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**IZA – Institute of Labor Economics**

Schaumburg-Lippe-Straße 5–9  
53113 Bonn, Germany

Phone: +49-228-3894-0  
Email: [publications@iza.org](mailto:publications@iza.org)

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## ABSTRACT

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# Early Life Circumstances and the Health of Older Adults: A Research Note

This paper reviews the latest evidence of the effects of early life circumstances on old-age health, distinguishing in utero exposures from childhood exposures to a wide range of environments. We then leverage the growing number of studies of the impact of the Great Chinese Famine (1959-1961) on the health of older adults to perform a meta-analysis and discuss potential mechanisms. Recent studies assembling multiple domains of early life circumstances are evaluated to better understand how various circumstances may coalesce and manifest in shaping long-term health.

**JEL Classification:** I14, J14, J13, I18

**Keywords:** early life circumstances, old-age health, famine, long-term health, meta-analysis, China

**Corresponding author:**

Xi Chen  
Department of Health Policy and Management  
Department of Economics  
Yale University  
60 College St  
New Haven, CT 06520  
USA  
E-mail: xi.chen@yale.edu

## 1. Introduction

Growing evidence suggests that ageing begins in the early stage of life, during which individual environments play important roles, it becomes increasingly important to understand the long-lasting impact of early life circumstances on old-age health. Insights into life course causes of diseases and identification of opportunities for effective interventions will help achieve healthy aging. As population ages and more people live longer with chronic conditions, the surging demand for cost-effective prevention, treatment and long-term care services also calls for a holistic life-course approach and interventions (Sayer and Gill. 2016; Kaeberlein, Rabinovitch, and Martin 2015; Clarke and Latham 2014; Ben-Shlomo et al. 2016; Moffitt et al. 2017).

This research note is organized as follows. Section 2 and section 3 respectively review evidence of the effects of *in utero* and *childhood* exposures to a wide range of environments on old-age health. Section 4 focuses on the branch of literature on the Great Chinese Famine (1959-1961) and performs a meta-analysis of its long-lasting effects on the health of Chinese older adults. Section 5 discusses the latest work that attempts to measure the contributions of early life circumstances to health in older ages. Finally, section 6 concludes.

## 2. *In Utero* Environments and Long-term Health

The association between *in utero* circumstances and healthy ageing has been well established. *In utero* is a critical period during which adverse circumstances may bear long-term consequences into older ages. For example, the Fetal Origin Hypothesis proposes that disruptions to the prenatal environments, such as through maternal and fetal health (e.g., nutrition and infection), social and economic shocks (e.g., political movements and recessions), and environmental pollution, may impact developmental health and well-being outcomes (Barker 1992; Almond and Currie. 2011).

A large and growing number of studies have validated this hypothesis in ageing populations. Specifically, *in utero* risk factors, such as nutritional adversity or exposure to famine (Crimmins 2015; Ko and Yeung 2018; St Clair et al. 2005; Yang et al. 2008; Song et al. 2009; Wang et al. 2010; Mu and Zhang 2011; Wang et al. 2012; Shi et al. 2013; Wang et al. 2015; Wang et al. 2016a; Wang et al. 2017; Li et al. 2018b; Chang et al. 2018; Li et al. 2018a; Sun et al. 2018; see our meta-analysis visualized in Figure 2), social unrests (Islam et al. 2017), birth season (Costa and Lahey 2005), maternal stress and exposure to violence (Black et al., 2016; Persson and Rossin-Slater, 2018), and

influenza pandemics (Mazumder et al. 2010; Almond et al. 2018), have been linked to increased susceptibility to diseases later in life. The resulting health problems stemming from these prenatal risk factors include accelerated productive ageing (e.g., difficulty in engaging in working, caring, and socially productive activities), schizophrenia (Xu et al. 2009), depressive symptoms, shorter stature, disability, premature death, anemia, obesity (Yang et al. 2008), diabetes, coronary heart disease, stroke, fatty liver disease, metabolic syndrome (e.g., hypertension, hyperlipidemia) (Zheng et al. 2012), reduced lung capacity, and cognitive impairment (Almond et al. 2018). Many of these health effects are latent until mid-life and persist into old age.

