ABSTRACT

Objective China's Great Famine between 1959 and 1961 has contributed to numerous adverse health outcomes in Chinese. This study aimed to examine the association between exposure to famine in early life and self-rated health (SRH) in adulthood.

Methods 4418 Chinese adults from the 2011 China Health and Retirement Longitudinal Study were included in the analysis. Multivariable logistic regression was conducted to estimate adjusted ORs (aORs) and 95% CIs of the association between exposure to famine in early life and SRH, stratified by sex.

Results Participants exposed to famine during infancy were more likely to report poor SRH (aOR 1.33; 95% CI 1.04 to 1.70) compared with the non-exposed group, adjusting for confounders. Males were 32% less likely than females to report poor SRH (aOR 0.68; 95% CI 0.54 to 0.86). Participants diagnosed with chronic diseases (aOR 3.11; 95% CI 2.68 to 3.61), disability (aOR 1.82; 95% CI 1.38 to 2.38) and vision impairment (aOR 2.07; 95% CI 1.72 to 2.49) were more likely to report poor SRH. Participants who were current alcohol users and with abnormal weight were less likely to report poor SRH. Stratification by sex showed no significant association between famine and SRH among males, but a consistently significant association was observed among females (aOR 1.46; 95% CI 1.02 to 2.12).

Conclusions Findings from this study indicated that females exposed to famine in China during infancy were more likely to report poor SRH in their adulthood. Implementing interventions to those who were exposed to famine in early life, especially for females, may improve their long-term consequences.

INTRODUCTION

China’s Great Famine that occurred between 1959 and 1961 resulted in 30 million Chinese citizens starving to death. The effects of this historical famine have been investigated in common adverse health outcomes among elderly Chinese in the last decades. Studies showed that exposure to the famine in an early stage of life was associated with an increased risk of developing chronic diseases later in life, including hyperglycaemic, diabetes and chronic kidney disease. Although the relationships between the famine and cause-specific diseases have been reported recently, there is a lack of large-scale studies on the impact of famine exposure and SRH. Future studies should consider these potential factors.
mental health, especially among older adults. Moreover, social and environmental factors have been documented to influence individuals’ health status. For example, lack of physical activity, obesity and lower socioeconomic status were related to poor SRH.

Biological sex is an obvious yet often-ignored social determinant of health. Central sex/gender theoretical concepts that considered a sex-gender perspective have been introduced in health science research to avoid sex bias. A previous study observed an association between famine and elevated risk of diabetes in both males and females. In contrast, another study found an increased risk of dyslipidaemia only in females exposed to famine during the early stages of life. Regarding famine exposure, there are still limited studies focusing on sex-specific measures. Therefore, building on previous literature, our study using unique national survey data from the China Health and Retirement Longitudinal Study (CHARLS) aims to: (1) examine whether different stages of famine exposure in early life were associated with SRH, and (2) assess sex-related differences in these associations.

METHODS
Study sample and the CHARLS survey
This is a cross-sectional study using the data from the CHARLS, a nationally representative longitudinal survey of persons aged 45 years or older and their spouses, including social, economic and health characteristics. The initial wave of the CHARLS survey was collected in 2011 and included 10,000 households, 18,245 individuals in 150 counties/districts and 450 villages/resident communities. A multistage probability sampling technique was used to create a sample using face-to-face, computer-assisted personal interviews. Individuals were followed up every 2 years, but this study only used baseline data (2011). Further details about the CHARLS data are available elsewhere.

Famine cohorts
We categorised famine exposure into four groups based on previous literature. Specifically, all cohorts were defined according to the participants’ birth dates. Participants (1) born between 1 October 1962 and 30 September 1964 were classified as the non-exposed cohort, (2) born between 1 January 1959 and 30 September 1961 were classified as fetal-exposed cohort, (3) born between 1 January 1958 and 31 December 1958 were classified as infant-exposed cohort and (4) between 1 January 1956 and 31 December 1957 were classified as preschool-exposed cohort. In 2011, their ages were 47–49, 50–52, 53, 54–55 years old for the non-exposed cohort, fetal-exposed cohort, infant-exposed cohort and preschool-exposed cohort, respectively. A total of 4,418 participants without missing data were included in the final sample.

