

Stockholm Research Reports in Demography | SRRD 2017:21



# Origins of Sickness

Evidence from China Famine Survivors in Sweden

Haodong Qi



Stockholm  
University

Demography Unit

ISSN 2002-617X | Department of Sociology

# Origins of Sickness

Evidence from China Famine Survivors in Sweden

Haodong Qi

*Stockholm University Demography Unit*

**Abstract:** This paper examines the effects of early-life malnutrition on adult health with a unique study population, those born around China Famine 1959-61 and later migrated from China to Sweden. The homogeneity and positive selectivity of this population minimizes mortality selection bias between the exposed and unexposed group. The findings are in stark contrast to previous estimates that were likely to be conservative due to culling effect. Specifically, this study shows that famine births are associated with an increased number of sick days. And this scarring effect is stronger among male survivors than female.

Keywords: Famine, Malnutrition, Migration, Sickness

Stockholm Research Reports in Demography 2017:21

ISSN 2002-617X

© Haodong Qi



This work is licensed under a [Creative Commons Attribution 4.0 International License](https://creativecommons.org/licenses/by/4.0/).

# 1 Introduction

The “Fetal Origin Hypothesis” posits that adverse early-life condition may exert long-term impact on adult health, the so-called “scarring effect” (Barker and Osmond, 1986; Barker et al., 1989; Godfrey and Barker, 2000). This hypothesis has been prominent in health research with many supporting evidence from observational studies, which suggests that public health policy might need to take a long-term perspective by including interventions early in life, in addition to modifying health behavior during adulthood. It is also of interest among social scientists to examine its implications for human capital and economic wellbeing over individual’s life-course (Almond and Currie, 2011). Empirical evidence generally show a positive association between birth condition and educational/socio-economic outcomes later in life. This positive association holds important implications for social, welfare, and economic policies, such that any disadvantages in lifetime opportunities (e.g. schooling, earnings, employment, etc.) that are accumulated from birth need to be tackled. However, the key is how to identify the early life effect (and isolate it from other factors) on health, as well as on other socio-economic outcomes.

Birth weight is commonly used as a marker for early-life conditions (Almond and Currie, 2011; Currie, 2011). And low birth weight is often associated with adverse health, educational, and/or labor market outcomes (Almond, 2006; Almond et al., 2007; Currie and Moretti, 2007; Oreopoulos et al., 2008; Black et al., 2007; Royer, 2009). However, Stein et al. (1975) showed that cohorts exposed to Dutch famine during the first half of pregnancy had normal birth weight, but higher risk of heart diseases later in life. And those exposed during second half of pregnancy had lower birth weight, but were healthier during adulthood. This raises the issue of whether birth weight adequately reflects early-life condition.

Moreover, the relation between birth weight and later-life outcomes may be confounded by factors that might correlate with both variables, but unobservable to researchers. For instance, Fetal Alcohol Syndrome suggests that children of alcoholic mother are more likely to have anomalies (Karp et al., 1995). And mother’s drinking behavior (if persists along childhood development) might also affect children’s education and socio-economic wellbeing. However, the duration and intensity of mothers drinking are seldom available in empirical data, thus the long-term effect of anomalies might be overstated. This is particularly challenging when studying adult outcomes, as parental and family characteristics are less traceable.

An alternative approach to identify early-life effects is to rely on non-laboratory

experiments, namely comparing a population naturally exposed to certain exogenous shocks during early life with those unexposed. Many have shown that fetal exposure to extreme conditions exerts adverse impacts on both health and wellbeing. For example, the average wage was 5% lower for children of infected mothers during the 1918 Influenza (Almond, 2006). Obesity rates were doubled among births exposed to the Dutch Hunger Winter (Ravelli et al., 1976). Births during the China Famine 1959-61 are less likely to work (Almond et al., 2007), and at higher risks of obesity, diabetes, hypertension, and/or Schizophrenia (St Clair et al., 2005; Wang et al., 2012, 2015; Xu et al., 2009, 2016; Yang et al., 2008). However, these evidence from extreme historical events may be conservative due to a culling effect - excessive mortality tends to wipe out the frailest in a population exposed to the shock, so that only the strongest survive, which may underestimate the true scarring effect. Indeed, a recent meta-analysis shows that the effects of fetal exposure to China famine 1959-61 tend to be small and insignificant when pre- and post-famine births are included as age-balanced controls (Li and Lumey, 2017).

This paper seeks to identify the early-life effects on adult health with a unique study population, those born around China famine 1959-61 and later migrated from China to Sweden. This migrant group is highly selective and homogeneous in terms of education and skills, and/or wealthy family background prior to going abroad, which helps minimize the potential culling effect, and obtain less biased scarring estimates. Mortality selection may be gender specific, such that excessive deaths are more likely to concentrate among males, compared to females (Almond et al., 2007; Sen, 1981). As a result, previous studies tend to find stronger famine effects on women than men (Chen et al., 2014; Huang et al., 2012; Wang et al., 2010, 2015; Yang et al., 2008; Zheng et al., 2012). And Mu and Zhang (2008) found that two-thirds of this difference may be explained by the gender-specific culling effect. Given the homogeneity of migrant population, this paper also examines the natural gender differences in famine impact on adult health.

It is noteworthy that the China Famine births in Sweden are fully affected by the Swedish Notional Defined Contribution pension system (NDC), which imposes substantial financial penalty for early retirement. If this population indeed tends to have worse health outcomes, they might struggle to work longer and eventually face large pension reduction when retiring. Hence, the findings in this paper hold important policy implication, in terms of whether a pension system that financially discourages early retirement need to consider supplementary policies to help those who are too sick to work longer due to accumulated disadvantages from birth.

## 2 Early-Life Famine Exposure and Adult Health

Early-life malnutrition may exert long-term adverse impacts on health (Barker and Osmond, 1986; Barker et al., 1989; Godfrey and Barker, 2000). Such health consequences are also suggested by economic theories, whereby an early-life health shock persists, or even amplifies, over the life-cycle, and ultimately leads to health deficits or low health capital (Heckman, 2007; Dalgaard and Strulik, 2014). These theories received ample empirical support from studies using famine as a quasi-experiment. For example, births exposed to the Dutch Hunger Winter, as well as to the China famine 1959-61, are more likely to be overweight later in life (Yang et al., 2008; Stein et al., 2006, 2007). This in turn increases the risk of chronic diseases associated with obesity, such as cardiovascular disease and type II diabetes (Wang et al., 2012, 2015; Xu et al., 2016). These famine exposed births were also found to be at a high risk of schizophrenia (Hoek et al., 1998; St Clair et al., 2005; Xu et al., 2009).