### **3. Childhood Environments and Long-term Health**

Childhood presents another critical period during which adverse circumstances may shape long-term health (Almond et al. 2018). As illustrated in Figure 1, the self-rated health among all respondents over three waves of the CHARLS national sample vary significantly with retrospective reports of health status before age 16. Even with some convergence over the life course, those reporting good health before age 16 are still 5-10 percentage points more likely to report being in excellent or very good health after turning 60.

Other dimensions of childhood circumstances, such as disease environment, home and social environments, child health status and toxic exposure, have also been linked to health later in life. Specific childhood risk factors include health endowment at birth and early life (Xiao et al. 2008; Smith et al. 2012; McGovern 2014; Stowasser et al. 2014; Gong et al. 2015; Wang and Shen 2016; Kendig et al. 2017; Wang et al. 2018), disease infections (Case and Paxson. 2009), access to healthcare (Zeng et al. 2007; Liu et al. 2019), parental SES (Zhang et al. 2008; Wen and Gu 2011; Shen and Zeng 2014; Gong et al. 2015; Zhang et al. 2018b; Zhang and Crimmins. 2018; Adhvaryu et al., 2019), adversity (Yang and Lou 2016; Tian et al. 2018), urban residence (Zhang et al. 2018b), neighborhood safety and cohesion (Lin and Chen 2021), nutritional status (Huang and Elo. 2009; Zhang et al. 2010; Zhang et al. 2018b), friendship (Zhang et al. 2018a), education and cognitive stimulation (Strauss et al. 2010; Langa and Larson 2014; Lin and Chen 2021), sibling gender-composition (Huang and Elo. 2009), childhood traumas (Yang et al. 2022; Cao et al. 2022b), exposure to social unrest (Islam et al. 2017), parent-child relationship (Zhang et al. 2018a), parenting skills (Krause, 1998), natural environments (Isen et al. 2017), exposure to famine (Wang et al. 2010;

Wang et al. 2012; Shi et al. 2013; Wang et al. 2015; Wang et al. 2016a; Wang et al. 2016b; Wang et al. 2017; Wang et al. 2017b; Wang et al. 2018b; Li et al. 2018a; Sun et al. 2018; see our meta-analysis in Figure 2), parental health behaviours (Nilsson, 2017), and migration and resettlement (Dong and Lee. 2014). These risk factors during childhood have been found to contribute to depressive symptoms, cognitive impairment, metabolic syndrome, frailty, reduced lung capacity, difficulty with activities of daily living (ADL) or instrumental activities of daily living (IADL), arthritis, and premature death.

#### **4. The Great Chinese Famine (1959-1961) and the Health of Older Adults**

Around half of the studies to date linking early life risk factors and ageing in China have leveraged exposures to this influential famine in human history (Lin and Yang 2000). Most Chinese people over age 60 today were exposed to the famine at some point in their early life. Animal and human studies suggest that the famine could have a **substantial** long-term impact on the burden of chronic diseases. Relationships between early-life undernutrition and adverse health outcomes in later life have been well-documented in the international literature (Victora et al. 2008).

Comparing birth cohorts exposed to the famine *in utero* or the postnatal period to those who were not directly exposed, several diseases in midlife or later life have been linked to exposure to this particular source of nutritional adversity. For example, famine exposure is associated with lower birth rates (St Clair et al. 2005), higher incidence of disability and illiteracy (Mu and Zhang 2011), elevated risks of hyperglycemia (Sun et al. 2018), fatty liver disease (Wang et al. 2016a), anemia (Shi et al. 2013), schizophrenia (St Clair et al. 2005; Song et al. 2009), shorter stature and obesity (Yang et al. 2008; Wang et al. 2010; Chang et al. 2018; Wang et al. 2010), diabetes (Wang et al. 2015), metabolic syndrome (Li et al. 2011; Wang et al. 2012; Wang et al. 2017), depression (Li et al. 2018a; Li et al. 2018b), arthritis (Wang et al. 2018b), chronic lung diseases (Wang et al. 2017b).

We identified relevant research articles by searching PubMed, Embase, Chinese Wanfang Data and Chinese National Knowledge Infrastructure databases. As shown in Figure 2, data from 19 studies could be used for a meta-analysis of overweight and obesity, diabetes, hyperglycaemia, metabolic syndrome, schizophrenia, fatty liver disease, anemia, depression, and arthritis. These studies provided data on famine births and post-famine births. Several reports findings for more than one health condition. The

forest plot above shows effect estimates for health conditions comparing famine births with post-famine births serving as controls.