Self-rated health
SRH was evaluated by the original question about how the respondents would rate their health status from CHARLS and treated as a dichotomous variable. Specifically, the response was measured on a 5-point Likert scale: 1=verygood, 2=good, 3=fair, 4=poor and 5=verypoor, which is consistent with prior studies. According to previous literature, the cut-off point was 3 and the respondents who reported ‘1’ (very good) or ‘2’ (good) were classified as ‘good’. Respondents who reported ‘3’ (fair), ‘4’ (poor) or ‘5’ (very poor) were all grouped as ‘poor’.

Demographic characteristics
Based on prior literature, we included demographic factors such as biological sex (male and female), education (less than elementary/elementary/middle school/higher than middle school), marital status (married and living with a spouse/married but not living with a spouse/separated or divorced or widowed/never married) and residence (rural and urban).

Covariates
Covariates were also selected according to previous studies. Smoking status was classified as current smoker, quit/former smoker, and never smoker. Drinking status was classified as current low frequency (<5 drinks per month) drinking, current high frequency (≥25 drinks per month) drinking, never-drinker or quitter, consistent with the Substance Abuse and Mental Health Services Administration report. Chronic disease was categorised as ‘yes’ if the participants had any of the following diseases: hypertension, dyslipidaemia, diabetes or high blood sugar, cancer or malignant tumour, chronic lung diseases, liver disease, heart disease, stroke, kidney disease, stomach or other digestive diseases, emotional/nervous/psychiatric problems, memory-related disease, arthritis and asthma. Vision impairment and disability status were coded as dummy variables as ‘yes’ or ‘no’ based on self-reports. We categorised body mass index [BMI (kg/m²)] into four groups: underweight (<18.5), normal weight (18.5–22.9), overweight (23.0–26.9) and obese (≥27.0), according to the BMI cut-off for Asian and Asian Americans.

Statistical analyses
Numbers and percentages were presented for the variables related to famine exposure. Since all included variables were categorical variables, χ² tests were employed to detect the association between each variable and famine exposure. Multivariable binary logistic regression models were used to assess the association between the exposure and outcome. Three adjusted models were used after adjusting for confounders (ie, demographic characteristics and covariates). Model A assessed the association between famine exposure and SRH. Model B and model C evaluated the association between famine and SRH among males and females, respectively. Data
## Table 1  Basic characteristics related to famine exposure for the overall sample (n=4418)