However, recent meta-analysis recognized a significant flaw in many of the earlier studies on the China Great Leap Forward Famine (Li and Lumey, 2017). That is that those born during the famine years are mostly compared with post-famine births who are 3-5 years younger, which has led to an age bias between the treatment and control group. When the famine births are compared with the age-balanced control groups, the estimates for most health outcomes became small and insignificant, except for schizophrenia. While schizophrenia seems to be a robust health consequence of early-life exposure to the China famine, as well as to the Dutch Hunger Winter, it received little support from the Finnish Famine 1866-68 and the famine caused by the siege of Leningrad (Kannisto et al., 1997; Stanner et al., 1997).

In brief, the long-term health effects of early-life famine exposure may be mild (as suggested by the aforementioned meta-analysis), or even debatable (given the inconsistent findings across different famine episodes). One explanation for some of the small and insignificant effects might be that early life conditions are less important for adult health, as Grossman (1972) suggested that the shock effect diminishes over time by continuous investment in health capital. However, the implicit assumption embedded in Grossman's model is that individuals are educated enough to efficiently invest time and money in health capital. This implies that, in order to offset the scarring effect, famine exposed births need to be sufficiently more educated than those unexposed, which however is unlikely to be true, as most famine exposed births were found to be worse off in educational outcomes (Currie and Moretti, 2007; Black et al., 2007; Oreopoulos et al., 2008; Royer, 2009).

An alternative explanation would be that survivors from severe famine tend to be healthier, compared to the population average. This mortality selection or culling effect might offset the scarring effect. Rasmussen (2001) argued that this is likely to be the explanation for the mild effects in Leningrad and Finland, as infant mortality rate was so high during the famine period. For the China famine 1959-61, the scope of culling may be even larger. Total fertility rates dropped by one-third during China famine 1959-61, and rebounded to 6 per woman in 1962, and mortality rates doubled in 1960. As a result, the 1990 China Population Census and the random survey sample (the China Health and Retirement Longitudinal Study - CHARLS) revealed a noticeable deficit in cohort size among those born during 1959-61 (Kim et al., 2016; Meng et al., 2015). This dramatic mortality increase coupled with sharp fertility decline indicates that the survivors are likely to be the strongest. As a result, the detected effects of fetal exposure to China famine 1959-61 tend to be small and insignificant when pre- and post-famine births are included as age-balanced controls (Li and Lumey, 2017).

### 3 Culling vs Scarring

This section explicitly elaborates how previous estimates for famine effects on health might be conservative due to a culling effect. Assuming adults who were born around the famine years can be classified as: 1) in good health and in bad health, 2) famine exposed and unexposed. The average level of sickness for the population can be written as,

$$\bar{\mu}(F) = \pi(F)\mu_b(F) + (1 - \pi(F))\mu_g(F) \quad (1)$$

where,  $\bar{\mu}$  is the average level of sickness,  $\pi$  is the proportion of population in bad health,  $\mu_b$  is the average level of sickness for population in bad health,  $\mu_g$  is the average level of sickness for population in good health, and  $F$  is an indicator of whether born during the famine.

The effect of famine exposure during early life on adult sickness can be written as the first-order derivative of (1), that is,

$$\bar{\mu}'(F) = \pi'(F)(\mu_b(F) - \mu_g(F)) + \pi(F)\mu_b'(F) + (1 - \pi(F))\mu_g'(F) \quad (2)$$

Barker's fetal origin hypothesis essentially suggests that the prevalence of sickness

would be greater among the famine exposed, compared to unexposed, that is the scarring effect. This effect may be present in both healthy and unhealthy population, and therefore one might expect  $\bar{\mu}'_g(F) > 0$  and  $\bar{\mu}'_b(F) > 0$ . Furthermore, The average level of sickness is expected to be higher among the population in bad health than those in good health, that is  $\mu_b(F) > \mu_g(F)$ . Given these relations, the average level of sickness among the famine births would be greater than the non-famine births, i.e.  $\bar{\mu}'(F) > 0$ .

However, the challenge of obtaining unbiased estimate for the scarring effect ( $\bar{\mu}'(F)$ ) is that the proportion of bad health in the famine exposed population may be different than the proportion in the unexposed population. In particular, with the presence of mortality selection, the most frail population tend to die out prematurely, as a result, the proportion of bad health being observed among the survivors tend to be smaller than that among non-famine births, i.e.  $\pi'(F) < 0$ . The negative culling effect ( $\pi'(F)$ ) may therefore suppress the scarring effect. As mentioned earlier, both the 1990 China Population Census and the China Health and Retirement Longitudinal Study showed a noticeable drop in cohort size for those born during the famine years, which is likely an outcome of selective prenatal and premature mortality caused by severe famine. And previous estimates using these type of survey and census data tend to find insignificant or even negative effects of famine on risk of diseases when the treated and control groups are age balanced. These surprising estimates are likely due to the culling effect.

In this paper, I focus on a population that is highly homogeneous between the famine-exposed and unexposed birth cohorts. Particularly, they are similarly and positively selected in terms of health, education, and even intention for migration from China to Sweden. In addition, the migrant population should not reveal any deficit among the famine birth cohorts, unless the approvals of visa applications are in favor of the non-famine births, or the size of the number of applications are unbalanced across cohorts. This homogeneity and positive selectivity in the sample permits two assumptions in the sickness model: 1) the frail composition between the famine exposed and unexposed births are the same, i.e.  $\pi'(F) = 0$ , and 2) the percentage share of population in bad health is close to zero, i.e.  $\pi(F) = 0$ . With these two assumptions, (2) may be reduced to (3) and reflects the health difference between treated and controlled groups among healthy population, which may be interpreted as a pure scarring effect. According to the fetal origin hypothesis, the effect of early life famine exposure on sickness in later life is expected to be positive, hence the derivative in (3) is greater than zero.

$$\bar{\mu}'(F) = \mu'_g(F) > 0 \quad (3)$$

As mentioned earlier, mortality selection may be gender-specific, as excessive premature deaths are more likely to concentrate among males than females (Almond et al., 2007; Sen, 1981). This implies that  $\pi'(F)$  in (2) may vary by gender, namely the negativity of this slope is stronger for men than women. This may, in turn, suppress the scarring effect on men's sickness to a greater extent, compared to the impact on women's, *ceteris paribus*. Previous studies using either China health survey data, or census data, consistently showed stronger adverse famine effect on women's health than men, and Mu and Zhang (2008) argue that gender-specific mortality selection is likely to be the main contributing factor for the gender difference in the famine effects. As the study population in this paper are homogeneous between famine and non-famine births for both gender, which provides an unique opportunity to examine the natural gender differences in scarring effects of early life exposure to famine, i.e.  $\mu'_g(F|Men)$  vs  $\mu'_g(F|Women)$ .