The summary effect estimates from random effects models show increases in the odds of overweight (OR 1.10; 95% CI: 1.00–1.21), hyperglycaemia (OR 1.48; 95% CI: 1.19–1.84), metabolic syndrome (OR 1.32; 95% CI: 1.03–1.70) schizophrenia (OR 1.52; 95% CI: 1.29–1.77), fatty liver disease (OR 1.39; 95% CI: 1.16–1.65), anemia (OR 1.45; 95% CI: 1.04–2.02) and depression (OR 2.07; 95% CI: 1.80–2.38). No significant effects are found for likelihood of being obese (OR 1.07; 95% CI: 0.81–1.41), diabetic (OR 1.41; 95% CI: 0.99–2.01), hypertensive (OR 1.14; 95% CI: 0.99–1.32), or arthritic (OR 1.04; 95% CI: 0.86–1.26). The estimates from fixed-effects and random effects models were comparable, although as expected the 95% CIs of random-effects models were wider due to between-study heterogeneity.

While much evidence so far has pointed to infancy, in comparison to *in utero* or in childhood, as the most critical period of nutritional adversity affecting health in later life (Wang et al. 2015; Wang et al. 2017; Wang et al. 2010; Wang et al. 2017b), some evidence also suggests adverse shocks during the first two trimesters of pregnancy may have even more impact on specific health outcomes (Wang et al. 2012; Li et al. 2018b). It would be useful to consider why the effects of malnutrition differ so much within this short time window in early life.

Salient gender differences are found for the impact of the Great Chinese Famine. Female survivors often demonstrate worse health outcomes as adults and into old age (Mu and Zhang 2011; Sun et al. 2018; Wang et al. 2016a; Yang et al. 2008; Wang et al. 2017; Wang et al. 2010; Li et al. 2018a; Chang et al. 2018; Wang et al. 2018b; Wang et al. 2017b). A plausible explanation is that the scarring effect often overwhelms mortality selection for women, while mortality selection trumps the scarring effect for males, resulting in larger detrimental health effects for female survivors than for male survivors.

Owing to biased food distribution toward urban China, rural areas were generally struck harder by the famine and suffered greater excess mortality. Therefore, the differential offsetting effects of mortality selection and scarring lead rural survivors to demonstrate smaller long-term health consequences than their urban counterparts (Song et al. 2009). Moreover, there is often a null or even positive effect of the famine on later-life disease risks among rural survivors but not among urban survivors. This is at least partly due to the much larger mortality selection effect in rural areas (Xu et al.

2016).

The adverse effect of the famine on late-life health tends to be larger for more vulnerable groups, such as those who are overweight or obese, lived in severely affected areas, or had lower educational attainments (Shi et al. 2013; Wang et al. 2016b; Wang et al. 2018b).

Importantly, early life exposure to the famine, coupled with ‘rich’ nutrient environment later in life, imposes further risks to health in old age, especially for those of high economic status (Wang et al. 2016a; Wang et al. 2015). Two historical events in China stood out as the driving force. Afflicted by the Great Chinese Famine in 1959-1961, people who suffered from undernutrition in early life may develop a “thrifty genotype” that altered the body’s physiology and metabolism to survive from food shortage. Such thriftiness, however, may become maladaptive as undernutrition was followed by rapid economic development since 1978 and the resulting nutritional abundance in later life, leading to higher risks of obesity, type 2 diabetes, and coronary heart diseases (Neel, 1999).