| Variables                  | Non-exposed cohort (n=1626) | Fetal-exposed cohort (n=892) | Infant-exposed cohort (n=576) | Preschool-exposed cohort (n=1324) | P value |
|----------------------------|-----------------------------|-----------------------------|-----------------------------|----------------------------------|---------|
| Age in 2011                | 47–49                       | 50–52                       | 53                          | 54–55                            |         |
| Birth date                 | 1 October 1962–30 September 1964 | 1 October 1959–30 September 1961 | 1 January 1958–31 December 1958 | 1 January 1956–31 December 1957 |         |
| Biological sex (%)         |                             |                             |                             |                                  | 0.0431  |
| Male                       | 762 (46.81)                 | 423 (47.37)                 | 307 (53.02)                 | 661 (49.96)                      |         |
| Female                     | 866 (53.19)                 | 470 (52.63)                 | 272 (46.98)                 | 662 (50.04)                      |         |
| Education (%)              |                             |                             |                             |                                  | <0.0001 |
| Less elementary            | 359 (22.05)                 | 241 (26.96)                 | 208 (36.05)                 | 565 (42.74)                      |         |
| Elementary                 | 323 (19.84)                 | 141 (15.77)                 | 103 (17.85)                 | 218 (16.49)                      |         |
| Middle school              | 603 (37.04)                 | 243 (27.18)                 | 161 (27.90)                 | 308 (23.30)                      |         |
| Over high school           | 343 (21.07)                 | 269 (30.09)                 | 105 (18.20)                 | 231 (17.47)                      |         |
| Marital status (%)         |                             |                             |                             |                                  | 0.0064  |
| Married with spouse present| 1386 (85.14)                | 749 (83.78)                 | 478 (82.70)                 | 1130 (85.28)                     |         |
| Married not living with spouse| 180 (11.06)                | 89 (9.96)                   | 60 (10.38)                  | 117 (8.83)                       |         |
| Separated/divorced/widowed | 54 (3.32)                   | 51 (5.70)                   | 30 (5.19)                   | 68 (5.13)                        |         |
| Never                      | 8 (0.49)                    | 5 (0.65)                    | 10 (1.73)                   | 10 (0.75)                        |         |
| Smoking status (%)         |                             |                             |                             |                                  | 0.0184  |
| Current                    | 428 (27.79)                 | 253 (29.98)                 | 179 (32.90)                 | 410 (32.64)                      |         |
| Quit/former                | 1030 (66.88)                | 552 (65.40)                 | 333 (61.21)                 | 764 (60.83)                      |         |
| Never                      | 82 (5.32)                   | 39 (4.62)                   | 32 (5.88)                   | 82 (6.53)                        |         |
| Drinking status (%)        |                             |                             |                             |                                  | 0.0023  |
| Current high-frequency     | 165 (11.26)                 | 99 (12.27)                  | 80 (15.24)                  | 171 (14.23)                      |         |
| Current low-frequency      | 284 (19.39)                 | 154 (19.08)                 | 90 (17.14)                  | 191 (15.89)                      |         |
| Quit/former                | 42 (2.87)                   | 23 (2.85)                   | 27 (5.14)                   | 60 (4.99)                        |         |
| Never                      | 974 (66.48)                 | 531 (65.80)                 | 328 (62.48)                 | 780 (64.89)                      |         |
| Residence (%)              |                             |                             |                             |                                  | 0.0757  |
| Rural                      | 1222 (75.15)                | 665 (74.55)                 | 454 (78.82)                 | 1033 (78.02)                     |         |
| Urban                      | 404 (24.85)                 | 227 (24.45)                 | 122 (21.18)                 | 291 (21.98)                      |         |
| Vision impairment (%)      |                             |                             |                             |                                  | <0.0001 |
| Yes                        | 346 (21.24)                 | 255 (28.52)                 | 171 (29.53)                 | 393 (29.66)                      |         |
| No                         | 1283 (78.76)                | 639 (71.48)                 | 408 (70.47)                 | 932 (70.34)                      |         |
| Physical activity (%)      |                             |                             |                             |                                  | 0.9152  |
| Light                      | 128 (7.86)                  | 70 (7.83)                   | 40 (6.91)                   | 110 (8.30)                       |         |
| Moderate                   | 187 (11.48)                 | 108 (12.08)                 | 74 (12.78)                  | 164 (12.38)                      |         |
| Vigorous                   | 267 (16.39)                 | 153 (17.11)                 | 84 (14.51)                  | 215 (16.23)                      |         |
| Insufficient               | 1047 (64.27)                | 563 (62.98)                 | 381 (65.80)                 | 836 (63.09)                      |         |
| Disability status (%)      |                             |                             |                             |                                  | 0.1059  |
| Yes                        | 183 (11.29)                 | 101 (11.43)                 | 86 (14.98)                  | 166 (12.62)                      |         |
| No                         | 1438 (88.71)                | 783 (88.57)                 | 488 (85.02)                 | 1149 (87.38)                     |         |
| Chronic diseases (%)       |                             |                             |                             |                                  | 0.0006  |
| Yes                        | 940 (58.68)                 | 521 (59.61)                 | 378 (66.32)                 | 839 (64.49)                      |         |
| No                         | 662 (41.32)                 | 353 (40.39)                 | 192 (33.68)                 | 462 (35.51)                      |         |
| Self-rated status (%)      |                             |                             |                             |                                  | 0.0004  |
| Good                       | 541 (33.50)                 | 276 (31.26)                 | 145 (25.17)                 | 370 (28.12)                      |         |
| Poor                       | 1074 (66.50)                | 607 (68.74)                 | 431 (74.83)                 | 946 (71.88)                      |         |

Continued
were expressed as adjusted ORs (aORs) with their corresponding 95% CIs. Statistical analyses were performed using SAS V.9.4 (SAS Institute) and a two-tailed \( p < 0.05 \) was considered statistically significant.

**Patient and public involvement**

In this study, we used baseline data from CHARLS, which is a nationally representative longitudinal survey. Therefore, no direct patient was involved and contacted.