## 4 Data and Study Population

The analysis in this paper relies on Swedish register data. I use the STAR (Sweden in Time: Activities and Relations) collections of data organized by the Demography Unit and the Swedish Institute for Social Research at Stockholm University. The data covers entire population residing in Sweden during the period 1993-2012. The study population of interest is the immigrants in Sweden who were born in China during the Great Leap Forward Famine 1959-1961, as well as the neighboring birth cohort 1955-1958 and 1962-1964. Given the time coverage of the register data, each cohort born between 1955 and 1964 can be equally followed over age 38-48 on the yearly basis.

However, one important note is that the Chinese immigrant population in STAR is aggregated into the East-Asian population (EA), which contains migrants from Hong Kong, Japan, South Korea, Singapore, and Taiwan. Nevertheless, according to Statistics Sweden, 75% of men and 64% of women aged 45-54 in 2009 in the EA group were born in mainland China<sup>1</sup>, which makes the EA group fairly representative for the Chinese immigrant population.

Furthermore, I exclude the EA population who migrated to Sweden before 1986.

---

<sup>1</sup>Source: Foreign-born Persons by Country of Birth, Age, Sex and Year (Statistics Sweden).



This is because of the special emigration history in China. Emigration was impossible during the Chinese Culture Revolution between 1966 and 1976, and it remained extremely difficult until 1986. In early 1986, China first introduced policy that allows any individuals to apply for private passport instead of ordinary public passport that was only reserved for state employees with restricted use, and must be applied for by state institutions on behalf of employees (Xiang, 2016). This policy marks the beginning of liberalization of Chinese emigration since 1980s. Given this special emigration history, I assume that the proportion of EA population arrived in Sweden prior to 1986 are most unlikely to come from mainland China. And excluding them in the study population helps make the aggregated EA group be a more precise proxy for the Chinese immigrant population.

Chinese emigrants born around the famine years were lucky babies, not only in terms of their survival at birth, but also the possibility for going abroad in the late 1980s, when they were in their 20s. However, emigration was highly selective for this generation. The majority of them were student migration who were either selected by the Ministry of Education pushed by Deng Xiao Ping, or self-financed (Xiang, 2016). This suggests that those individuals who were able to go abroad were very homogeneous, in terms of high level of education and skills, and/or wealthy family background. Such a population allows for assuming a constant frail composition across both famine exposed and unexposed birth cohorts. Figure 1 shows that the EA population size gradually increased between the 1955 and 1964 cohorts, which is very different than the cohort pattern illustrated by Meng et al. (2015) and Kim et al. (2016) based on CHARLS and China Population Census. In particular, there is no visible deficit in population size among those born during the famine years 1959-1961. In other words, the study population here does not reflect any excessive prenatal and/or premature deaths in the famine-exposed cohorts. This sample characteristic is essential to estimate the unbiased scarring effects of famine exposure in early life, such as in (3).

Figure 1 about here

## 5 Descriptive Results

This paper seeks to understand how early-life malnutrition, measured by exposure to severe famine, affect adult health. Specifically, I use the average number of sick days per year over age 38-48 as a measure of adult health, and examine its difference between the famine exposed and unexposed births. The annual sick days

are recorded by the Swedish Social Insurance Agency (Forsakringskassan) when individuals claim for sickness benefits. These information are then compiled with other registers and maintained by Statistics Sweden.

Figure 2 illustrates the distribution of crude death rates over the period 1955-1964, and average annual sick days (over age 38-48) across the birth cohorts 1955-1964 for the East-Asian migrants coming to Sweden after 1986. The mortality variation clearly reveals that famine intensity was the strongest in 1960 among the three-year Great Leap Forward, death rate spiked from 12.5 in 1959 to 19 per thousand in 1960, a 52% increase during a single year.

Figure 2 about here

The mortality pattern is closely mirrored by the cross-cohort variation in sick days. Famine birth cohorts 1959-1961 are associated with a greater number of sick days, compared to those born before and after the famine. In particular, men born in 1960 (the year that mortality spiked), on average, spent 9 days per year on sick leave between age 38 and 48, which exceeded the cross-cohort mean by nearly two standard deviations, whereas the corresponding number is lower for women (7.7 days). For the rest cohorts, however, men, on average, had a lower level of sickness absence, compared to women. This cohort patterns generally indicate that male survivors from the famine appeared to be more vulnerable than female ones.

One important note is that sickness benefits from day 1 to day 14 are paid out directly by employer, only from day 15 onwards, they are paid by the Swedish Social Insurance Agency. Since the information on employer paid days are not systematically collected, the cross-cohort variation shown in Figure 2 only reflect the distribution of sick days that are paid by the Swedish Social Insurance Agency, and leaving the distribution of employer paid days unknown. This will certainly be a bias for estimating the average level of sickness for each birth cohort, it may also be a potential bias for examining the difference in sickness across cohorts, if the average employer paid sick days are not constant across cohort. The first bias is not a major concern in this paper, but the second one is, as the goal is to examine the relative sickness between famine-exposed and unexposed birth cohorts.

Although the number of employer paid sick days is unobserved, the propensity of reaching the upper limit of the employer paid 14 days (or, equivalently, the propensity of receiving sickness benefits from the Swedish Social Insurance Agency) may be observed. To do this, I decompose the average sick days into two components: 1) the percentage of the study population whose sickness exceeds 14 days, and 2) the

average number of sick days within the population whose sickness exceeds 14 days. The first component may be interpreted as the likelihood of being severely sick, and the second may reflect the intensity of sickness.

Figure 3 illustrates the cohort pattern of the percentage share of the East-Asian population who reached the maximum employer paid sick days. The pattern does not mirror the mortality variation, nor does it mimic the cohort difference in the average annual sick days, which were shown in Figure 2. This indicates that (in terms of the sickness at extensive margin of employer paid days) famine-exposed births (namely the 1960 cohort) are not much different than the other cohorts. And the increase in average sick days for the 1960 cohort that were shown in Figure 2 is unlikely to be driven by more individuals in this cohort who reached the upper limit of employer paid sick days.

Figure 3 about here

Figure 4 depicts the average number of sick days by cohort within the subsample whose sickness duration all exceeded the employer paid days. The cohort variation for men is similar to the patterns shown in Figure 2. In particular, the cohort born in 1960, the year that mortality spiked, had 155 social insurance paid sick days that were on top of the 14 employer paid days. In other words, among those who were severely sick (reached the ceiling of employer paid sick days), male survivors from the China famine, on average, spent 169 days per year on sick leave. However, the corresponding number for female survivors is merely 81 days, which is much lower than male's figure, and also shows little difference than the other birth cohorts. Taking the patterns in Figure 3 and Figure 4 altogether, it becomes clear that the overall increase in average sick days for men born in 1960 (shown in Figure 2) was largely due to the intensity of sickness among those who were severely sick, but not due to an increased number of individuals who became severely sick.

