Prestige Measurement Index” compiled by Li Chunling (Li, 2005), which can be broadly categorized into seven hierarchical prestige groups. For specific variable definitions, see the Data Appendix.

Table 2 reports the summary statistic of the sample used for analysis. Since our access to the 2015 population data does not include income, occupation, and labor data, these variables have a smaller sample size. Table 2 shows that females' education level was much lower than males. On average, women finished 6.79 years of education and men finished 8.41 years of education. Meanwhile, women also perform less well than men in income. Men's income is almost two times larger than women's. A man also performed much better than a woman in the labor market. Man's occupational prestige score is about 7.5 points higher than women and men worked 44.93 hours while women worked 35.55 hours per week. The last three rows report the mean value of hunger intensity experienced by individuals affected by the famine in utero, within age 0-1, and within age 1-3. We can see that the average hunger intensity of males is almost the same as that of females.

Table 2. Summary statistics

Variable	Men			Woman		
	Mean	SD	N	Mean	SD	N
<i>First Generation</i>						
Age	52.4	5.7	199,989	52.2	5.7	200,378
Years of schooling (year)	8.4	3.0	199,989	6.8	3.5	200,378
income (yuan per week)	469.8	598.8	93,753	249.8	253.4	96,441
Occupational prestige score	51.1	14.7	93,753	43.692	19.6	96,441
Weekly labor supply (hours)	44.9	16.4	93,753	35.551	20.6	96,441
In-utero hunger intensity (1%)	1.1	—	20,881	1.170	—	21,382
Hunger intensity within age 0-1 (1%)	2.7	—	22,348	2.634	—	22,066
Hunger intensity within age 1-3 (1%)	7.9	—	48,455	7.695	—	48,081
<i>Second Generation</i>						
Age	23.2	2.6	219,975	23.3	2.6	219,476
Years of schooling (year)	10.8	3.3	219,975	10.6	3.5	219,476
income (yuan per year)	2062.4	1573.5	77,229	1883.8	1369.1	82,320
Occupational prestige score	47.0	22.7	77,416	41.2	24.7	82,526
Weekly labor supply (hours)	39.2	20.6	77,416	32.3	22.2	82,526

3.3 Empirical strategies

To identify the impacts of the famine, we combine two variations: different famine intensities across provinces and a comparison between cohorts experiencing and not experiencing the famine in early life. The identification strategy essentially follows the idea of difference-in-difference. Because specific provinces in China may change slowly over long periods, we attempt to isolate changes in individuals' outcomes that differ from the long-term trend in their province of birth. When studying the relationship between famine experience and

adult outcomes, we first used the groups who experienced hunger in the fetus and before the age of three as the experimental group, which assigned the value 1, and the groups born in 1954-1958 as the control group that assigned the value 0.

The regression we estimate is the following reduced-form linear relationship between adult outcomes Y_{ijmt} of the adult i born in province j in m months of t year and independent variables:

$$Y_{ijmt} = \beta_0 + \beta_1 \times HI_{ijmt} + X_i + \mu_j + \delta_t + \varepsilon_{ijmt} \quad (2)$$

It can be seen that the model replaces the time dimension dummy variable of policy shock in traditional DID with the dummy variable of birth cohort (year). Y_{ijmt} is a series of SES variables including years of education, logarithm of personal weekly earnings, occupational prestige and weekly labor hours. The coefficient we are concerned is β_1 which can show the impact of the hunger intensity experienced on adult outcomes; X_i represents personal characteristics variables, including a series of dummy variables like whether individual i is male, belongs to 2005 census data and comes from rural area. μ_j is birth province fixed effect, δ_t is birth year fixed effect, and ε_{ijmt} is an error term.

4. Results

Table 3 shows the result of early-life hunger experience on Education, wealth and labor market performance. We can see that early-life hunger experience has a negative effect on later-life income at 10% significant level and on education, though the effect on education is not significant. And, early-life hunger experience has little effect on labor market performance. Besides, whether individual belongs to 2005 census data (wave), whether individual is male (male), and whether individual comes from rural area (rural) all have significant on the results. Because of the inability to control for sample selection problems due to child deaths in famine,

the estimates in this paper can be considered as a lower bound on the impact of hunger experience.