## **5. Measuring the Contributions of Early Life Circumstances to Health in Older Ages**

A few studies have recently assembled comprehensive domains of risk factors to understand better how various childhood factors may coalesce and manifest in health inequality later in life (Yan et al. 2020). Measuring each risk factor's *absolute* and *relative* contributions to old-age health can inform public policies that aim to achieve efficient and equitable resource allocation in a way that mitigates health inequality and disparities among population subgroups. For example, a burgeoning literature shows that in China, low educational attainment is the most important contributor to the risk of late-life phenotypic and functional aging, followed by low childhood neighbourhood quality, poor childhood health, and low paternal education (Li et al. 2020; Liu et al. 2019; Cao et al. 2022a). In the United States, genetic, behavioural, and socioenvironmental circumstances in early life account for about 18 percent of phenotypic ageing differences. Genetic factors contribute more than childhood SES, childhood health and adversity (Liu et al. 2019). In both China and the United States, prospects for child cognitive development (as indicated by the number of books at home), family SES, and childhood health status are all important predictors of frailty and mental illness in old age (Chen and Huo 2019). Among older Chinese, region and



rural/urban status at birth are key predictors of risk factors, but these are less important for older Americans (Chen et al. 2022).

Decomposing the contribution of a comprehensive set of childhood circumstances to health variations in old age, Figure 3 displays their overall contribution and the roles of each domain. Specifically, the domain of war and economic crisis includes variables associated with World War II and China's Civil War (1946-1949) period. The domain of regional and urban/rural status involves rural/urban status at birth and six Chinese geographic regions. Family SES includes parental party membership, parental schooling, financial status, and type of residence at birth. Health and health behaviours include measures of parental health condition, alcohol consumption and smoking. Health and nutrition conditions include self-rated health and hunger experiences in childhood, vaccination, access to various types of healthcare. Relationship with parents includes co-residence and child abuse; and finally, friendship in children measures the number of good friends in childhood.

Figure 3 shows that a set of seven domains of childhood circumstances may account for 20-33 percent of health variations in old age. Overall, their contributions to mental health and cognitive health are larger than their contributions to frailty and self-rated health. Exposure to war or economic crisis contributes to elevated risks of frailty (5%), cognitive impairment (5.5%), mental illness (4%), and poor self-rated health (6%). Being born in less developed regions or in rural areas and poor child health also contribute significantly to worse outcomes of all four health measures. Low family SES, poor parental health and unhealthy behaviours, and lack of friends in childhood contribute more to mental illness and cognitive impairment than to the other health measures. Bad relationship with parents contributes more to mental illness than to the other health measures.

Overall, adverse health outcomes attributable to early life environments are largely beyond the realm of individuals' choices. An important principle emphasized in Equality of Opportunity (EOP) is that childhood circumstances are illegitimate sources of health inequality that deserve prioritized policy interventions (Roemer 1998; Andreoli et al. 2019). Therefore, policies should be implemented to eliminate or compensate for health inequality resulting from childhood circumstances (Roemer and Trannoy 2016).

## **6. Concluding Remarks**

The comprehensive dimensions of early life circumstances and multiple health-related sectors affecting healthy ageing call for a holistic life-course approach and instrumental actions to promote public health in an aging society. Such interventions can be most successful if applied early in the life course, targeting women of childbearing age and childhood, before the onset of disease and disability, to slow the ageing process and benefit population health and quality of life in old age.

The implementation of Healthy China 2030 national initiative since 2016 has been calling for more comprehensive approaches to serving population health, including transformation from managing disease episode to full life-cycle health management as well as from health policy narrowly defined to Health-in-All policies (The State Council of China 2016). The best scientific evidence so far linking a wide range of early life circumstances with old-age health in China will inform policy and interventions.