Figure 4 about here

It is noteworthy that the gender difference shown in Figure 2 and Figure 4 is quite on the contrary to previous findings. As stressed earlier, the main reason for the stronger famine impact on women in previous studies is that mortality selection may be gender-specific. This, however, is unlikely to be the issue for the study population in this paper, as seen from Figure 1, the cohort size in the sample, particularly those born in 1960, does not reveal any deficit for both men and women. Therefore, the difference between men and women observed here is likely to be the natural gender difference in terms of the famine effect on adult sickness.

## 6 Regression Results

This section presents the regression results for testing the hypothesis: whether early-life exposure to severe famine exerts an impact on adult sickness. The goal here is to quantify the magnitude, as well as examine the statistical significance, of the effect of famine exposure on number of sick days. For the regression analysis, only individuals whose sickness absence exceeded the employer paid days are included in the sample. This is to eliminate the unobserved difference in the employer paid sick days.

Two versions of models were estimated, which are distinguished by the measurements of famine exposure. The first version uses the log mortality during the year that an individual was born as a continuous measure for famine exposure. The coefficient in this version provides an estimate for the marginal effect of a unit increase in mortality during the birth year on the number of sick days. In the second version, exposure is classified by whether an individual was born before, during, or after the famine. And the estimated coefficients reflect the number of additional sick days due to early-life famine exposure. Note, in order to control for the heterogeneity among individuals of different characteristics, the sample are stratified by gender, and all regressions include fixed-effects for levels of education and marital status (measured at age 38).

The first two columns in Table 1 report the estimates for regression of sick days on log mortality during 1955-1964, China. On average, a 10% increase in crude death rate during the year of birth is associated with 7.2 additional days being sick for men, this figure, however, is merely 1.7 days for women, and statistically insignificant. The last two columns in Table 1 indicate that, compared to the post-famine birth, the pre-famine births had fewer, but insignificant sick days, yet the famine cohort 1959-1961 had a more prolonged duration of sickness. Nevertheless, the estimate for famine cohort is only statistically significant for men, but not for women. And the magnitude of this effect for men is four times greater than for women.

Table 1 about here

The statistical results presented here generally lend support to the fetal origin hypothesis that early-life malnutrition due to famine exposure elevates the intensity of sickness. This supporting evidence is in stark contrast to the results from the meta-analysis by Li and Lumey (2017), whereby the detected effects were small and insignificant. It is also saliently different than the evidence from the Finnish Famine

1866-68 and the siege of Leningrad. The different findings across various famine studies are likely to be the outcome of culling, which is minimal in the current analysis, but present in previous ones.

Moreover, unlike previous studies consistently suggest that the adverse famine impact is stronger on women than on men (Mu and Zhang, 2008), the results here show that the scarring effect is not only much smaller for women (compared to men), but also statistically insignificant. This contrasting finding is also likely to be associated with mortality selection. In particular, population size of the famine-exposed births show no visible drop within the migrant population from China to Sweden, whereas male survivors is noticeably fewer than female ones in the random survey sample (CHARLS) and China Population Census (Meng et al., 2015; Kim et al., 2016).

While the results reported here are unbiased in terms of selective mortality, they might still be conservative and biased towards lower bound. The true scarring effect could be even greater if the study population (both exposed and unexposed) is not as positively selected as the Chinese emigrants in Sweden, namely those who survived from the famine, but were not selected or unable to self-finance to study abroad.

## 7 Conclusion

Barker’s fetal origin hypothesis implies that impaired adult health may be associated with early-life malnutrition. This scarring effect, if established, suggests that health interventions should not only focus on adult health behavior, but also on factors associated with condition during birth and/or early childhood. It also holds important implications for social, welfare, and economic policies, such that any disparity in lifetime opportunities that arise from inequality at birth needs to be tackled. This paper revisits the fetal origin hypothesis, and seeks to identify the early-life effect on adult health. Specifically, it examines the differences in the onset and intensity of sickness between those who were born during the China Famine 1959-61 and the pre- and post-famine birth cohorts.

With a unique study population, migrants from China to Sweden who were homogeneously selected in terms of high level of human capital and family wealth prior to emigration, this paper overcomes one important drawback in previous quasi-experimental studies on severe famine, namely the culling effect. In particular, with minimal selective mortality in this study population, the scarring effect of famine

exposure during birth is noticeable. While the findings generally lend support to the fetal origin hypothesis, the estimated scarring effect is much stronger on men, compared to women. This is in stark contrast to previous estimates, whereby gender-specific culling was present. Specifically, the results here are more likely to reflect the natural gender difference in scarring effect of famine, as the study population is much more homogeneous, compared to those in previous studies, which is essential to rule out gender-specific mortality selection.

The findings in this paper hold two main implications. First, the elevated level of sickness among the China famine survivors in Sweden implies that this group might be associated with an impaired working life, e.g. limited employment opportunities and/or low income. This detrimental impact is likely to be amplified when they reach the retirement age, as these birth cohorts are fully affected by the new Swedish pension system (Notional Defined Contribution - NDC) which imposes strong financial penalty for early retirement. In other words, they might struggle for work longer, in order to receive adequate pension benefits that are largely determined by lifetime earning history. Hence, NDC, as one of the most important social and welfare policies in Sweden, needs to consider supplementary options for those who were unable to work longer due to accumulated disadvantages from birth.

Second, this paper raises a big concern for public health in mainland China, as the population size exposed to this tragic famine is roughly 35 million. And they have now reached their 50s, the age that various chronic diseases associated with fetal nutrition deficiency are about to be triggered. Although the findings provided in this paper might not be generalizable to the same cohorts in China, they are likely to be at the lower bound of the true scarring effect, as this migrant population in Sweden is more positively selected, compared to those who survived from the famine, but were unable to emigrate.

I would like to conclude this paper by discussing some caveats in this study. First, it is debatable to use crude mortality rates as a measure for famine intensity. It is certainly preferable to identify famine exposure by birth place and date. These information are unfortunately lacking in the Swedish register data. However, this may only be a concern for the magnitude, not for the direction of the estimates presented in this paper. Second, the study population actually contains the Chinese migrants together with those from other East-Asian countries. This may raise the concern for the extent to which this aggregated group represents the Chinese-born population. However, as discussed earlier, Chinese origin constitutes the majority of the East-Asian population. And with conditioning the sample by migration year

after 1986, the East-Asian population should reflect the key feature of the Chinese immigrant group, such as the cross-cohort variation in sick days presented in this paper. Finally, this study should be extended for more specific disease outcomes that are associated with early-life malnutrition, e.g. diabetes and heart diseases, which is possible to study based on other sources of Swedish administrative register data.