**RESULTS**

Table 1 shows the characteristics of the study participants related to famine exposure (n=4418). Overall, 1626 (36.8%) participants were not exposed to the famine period, 892 (20.2%) were exposed in the fetal period, 576 (13.0%) were exposed in the infant period and 1324 (30.0%) were exposed in the preschool period. Across all four groups, a higher proportion was observed among participants who were married and lived with a spouse, lived in a rural area, reported SRH as poor. Furthermore, there was a higher proportion in the participants who were former smokers, never drinkers, without vision impairment and disability, with chronic diseases, had insufficient physical activity. Among the non-exposed group, a higher proportion was noticed in participants who had a middle school education (37.0%) compared with the other three groups. Among the fetal-exposed group, a higher proportion was found in participants who had more than a high school education (30.1%) compared with the other three groups. Among those who exposed to famine in the infant and preschool-exposed groups, 36.1% and 42.7% of participants reported incomplete elementary school education, respectively. About one third of participants in the non-exposed and fetal-exposed groups were overweight (30.0% and 30.3%, respectively). Overweight was higher among infant-exposed participants (31.1%) compared with other groups. Normal weight was higher among preschool-exposed participants (35.2%) compared with other groups.

Table 2 presents the results from multivariable logistic regression models assessing famine and SRH and stratified by biological sex. Infant-exposed participants were more likely to report SRH as poor compared to the non-exposed group after adjusting for confounders (aOR 1.33; 95% CI 1.04 to 1.70) (model A). Males were 32% less likely to report SRH as poor compared with females (aOR 0.68; 95% CI 0.54 to 0.86). Participants who had chronic diseases (aOR 3.11; 95% CI 2.68 to 3.61), disability (aOR 1.82; 95% CI 1.38 to 2.38) and vision impairment (aOR 2.07; 95% CI 1.72 to 2.49) were more likely to report SRH as poor. Interestingly, participants who were current alcohol users and whose weight was out of the normal range (ie, underweight, overweight and obese) were less likely to report SRH as poor.

In stratified analyses by biological sex, no significant association was observed between famine and SRH among males (model B), whereas the findings among female participants were statistically significant in the infant-exposed group (aOR 1.46; 95% CI 1.02 to 2.12) (model C). Both male and female participants who had chronic diseases, disability and vision impairment were more likely to report SRH as poor. Female participants who were married and lived with their spouse or were separated were more likely to report SRH as poor compared with those who were never married. Female low-frequency drinkers and former drinkers were less likely to report SRH as poor. Underweight females were less likely to report SRH as poor (aOR 0.72; 95% CI 0.54 to 0.97).

**DISCUSSION**

In this study, we observed that infant stage exposure to the Chinese famine significantly increased the likelihood of reporting SRH as poor in adulthood. After stratification by sex, in the infant-exposed cohort, females were consistently more likely to report poor SRH, while we did not observe a significant association with SRH in males. Besides, no significant differences were found among the other two famine-exposed cohorts and the non-exposed cohort in both males and females.

Famine exposure in infant-exposed individuals might be a critical factor for poor SRH in their adulthood. A possible explanation is that famine in early life is associated with chronic disease development, impacting SRH. 13-25 During early life, malnutrition could change...

---

**Table 1**

| Variables                  | Non-exposed cohort (n=1626) | Fetal-exposed cohort (n=892) | Infant-exposed cohort (n=576) | Preschool-exposed cohort (n=1324) | P value |
|----------------------------|-----------------------------|-----------------------------|-------------------------------|----------------------------------|---------|
| BMI (%)                    |                             |                             |                               |                                  | <0.0001 |
| Underweight                | 488 (29.96)                 | 271 (30.31)                 | 159 (27.46)                   | 354 (26.72)                      |         |
| Normal weight              | 443 (27.19)                 | 232 (25.95)                 | 171 (29.53)                   | 466 (35.17)                      |         |
| Overweight                 | 441 (27.07)                 | 262 (29.31)                 | 180 (31.09)                   | 324 (24.45)                      |         |
| Obese                      | 257 (15.78)                 | 129 (14.43)                 | 69 (11.92)                    | 181 (13.66)                      |         |