Table 3. Effects of the hunger experience in early life

	(1)	(2)	(3)	(4)
Variable	Education	Wealth	Labor market performance	
	Years of schooling	Logarithm of income per week	Occupational prestige	Labor supply (Working hours per week)
Hunger intensity experienced	-0.237 (0.148)	-0.054* (0.030)	0.058 (0.041)	0.021 (0.019)
Wave	-2.089*** (0.157)	—	—	—
Rural	-2.965*** (0.158)	-0.858*** (0.041)	0.241*** (0.013)	0.040*** (0.005)
Male	1.517*** (0.110)	0.390*** (0.024)	0.027** (0.013)	0.041*** (0.007)
Birth year fixed effects	Yes	Yes	Yes	Yes
Province fixed effects	Yes	Yes	Yes	Yes
Number of observations	420,949	252,639	103,326	84,236
R-squared	0.264	0.425	0.100	0.019

4.1 Results of fetal, 0-1, and 1-3 years old of hunger experience

To further explore whether the effects of early hunger experiences differ in different periods, we subdivide it into hunger experiences in utero, hunger experiences in the first year after birth and hunger experiences between ages one and three. Because of the large influence of male variable, we separate the male and female samples for regression. Tables 4, 5 and 6 in appendix show the respective results.

We can see from Table 3 that, mirroring the results for men, a negative and statistically significant association is observed between in-utero hunger experience and labor market

performance for women. As shown in columns 5 and 6, each 1% increase in hunger intensity is associated with a 2.73 point and 2.62 hour decrease in women's future occupational prestige and labor hours. This result is significant at the 10% and 5% levels of significance, respectively. And a 0.1 unit increase in hunger intensity is associated with a 2.96 point and 2.13 hour decrease in men's future occupational prestige and labor hours, and these effects are significant at the 1 % level.

Table 4 shows that hunger experience during the first year of life has a significant effect on individual's working hours in adulthood for both men and women. One unit increase in famine intensity will cause 7.24 hours decrease in women's working hours per week and 3.79 hours decrease in men's working hours per week. Only women's occupational prestige is significant affected, it will decrease by 4.38-points with 1 unit increase in famine intensity. It also leads to 0.64 years increase in female's education, which is contrary to some research. This may be because people who experience hardship early in life are more likely to become entrepreneurs and earn more in adulthood.

From table 5, we can see that hunger experience within age 1-3 have slight positive effect on women's education and have slightly negative effect on women's occupational prestige, but it has no significant effect on men.

4.2 robustness test

In the robustness test section, we first think about the fertility choices problem, which means those parents who are in better health or whose families are better off are more likely to choose to have children during a famine, which will result in a tendency for famine-born children to grow up to be in better health condition and can get better education, which will

lead to better socioeconomic status when they grow up. If choices exist, the negative effects of hunger experience may also be underestimated. Since it is impossible to control, the estimation results in this paper can be regarded as the lower limit of the impact of hunger experience. Besides, we generate variable TREND, a time trend specific to the province and add it into the model (3). It absorbs the long-run time trends in the outcomes that may vary depending on the province. Its coefficient allows the time trend to vary across provinces (Shi, 2011). We find that though the result is slightly different, the effects still exist.

Despite the potential problems, the results of robustness tests still provide certain support to the general finding that hunger experience in early life tends to affect socioeconomic status in later life. The results of the above empirical analysis also suggest that fetal hunger experience mainly have negative effects on individuals' socioeconomic status, especially on labor market performance. But as the period of hunger experience progresses, the positive effects of hunger experience begin to emerge between 0 and 1 year of age, with the smallest effect of hunger experience between 1 and 3 years of age, which may cause by the mutual offsetting of positive and negative impacts. This may contribute to evidence that early life experiences lead to personality differences. For example, individuals who have experienced hardships have more qualities to overcome difficulties when they grow up and this leads to differences in future earnings.

5. Intergenerational result

We then extend this analysis by estimating multigenerational impacts on the second generation. We find the offspring of people born in 1954-1962 based on family relationship and age variables. The estimating equation is given by the following form:

$$Y_{ijmt} = \beta_0 + \beta_1 \times DADFI_{ijmt} + \beta_2 \times MOMFI_{ijmt} + dbirthage + mbirthage + siblings + male + \mu_j + \delta_t + \varepsilon_{ijmt} \quad (4)$$

Our primary focus is on the coefficient β_1 and β_2 , which measures the effect of having a parent experienced hunger on several outcomes for individuals. $DADFI_{ijmt}$ is the hunger intensity experiences by the father of individual i born in province j in month m of year t . $MOMFI_{ijmt}$ is the hunger intensity experiences by the mother of individual i born in province j in month m of year t . Considering parental age is an important factor in pregnancy outcome and child development (Nortman, 1974), we add $dbirthage$ and $mbirthage$ that represent the father's age at birth and mother's age at birth. Because reductions in sibling number contribute to increasing years of schooling (Blake, 1989), we add $siblings$ to the equation. $male$ is a dummy variable to control gender. μ_j is birth province fixed effect, δ_t is birth year fixed effect, and ε_{ijmt} is an error term.