## Acknowledgments

We are grateful for financial support from the Swedish Research Council (Vetenskaprådet) via the Linnaeus Center for Social Policy and Family Dynamics in Europe (SPaDE), grant registration number 349-2007-8701.

## References

- Almond, D. (2006). Is the 1918 Influenza Pandemic over? Long-term Effects of in Utero Influenza Exposure in the Post-1940 U.S. Population. *Journal of Political Economy* 114(4), 672-712.
- Almond, D. and J. Currie (2011). Killing Me Softly: The Fetal Origins Hypothesis. *The Journal of Economic Perspectives* 25(3), 153–172.
- Almond, D., L. Edlund, H. Li, and J. Zhang (2007, September). Long-term effects of the 1959-1961 china famine: Mainland china and hong kong. Working Paper 13384, National Bureau of Economic Research.
- Barker, D., P. Winter, C. Osmond, B. Margetts, and S. Simmonds (1989). Weight in Infancy and Death from Ischaemic Heart Disease. *Lancet* 2, 577-580.
- Barker, D. J. P. and C. Osmond (1986). Infant Mortality, Childhood Nutrition and Ischaemic Heart Disease in England and Wales. *Lancet* 1, 1077–1081.
- Black, S. E., P. J. Devereux, and K. G. Salvanes (2007). From the cradle to the labor market? the effect of birth weight on adult outcomes. *Quarterly Journal of Economics* 122(1), 409-439.
- Chen, H., W. N. Nembhard, and H. G. Stockwell (2014). Sex-Specific Effects of Fetal Exposure to the 1959–1961 Chinese Famine on Risk of Adult Hypertension. *Maternal and Child Health Journal* 18(3), 527–533.

- Currie, J. (2011). Inequality at Birth: Some Causes and Consequences. *American Economic Review Papers and Proceedings* (2), 984-990.
- Currie, J. and E. Moretti (2007). Biology as destiny? short- and long-run determinants of intergenerational transmission of birth weight. *Journal of Labor Economics* 25(2), 231–264.
- Dalgaard, C. J. and H. Strulik (2014). Optimal Aging and Death: Understanding the Preston Curve. *Journal of the European Economic Association* (12), 672–701.
- Godfrey, K. M. and D. J. P. Barker (2000). Fetal Nutrition and Adult Disease. *American Journal of Clinical Nutrition* 71(5), 1344-1352.
- Grossman, M. (1972). On the Concept of Health Capital and the Demand for Health. *Journal of Political Economy* 80(2), 223–255.
- Heckman, J. (2007). The Economics, Technology, and Neuroscience of Human Capability Formation. *PNAS* 104(33), 13250–13255.
- Hoek, H., A. Brown, and E. Susser (1998). The dutch famine and schizophrenia spectrum disorders. *Social Psychiatry Psychiatr Epidemiology* 33(8), 373–9.
- Huang, C., M. R. Phillips, Y. Zhang, J. Zhang, Q. Shi, Z. Song, Z. Ding, S. Pang, and R. Martorell (2012, December). Malnutrition in Early Life and Adult Mental Health: Evidence From a Natural Experiment. *Social science & medicine* (1982) 97.
- Kannisto, V., K. Christensen, and J. Vaupel (1997). No increased mortality in later life for cohorts born during famine. *American Journal of Epidemiology* 145(11), 987–94.
- Karp, R. J., Q. H. Qazi, K. A. Moller, W. A. Angela, and J. M. Davis (1995). Fetal alcohol syndrome at the turn of the century: An unexpected explanation of the kallikak family. *Archives of Pediatrics and Adolescent Medicine* 149(1), 45-48.
- Kim, S., B. Fleisher, and J. Y. Sun (2016). The Long-term Health Effects of Fetal Malnutrition: Evidence from the 1959-1961 China Great Leap Forward Famine. *Health Economics*.
- Li, C. and L. H. Lumey (2017). Exposure to the Chinese Famine of 1959-61 in Early Life and Current Health Conditions: A Systematic Review and Meta-analysis. *The Lancet* 388.



- Meng, X., N. Qian, and P. Yared (2015). The Institutional Causes of China's Great Famine, 1959-1961. *Review of Economic Studies*.
- Mu, R. and X. Zhang (2008). Gender Difference in the Long-term Impact of Famine. Discussion paper, International Food Policy Research Institute (IFPRI).
- Oreopoulos, P., M. Stabile, R. Walld, and L. Roos (2008). Short, medium, and long-term consequences of poor infant health: An analysis using siblings and twins. *Journal of Human Resources* 43(1).
- Rasmussen, K. M. (2001). The "fetal origins" hypothesis: Challenges and opportunities for maternal and child nutrition. *Annual Review of Nutrition* 21, 73-95.
- Ravelli, G.-P., Z. A. Stein, and M. W. Susser (1976). Obesity in young men after famine exposure in utero and early infancy. *The New England Journal of Medicine* 295(7), 3493-53.
- Royer, H. (2009). Separated at girth: US twin estimates of the effects of birth weight. *American Economic Journal: Applied Economics* 1(1), 498-515.
- Sen, A. (1981). *Poverty and Famine: An Essay on Entitlement and Deprivation*. Oxford: Clarendon Press.
- St Clair, D., M. Xu, P. Wang, and et al (2005). Rates of Adult Schizophrenia Following Prenatal Exposure to the Chinese Famine of 1959-1961. *JAMA* 294(5), 557-562.
- Stanner, S. A., K. Bulmer, C. Andrs, O. E. Lantseva, V. Borodina, V. V. Poteen, and J. S. Yudkin (1997). Does malnutrition in utero determine diabetes and coronary heart disease in adulthood? results from the leningrad siege study, a cross sectional study. *BMJ: British Medical Journal* 315(7119), 1342-1348.
- Stein, A. D., H. S. Kahn, A. Rundle, P. A. Zybert, K. van der Palde Bruin, and L. Lumey (2007). Anthropometric measures in middle age after exposure to famine during gestation: Evidence from the dutch famine. *American journal of clinical nutrition*. *American Society for Clinical Nutrition* 85(3), 869-876.
- Stein, A. D., P. A. Zybert, K. van der Palde Bruin, and L. H. Lumey (2006). Exposure to famine during gestation, size at birth, and blood pressure at age 59 y: Evidence from the dutch famine. *European Journal of Epidemiology* 21(10), 759-765.