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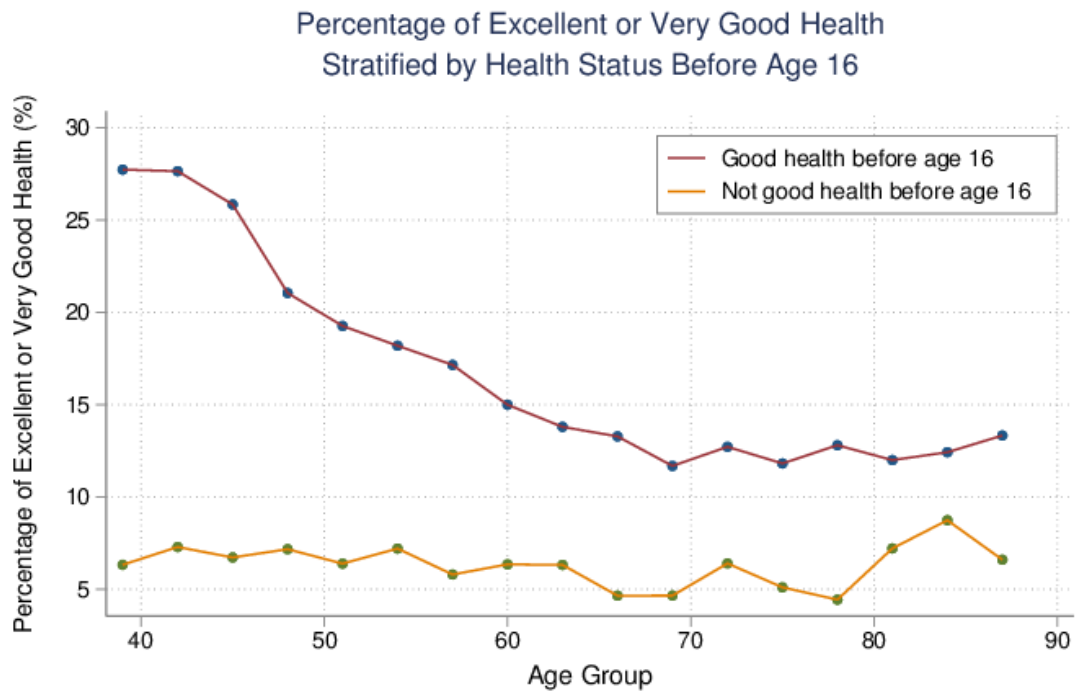
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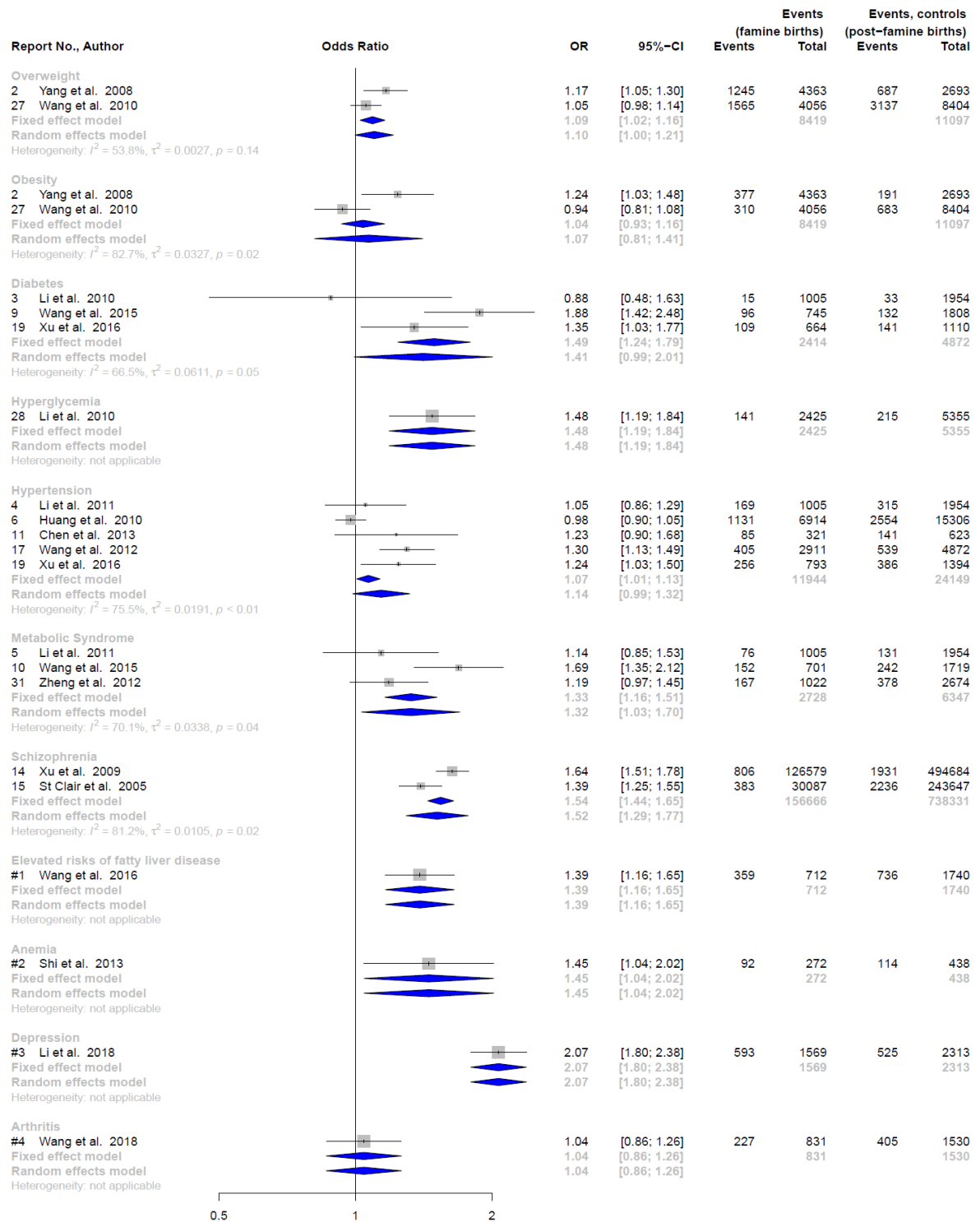
**Figure 1. Self-rated Health among Middle-Aged and Older Adults by Child Health**