Table 7. Effects of the famine experience on the next generation

	(1)	(2)	(5)	(6)
Variable	Education	Wealth	Labor market performance	
	Years of schooling	Logarithm income per week	Occupational prestige	Labor supply
<i>Woman</i>				
Father's hunger intensity	0.020 (0.015)	-0.002 (0.003)	-0.007 (0.097)	0.084 (0.080)
Mother's hunger intensity	0.013 (0.025)	0.002 (0.003)	0.156* (0.087)	0.184** (0.068)
Birth year fixed effects	Yes	Yes	Yes	Yes
Province fixed effects	Yes	Yes	Yes	Yes
Number of observations	74,843	32,947	32,947	32,947
R-squared	0.161	0.481	0.163	0.168

Man

Father's hunger intensity	0.037** (0.016)	-0.005*** (0.002)	-0.099 (0.066)	-0.076 (0.072)
Mother's hunger intensity	0.014 (0.021)	-0.000 (0.002)	-0.017 (0.048)	0.048 (0.052)
Birth year fixed effects	Yes	Yes	Yes	Yes
Province fixed effects	Yes	Yes	Yes	Yes
Number of observations	78,760	63,068	63,068	63,068
R-squared	0.133	0.452	0.185	0.184

Table 7 shows that there is a significant positive effect of mother's hunger experience on female offspring's occupational prestige and labor supply and male offspring's housing size in adulthood. For one percent increase in hunger intensity experienced by mothers, the occupational prestige and labor intensity of the female offspring increased by 0.156 points and 0.184 hours/week, the per capita housing area of male offspring increased by 0.126 square meters. The effects of maternal early-life hunger experience are all positive, which may because the death situation caused by famine is serious, especially for women, so the women who survive are better in all aspects and pass it on to their offspring. Father's hunger experience has a positive effect on male offspring's education at the 5% level of significance and has a significant negative effect on male offspring's income and house size in adulthood.

6. Conclusion

This paper examines the effect of early hunger experience on children from in-utero to age 3. Following the idea of DID, we use the double fixed effects model and find that early-life hunger experience has a significant potential impact on socioeconomic status in adulthood, particularly in terms of occupational prestige and working hours. However, this effect varies with the timing of the hunger experience, and results differ between males and females. The

negative impact on labor market performance is greatest for the experience of hunger in the fetal period, less for the experience of hunger from 0-1 year and least for the experience of hunger from 1-3 years. Besides, fetal hunger experience may reduce men's average housing areas in adulthood and hunger experience within age 0-3 can increase women's education years. When it comes to the next generation, we find that father's hunger experience reduces male offspring's income and house area.

Our analysis is unable to fully distinguish between the socioeconomic and biological intergenerational channels proposed in part 2, but it is important to note that the channels are by no means mutually exclusive. From a policy perspective, our results obtained by using a large national sample add evidence to the persistence of early shocks experience and reemphasize the importance of food security. In the context of the current Covid-19 epidemic and the deterioration of global food security, our finding may be of reference significance for many countries and regions to cope with food shortages and allocate resources more effectively and rationally. It also emphasizes that even though individuals experience harmful shocks, they can still reduce negative impacts through certain methods. In the next step, we intend to use the micro survey data to supplement the impact mechanism research.