- Stein, Z., M. Susser, G. Saenger, and F. Marolla (1975). *Famine and Human Development: The Dutch Hunger Winter of 1944/1945*. New York: Oxford University Press.
- Wang, N., X. Wang, B. Han, Q. Li, Y. Chen, C. Zhu, Y. Chen, F. Xia, Z. Cang, C. Zhu, M. Lu, Y. Meng, C. Chen, D. Lin, B. Wang, M. D. Jensen, and Y. Lu (2015, October). Is Exposure to Famine in Childhood and Economic Development in Adulthood Associated With Diabetes? *The Journal of Clinical Endocrinology and Metabolism* 100(12), 4514–4523.
- Wang, P., J. J. Wang, Y. X. Lei, L. Xiao, and Z. C. Luo (2012, 11). Impact of Fetal and Infant Exposure to the Chinese Great Famine on the Risk of Hypertension in Adulthood. *PLOS ONE* 7(11), 1–8.
- Wang, Y., X. Wang, Y. Kong, J. H. Zhang, and Q. Zeng (2010). The Great Chinese Famine Leads to Shorter and Overweight Females in Chongqing Chinese Population After 50 Years. *Obesity* 18(3), 588–592.
- Xiang, B. (2016). Emigration Trends and Policies in China, Movement of the Wealthy and High Skilled. Technical report, Migration Policy Institute.