*Data were presented as numbers with percentages. BMI, body mass index.*
**Table 2**  Multivariate logistic regression assessing the association between famine and SRH (n=3864)

| Variables                          | Model A† Adjusted OR (95% CI) | Model B‡ Adjusted OR (95% CI) | Model C§ Adjusted OR (95% CI) |
|------------------------------------|-------------------------------|-------------------------------|-------------------------------|
| **Famine**                         |                               |                               |                               |
| Non-exposed                        | Ref.                          | Ref.                          | Ref.                          |
| Fetal exposed                      | 1.06 (0.87 to 1.30)           | 1.05 (0.78 to 1.42)           | 1.05 (0.79 to 1.38)           |
| Infant exposed                     | **1.33 (1.04 to 1.70)**       | 1.22 (0.87 to 1.72)           | **1.46 (1.02 to 2.12)**       |
| Preschool exposed                  | 1.16 (0.96 to 1.40)           | 1.10 (0.84 to 1.45)           | 1.21 (0.93 to 1.58)           |
| **Biological sex**                 |                               |                               |                               |
| Male                               | 0.68 (0.54 to 0.86)**         | –                             | –                             |
| Female                             | Ref.                          | –                             | –                             |
| **Marital status**                 |                               |                               |                               |
| Married with spouse present        | 0.81 (0.31 to 2.16)           | 0.35 (0.10 to 1.28)           | **11.24 (1.08 to 116.62)**    |
| Married not living with spouse     | 0.82 (0.30 to 2.25)           | 0.42 (0.11 to 1.68)           | 10.14 (0.96 to 107.39)        |
| Separated/divorced/widowed         | 0.94 (0.33 to 2.66)           | 0.34 (0.08 to 1.36)           | **14.97 (1.37 to 163.47)**    |
| Never                              | Ref.                          | Ref.                          | Ref.                          |
| **Education**                      |                               |                               |                               |
| <Elementary                        | 1.07 (0.87 to 1.32)           | 0.90 (0.65 to 1.25)           | 1.24 (0.94 to 1.65)           |
| Elementary                         | 1.13 (0.90 to 1.42)           | 0.99 (0.72 to 1.35)           | 1.34 (0.95 to 1.88)           |
| Middle school                      | Ref.                          | Ref.                          | Ref.                          |
| ≥High school                       | 0.94 (0.76 to 1.16)           | 0.93 (0.70 to 1.21)           | 1.01 (0.72 to 1.41)           |
| **Physical activity**              |                               |                               |                               |
| Light                              | 0.86 (0.66 to 1.11)           | 0.85 (0.57 to 1.27)           | 0.88 (0.61 to 1.26)           |
| Moderate                           | 1.05 (0.83 to 1.33)           | 1.25 (0.86 to 1.80)           | 0.93 (0.69 to 1.26)           |
| Vigorous                           | 0.99 (0.81 to 1.22)           | 1.14 (0.86 to 1.53)           | 0.84 (0.62 to 1.14)           |
| Insufficient                       | Ref.                          | Ref.                          | Ref.                          |
| **Drinking status**                |                               |                               |                               |
| Current high frequency             | 0.58 (0.46 to 0.74)**         | 0.64 (0.49 to 0.83)**         | 0.66 (0.31 to 1.40)           |
| Current low frequency              | 0.80 (0.65 to 0.99)**         | 0.95 (0.73 to 1.25)           | **0.63 (0.44 to 0.89)**       |
| Quit/former                       | 1.11 (0.72 to 1.69)           | 1.56 (0.95 to 2.56)           | **0.41 (0.17 to 0.97)**       |
| Never                              | Ref.                          | Ref.                          | Ref.                          |
| **Smoking status**                 |                               |                               |                               |
| Current                            | 1.03 (0.82 to 1.29)           | 1.02 (0.79 to 1.32)           | 0.90 (0.52 to 1.56)           |
| Quit/former                        | 1.23 (0.86 to 1.78)           | 1.22 (0.82 to 1.80)           | 1.43 (0.38 to 5.34)           |
| Never                              | Ref.                          | Ref.                          | Ref.                          |
| **Residence**                      |                               |                               |                               |
| Rural                              | 1.19 (0.99 to 1.44)           | 1.15 (0.87 to 1.50)           | 1.23 (0.94 to 1.60)           |
| Urban                              | Ref.                          | Ref.                          | Ref.                          |
| **Chronic diseases**               |                               |                               |                               |
| Yes                                | **3.11 (2.68 to 3.61)**       | 3.19 (2.57 to 3.97)**         | **3.16 (2.56 to 3.90)**       |
| No                                 | Ref.                          | Ref.                          | Ref.                          |
| **Disability status**              |                               |                               |                               |
| Yes                                | **1.82 (1.38 to 2.38)**       | **1.92 (1.33 to 2.76)**       | **1.64 (1.08 to 2.47)**       |
| No                                 | Ref.                          | Ref.                          | Ref.                          |
| **Vision impairment**              |                               |                               |                               |
| Yes                                | 2.07 (1.72 to 2.49)**         | 2.25 (1.70 to 2.97)**         | 1.91 (1.49 to 2.46)**         |
| No                                 | Ref.                          | Ref.                          | Ref.                          |
usual longer than males. This could be explained to report a health problem compared with males, they report a lower SRH. While females were more inclined to abnormal growth and metabolic function in adulthood. Moreover, epigenetic changes involved in normal development and human diseases may play an essential role, especially in the postnatal period leading to ‘metabolic imprinting’ as the biological mechanisms underlying the association between malnutrition in early life and metabolic diseases in adulthood. Individuals who were experiencing chronic diseases may be more likely to report poor SRH. Consequently, compared with the non-exposed cohort, participants exposed to famine in the infant-exposed group were more likely to report poor SRH.