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Appendix

Professional Prestige Scoreboard

Grouping values	Score	Details
Group1	<25	is perceived as an occupation of a lower or lowly nature, i.e., work that involves selling hard labor or serving people (e.g., trishaw drivers, porters and nannies, etc.)
Group2	25-40	includes workers without technical expertise, laborer's (i.e., manual or semi-manual), employees in business services (e.g., hotel attendants, hairdressers, cleaners, bus conductors, shopkeepers, vegetable market vendors, etc.), agricultural labourers and small self-employed people (individual tailors).
Group3	40-50	mainly includes rural professionals and technicians, skilled workers, business and service sector employees with certain skills and expertise (e.g., postal workers, salesmen, restaurant cooks, taxi drivers, etc.), self-employed or professional households (e.g., farming professionals, human transport professionals, individual small shop owners, etc.), and lower-level clerical staff or lower-level white-collar occupations (computer typists)
Group4	50-65	mainly includes lower-level professionals and technicians (e.g. fashion designers, primary school teachers, nurses, accountants, etc.), general clerical staff (including grassroots community managers such as military personnel and neighbourhood committee chairmen, etc.), higher-income business service employees with quasi-white-collar occupational characteristics (e.g. corporate buyers, minivan drivers of government units, etc.), and presidents of corporate trade unions and construction team foremen
Group5	65-75	mainly includes professional and technical personnel (such as film stars, writers, aircraft pilots, sports athletes, doctors, enterprise technicians, etc.), ordinary cadres in government departments, clerical staff in special sectors (sectors with privileges or high economic benefits) (such as industrial and commercial tax officers, clerks in government offices, bank tellers, police officers, etc.), leading cadres in rural areas, municipal democratic parties leaders and owners of private enterprises
Group6	75-85	mainly includes middle-level leading cadres (e.g., directors of government agencies, section heads of government agencies), senior managers of various

		enterprises (e.g., managers of foreign-funded enterprises, factory directors of state-owned enterprises, factory directors of collective enterprises) and some professionals with higher income and social influence (e.g., secondary school teachers, newspaper reporters, lawyers)
Group7	>=85	mainly includes senior leading cadres (such as municipal people's congress chiefs, mayors, county party secretaries, etc.) and senior intellectuals (such as engineers, scientists, university teachers, etc.)

Table 4. Effects of the famine experience in utero

	(1)	(2)	(3)	(4)
Variable	Education	Wealth	Labor market performance	
	Years of schooling	Logarithm of annual household income per capita	Occupational prestige	Labor supply (Working hours per week)
<i>Women</i>				
Hunger intensity experienced in utero	-0.100 (0.164)	-0.088 (0.078)	-2.726* (1.451)	-2.624** (0.948)
Birth year fixed effects	Yes	Yes	Yes	Yes
Province fixed effects	Yes	Yes	Yes	Yes
Number of observations	70,154	34,214	34,214	34,214
R-squared	0.171	0.383	0.069	0.117
<i>Men</i>				
Hunger intensity experienced in utero	-0.167 (0.154)	-0.007 (0.046)	-2.960*** (0.638)	-2.127*** (0.677)
Birth year fixed effects	Yes	Yes	Yes	Yes
Province fixed effects	Yes	Yes	Yes	Yes
Number of observations	70,017	33,377	33,377	33,377
R-squared	0.110	0.381	0.015	0.034

Table 5. Effects of the famine experience within age 0-1

Variable	(1)	(2)	(3)	(4)
	Education	Wealth	Labor market performance	
	Years of schooling	Logarithm of annual household income per capita	Occupational prestige	Labor supply
<i>Women</i>				
Hunger intensity experienced within age 0-1	0.642* (0.363)	-0.143 (0.106)	-4.337* (2.282)	-7.238*** (2.145)
Birth year fixed effects	Yes	Yes	Yes	Yes
Province fixed effects	Yes	Yes	Yes	Yes
Number of observations	70,838	34,502	34,502	34,502
R-squared	0.154	0.391	0.069	0.115
<i>Men</i>				
Hunger intensity experienced within age 0-1	0.397 (0.590)	0.198 (0.173)	-3.595 (2.233)	-3.794* (2.217)
Birth year fixed effects	Yes	Yes	Yes	Yes
Province fixed effects	Yes	Yes	Yes	Yes
Number of observations	71,484	34,121	34,121	34,121
R-squared	0.093	0.385	0.011	0.034

Table 6. Effects of the famine experience within age 1-3

	(1)	(2)	(3)	(4)
	Education	Wealth	Labor market performance	
Variable	Years of schooling	Logarithm of annual household income per capita	Occupational prestige	Labor supply
Women				
Hunger intensity experienced within age 1-3	0.058*** (0.013)	-0.005 (0.005)	-0.291* (0.158)	-0.179 (0.120)
Birth year fixed effects	Yes	Yes	Yes	Yes
Provincial fixed effects	Yes	Yes	Yes	Yes
Number of observations	96,853	47,416	47,416	47,416
R-squared	0.150	0.378	0.063	0.112
Men				
Hunger intensity experienced within age 1-3	0.017 (0.025)	0.005 (0.007)	0.001 (0.081)	0.049 (0.074)
Birth year fixed effects	Yes	Yes	Yes	Yes
Province fixed effects	Yes	Yes	Yes	Yes
Number of observations	97,591	47,091	47,091	47,091
R-squared	0.087	0.386	0.012	0.033