- Xu, H., L. Li, Z. Zhang, and J. Liu (2016). Is Natural Experiment A Cure? Re-examining the Long-term Health Effects of China’s 1959-1961 Famine. *Social Science & Medicine* 148, 110 – 122.
- Xu, M., W. S. Sun, B. X. Liu, G. Y. Feng, L. Yu, L. Yang, G. He, P. Sham, E. Susser, D. StClair, and L. He (2009). Prenatal Malnutrition and Adult Schizophrenia: Further Evidence From the 1959-1961 Chinese Famine. *Schizophrenia Bulletin* 35(3), 568.
- Yang, Z., W. Zhao, X. Zhang, R. Mu, Y. Zhai, L. Kong, and C. Chen (2008). Impact of famine during pregnancy and infancy on health in adulthood. *Obesity Reviews* 9, 95–99.
- Zheng, X., Y. Wang, W. Ren, R. Luo, S. Zhang, J. H. Zhang, and Q. Zeng (2012, February). Risk of Metabolic Syndrome in Adults Exposed to the Great Chinese Famine during the Fetal Life and Early Childhood. *Eur J Clin Nutr* 66(2), 231–236.

Figure 1: Cohort Size of East-Asian Population in Sweden

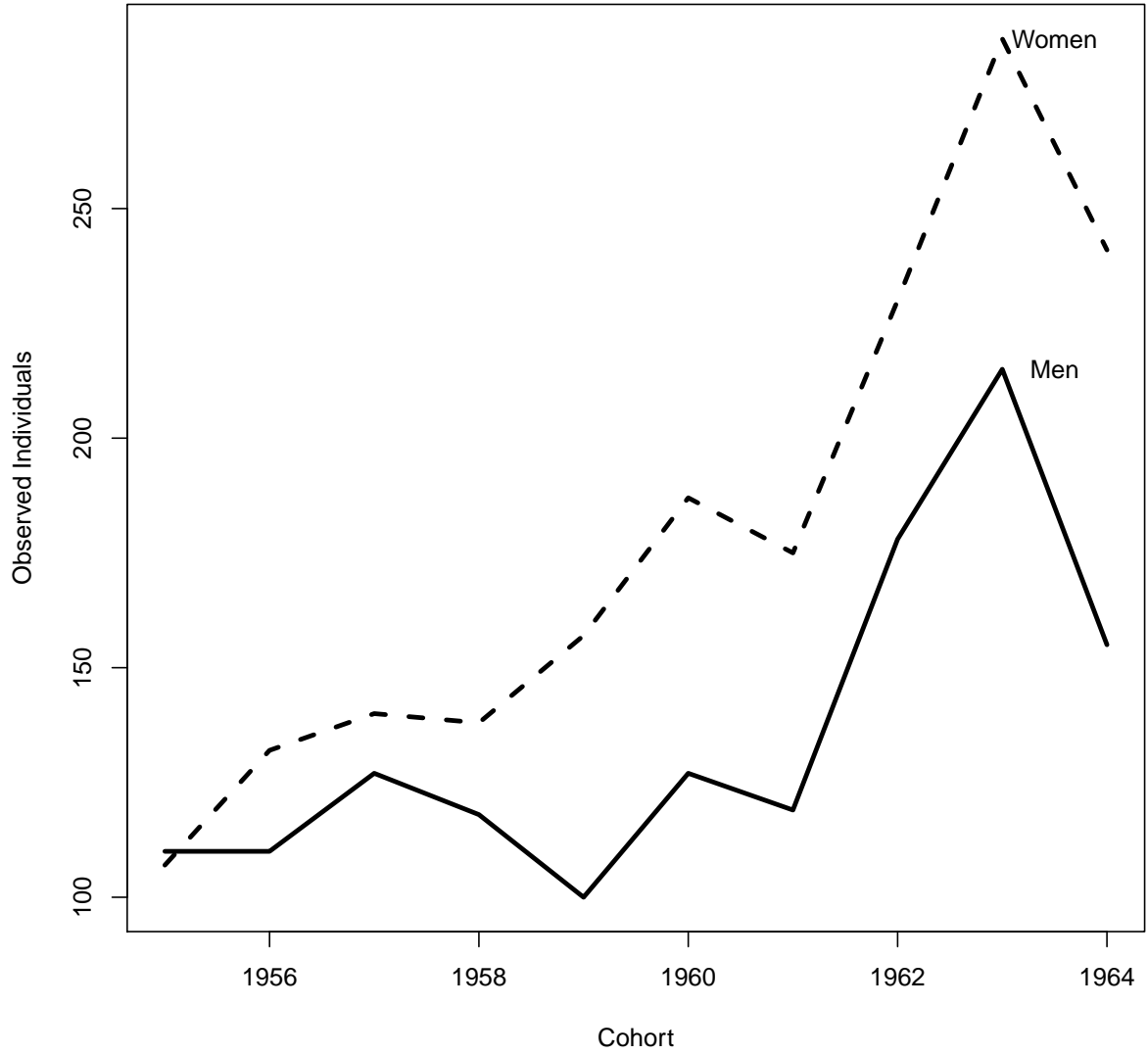
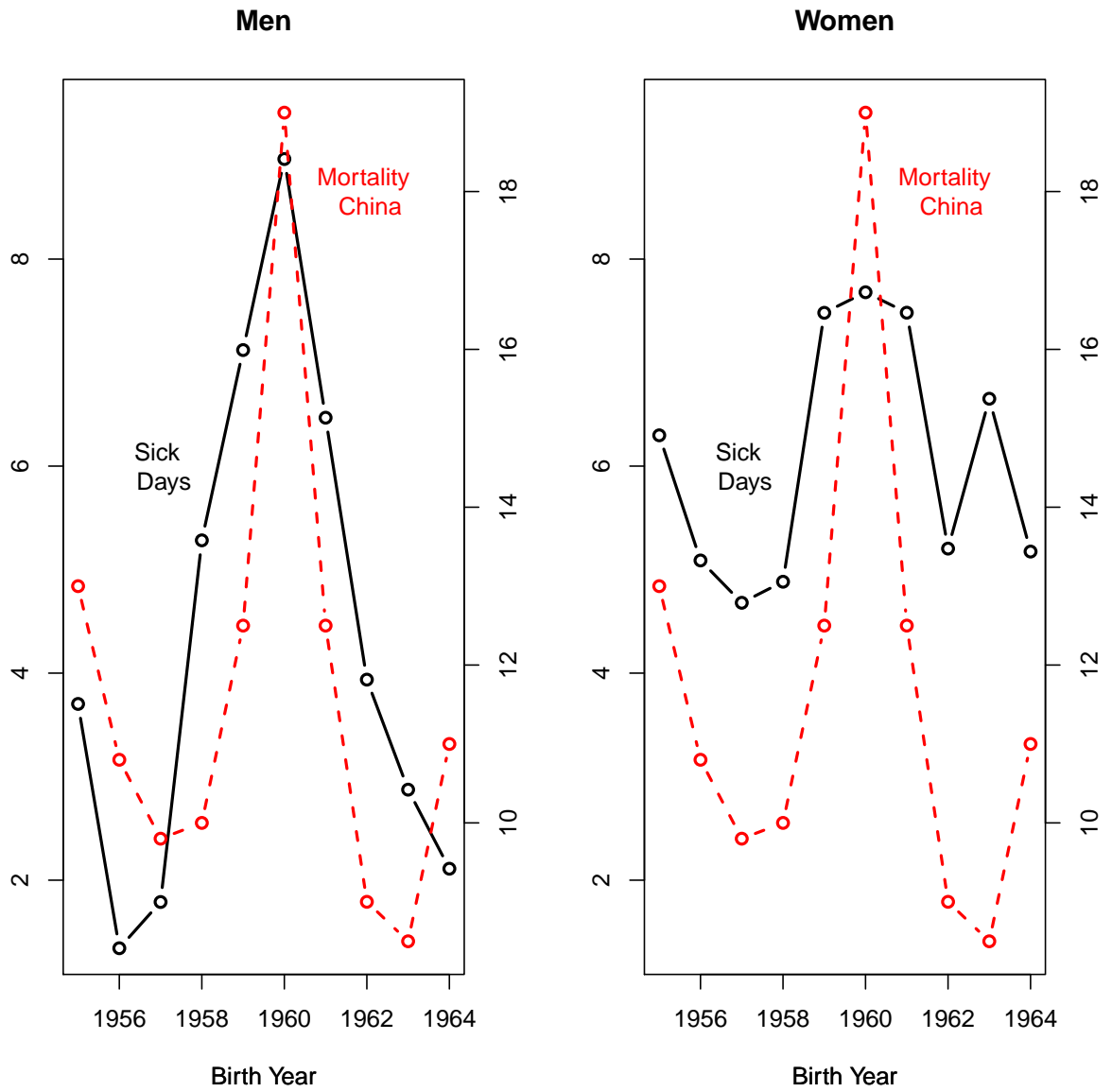