Sex differences in the relationship between famine and SRH could be partly explained by the mortality selection theory and Chinese culture. Our results showed that the association between early-life exposure to famine and poor SRH was only noted in females (not in males) after stratification by biological sex, consistent with previous studies. First, females having greater body fatness and lower metabolism, compared with males, had a better outcome during the famine period resulting in lower mortality. Therefore, surviving males were less likely to develop disease and report poor SRH in later life because they were healthier than the surviving females. Second, the traditional Chinese culture or culture in other countries might have provided a protective umbrella for males compared with females during the famine period. China’s preference for sons over daughters provided males with access to more food and welfare, resulting in less adverse health outcomes and a lower likelihood of reporting poor SRH in later life. Lastly, compared with males, females were more likely to report a lower SRH. While females were more inclined to report a health problem compared with males, they usually live longer than males. This could be explained by females being more susceptible to chronic diseases and more likely to seek preventive medical care than males. Consequently, females differ from males in the way they evaluate and report their health status. This may explain the difference in the observed effects of famine-SRH associations in males and females in this study.

Additionally, our results indicated that famine exposure in the infant-exposed cohort was strongly associated with an increased likelihood of poor SRH among disabled individuals, suffering from chronic diseases and vision impairment. Moreover, individuals exposed to famine in the infant period, and who were alcohol users were less likely to report poor SRH. In other words, our study demonstrated that alcohol use was associated with a better SRH compared with non-use and this association was even stronger among high-frequency users compared with low-frequency users. It could be due to a general concept that drinking relates to better health status and that people in poor health tend to stop drinking earlier. Another study found that elderly people (over 50 years old) who drank moderately indicated a better health status compared with non-drinkers such as better quality of life and fewer depressive symptoms, which is consistent with our findings. Interestingly, unlike normal weight, abnormal weight (ie, underweight, overweight and obese) is less likely to be associated with poor SRH.

Table 2

| Variables       | Model A† | Model B‡ | Model C§ |
|-----------------|----------|----------|----------|
|                 | Adjusted OR (95% CI) | Adjusted OR (95% CI) | Adjusted OR (95% CI) |
| BMI             |          |          |          |
| Underweight     | 0.73 (0.59 to 0.89)** | 0.73 (0.54 to 0.98)* | 0.72 (0.54 to 0.97)* |
| Normal weight   | Ref.      | Ref.      | Ref.      |
| Overweight      | 0.74 (0.61 to 0.90)** | 0.65 (0.50 to 0.87)** | 0.81 (0.61 to 1.07)  |
| Obese           | 0.71 (0.56 to 0.90)** | 0.60 (0.42 to 0.86)** | 0.80 (0.58 to 1.12)  |

Bold values indicate statistical significance at p<0.05; 95% CI.

†Model A: adjusted for gender, education, marital status, smoking status, drinking status, residence, vision impairment, physical activity, disability and BMI.
‡Model B: adjusted for education, marital status, smoking status, drinking status, residence, insurance, vision impairment, physical activity, disability and BMI among males.
§Model C: adjusted for education, marital status, smoking status, drinking status, residence, insurance, vision impairment, physical activity, disability and BMI among females.

BMI, body mass index; SRH, self-rated health.
guidance to healthcare professionals, facilitate intervention strategies and develop public health policies.