Data: CHARLS National Sample (2011, 2013, 2015)

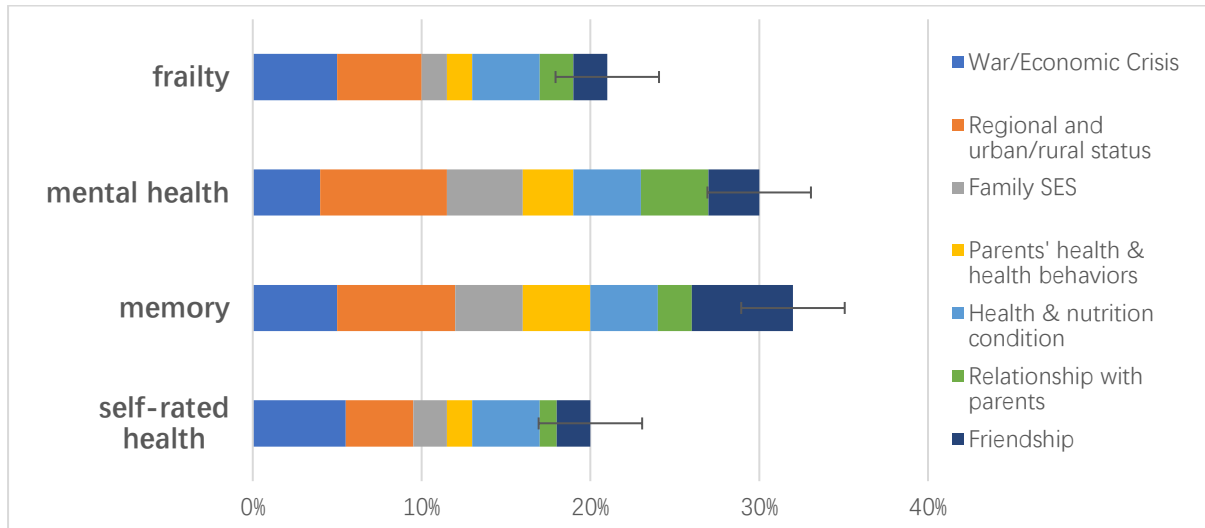
Notes: In this figure, each respondent in the longitudinal survey is only counted once. In cases when a respondent participated in multiple waves of survey, information on the earliest wave of participation is used in plotting the figure.

**Figure 2. Effect estimates on selected health conditions comparing famine births with controls (post-famine births, meta-analysis)**



Notes: Mantel-Haenszel fixed-effects model summary estimates and DerSimonian-Laird random-effects model summary estimates are reported. Boxes and horizontal lines represent odds ratios (OR) and 95% confidence intervals (CIs) for each outcome. The size of each box is proportional to the weight of the report for each outcome. Diamonds represent the 95% CI for pooled estimates of effect and are centred on the pooled odds ratio of a fixed-effects model or a random-effects model of each outcome.

**Figure 3. Contribution to Health Inequalities in Old Age by Domain of Childhood Circumstances**



Notes: A parametric Shapley Value Decomposition approach is implemented.