Figure 2: Average Annual Sick Days by Cohort and Crude Mortality Rate 1955-1964 China



Source: Mortality data is adapted from Meng et al. (2015).

Figure 3: Percentage of Sickness Over 14 Days by Cohort, East-Asian Population in Sweden

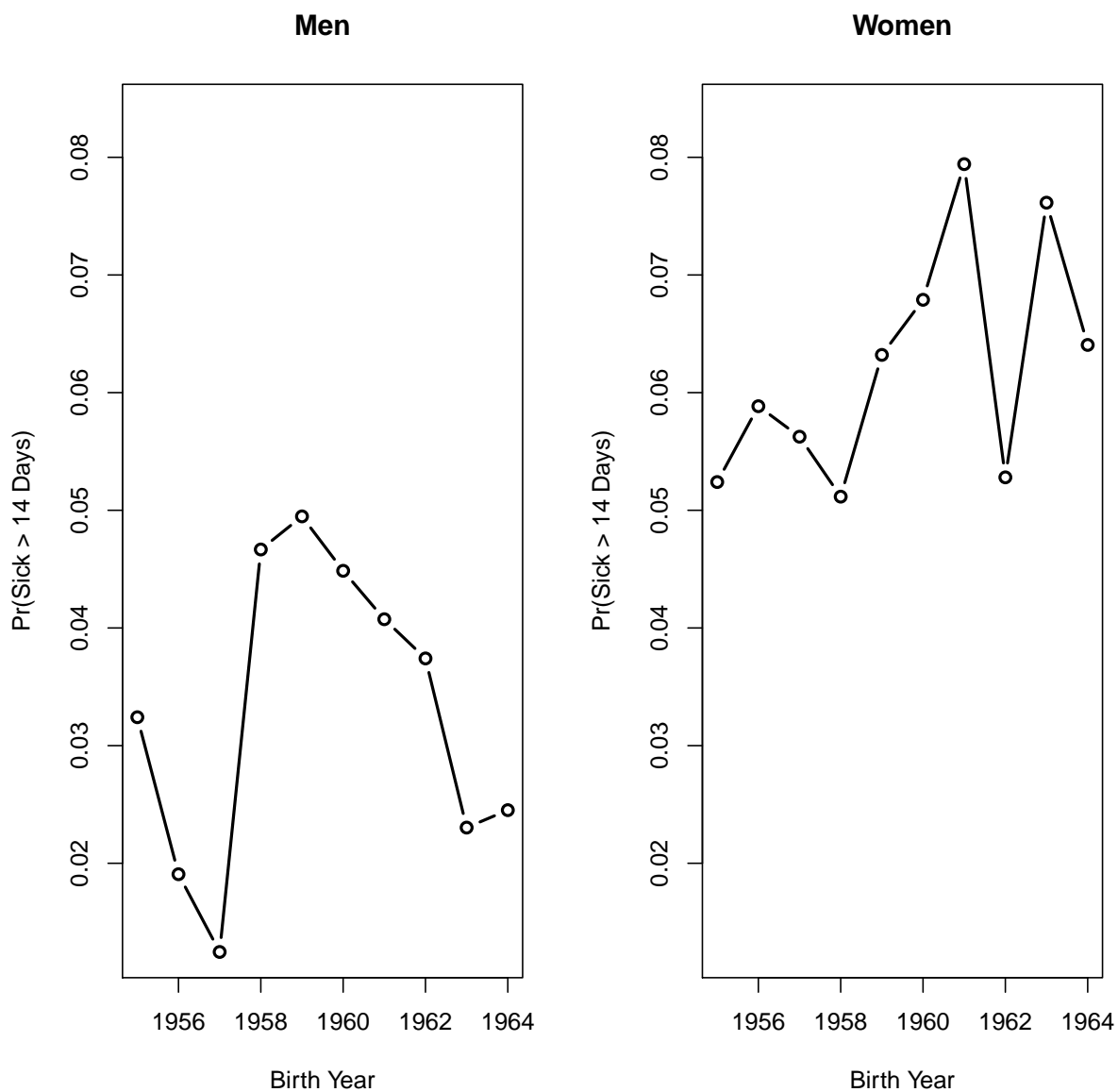


Figure 4: Sick Days After 14 Days by Cohort, East-Asian Population in Sweden

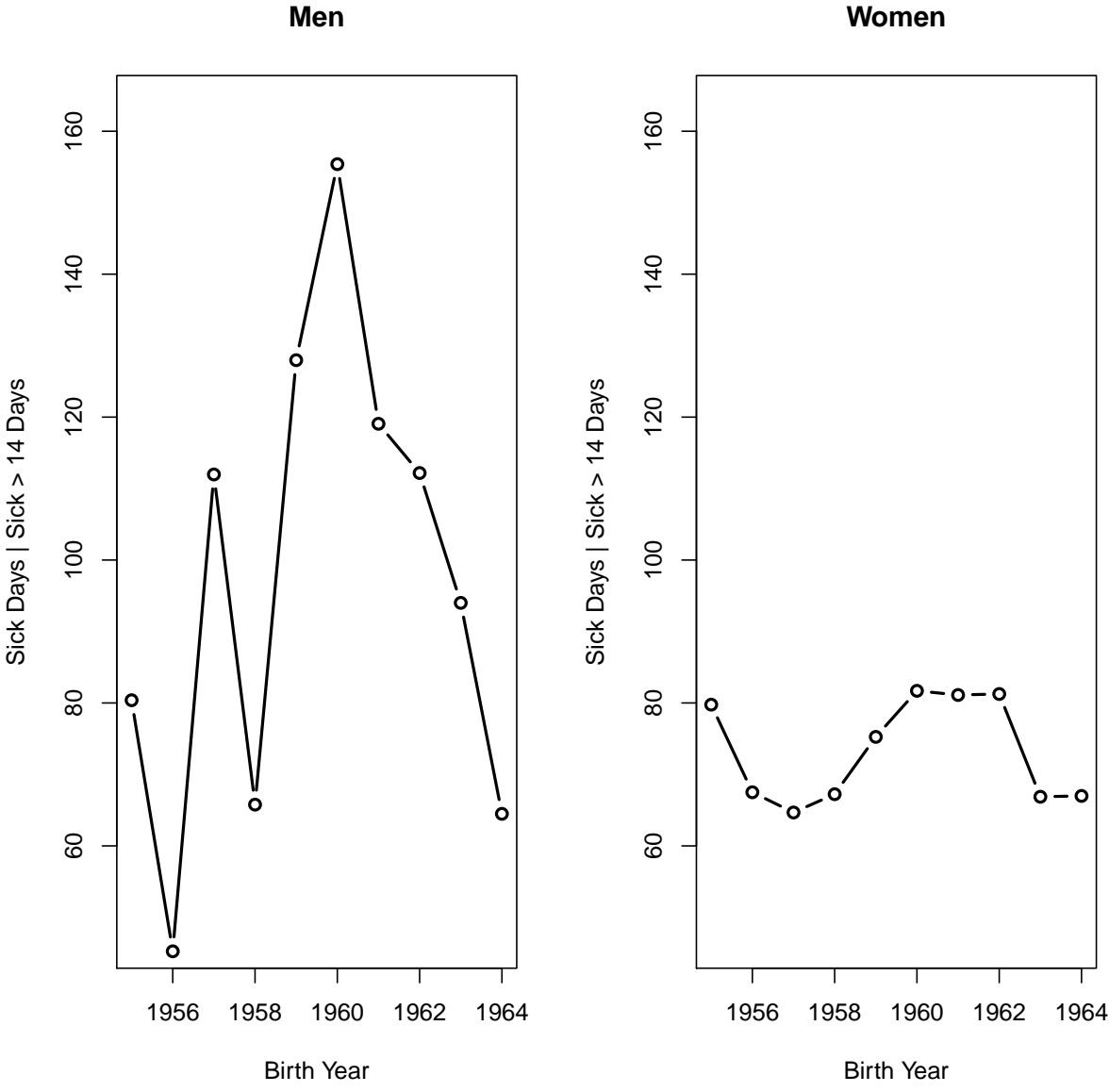


Table 1: Linear Regression on Individuals' Average Annual Sick Days Paid by Social Insurance, East-Asian Population in Sweden with Sickness Duration Exceeded Employer Paid Days

	<i>Dependent variable:</i>			
	Sick Days			
	Men	Women	Men	Women
log(Mortality)	72.488** (34.071)	16.875 (15.521)		
Cohort 1955-58			-17.646 (18.365)	-0.793 (8.960)
Cohort 1959-61			42.425** (18.699)	10.078 (8.474)
Cohort 1962-64			Ref.	
Primary Education			Ref.	
Secondary Education	-18.028 (19.690)	-15.774 (10.985)	-11.897 (19.475)	-15.844 (11.044)
University Education	-17.851 (18.998)	-7.036 (9.680)	-12.959 (18.835)	-7.022 (9.692)
Married	-25.010 (20.171)	-16.797* (9.289)	-18.629 (20.238)	-17.326* (9.289)
Unmarried			Ref.	
Constant	-47.211 (84.211)	52.323 (38.343)	112.281*** (21.526)	90.346*** (10.717)
Observations	165	496	165	496
Adjusted R <sup>2</sup>	0.019	0.005	0.045	0.004

*Note:*

\*p<0.1; \*\*p<0.05; \*\*\*p<0.01

**Stockholm Research Reports in Demography**

Stockholm University, 106 91 Stockholm, Sweden  
www.su.se | info@su.se | ISSN 2002-617X



Stockholm  
University

---

**Demography Unit**