Limitations and strengths

Some limitations of our study should be mentioned. First, the main limitation of this study is selection bias. As we mentioned before, females had lower mortality compared with males during the famine period. Consequently, male survivors were stronger and healthier. The bias may underestimate the impact of famine exposure on SRH in males. Future studies with better study design or questionnaire (eg, confirming the participants with self-reported famine exposure) may help solve this issue.

Furthermore, though we included numerous covariates relevant to various aspects of lifestyle and comorbidity, we were unable to assess dietary factors and covariates covering different provinces. Diet and nutrition may both have an important impact on SRH. The severity of the famine in China varied across provinces related to differences in regional climate, population density and local food policies,18 therefore, SRH may also be different depending on provinces. Third, age was not evenly distributed in famine exposed and famine non-exposed groups. However, according to a previous study, that age difference was very small in this cohort and unlikely to significantly change our results.3 Despite these limitations, this study is the first study to assess the influence of Chinese famine on SRH using data collected from 28 provinces that broadly represented the entire mainland of China. Such significant findings extend our knowledge of the effect of famine on SRH among the elderly Chinese providing evidence on sex-specific SRH that may be used to prevent potential diseases among the populations at risk.

CONCLUSIONS

In conclusion, this study compared famine exposure during fetal, infant and preschool stages to a non-exposed stage. A significant association was found between SRH and famine only in the infant-exposed stage. Our study emphasizes that the early life environment plays a vital role in SRH in adulthood. Implementing interventions to those who were early exposed to famine, especially for females, may help to improve their long-term consequences.

REFERENCES

1. Smil V. China’s great famine: 40 years later. BMJ 1999;319:1619–21.
2. Li Y, He Y, Qi L, et al. Exposure to the Chinese famine in early life and the risk of hyperglycemia and type 2 diabetes in adulthood. Diabetes 2010;59:2400–6.
3. Wang N, Chen Y, Ning Z, et al. Exposure to famine in early life and nonalcoholic fatty liver disease in adulthood. J Clin Endocrinol Metab 2016;101:2218–25.
4. Wang Z, Zou Z, Yang Z, et al. The association between fetal-stage exposure to the Chinese famine and risk of diabetes mellitus in adulthood: results from the China health and retirement longitudinal study. BMC Public Health 2018;18:1205.
5. Wang Z, Li C, Yang Z, et al. Fetal and infant exposure to severe Chinese famine increases the risk of adult dyslipidemia: results from the China health and retirement longitudinal study. BMC Public Health 2017;17:488.
6. Wang Z, Li C, Yang Z, et al. Infant exposure to Chinese famine increased the risk of hypertension in adulthood: results from the China health and retirement longitudinal study. BMC Public Health 2016;16:435.
7. Li S, Shen Z, Zhang H, et al. Association between exposure to the Chinese famine during early life and the risk of chronic kidney disease in adulthood. Environ Res 2020;184:109312.
8. World Health Organization. Promoting mental health, 2005. Available: https://www.who.int/mental_health/evidence/MH_Promotion_Book.pdf [Accessed Nov 2020].
9. Wu S, Wang R, Zhao Y, et al. The relationship between self-rated health and objective health status: a population-based study. BMC Public Health 2013;13:320.
10. Loren G, Cook S, Leon DA, et al. Self-Reported health as a predictor of mortality: a cohort study of its relation to other health measurements and observation time. Sci Rep 2020;10:4886.
11. Hirotsu S, Okumiya K, Wada T, et al. Self-Rated health is associated with subsequent functional decline among older adults in Japan. Int Psychogeriatr 2017;29:1475–83.
12. Ho SY, Mak KK, Thomas GN, et al. The relation of chronic cardiovascular diseases and diabetes mellitus to perceived mortality: a cohort study of its relation to other health measurements and observation time. Sci Rep 2020;10:4886.
health, and the Moderating effects of sex and age. Soc Sci Med 2007;65:1386–96.
13 Ahmad F, Jhaij AK, Stewart DE, et al. Single item measures of self-rated mental health: a scoping review. BMC Health Serv Res 2014;14:398.
14 Meyer OL, Castro-Schilo L, Aguilar-Gaxiola S. Determinants of mental health and self-rated health: a model of socioeconomic status, neighborhood safety, and physical activity. Am J Public Health 2014;104:1734–41.
15 Phillips SP. Measuring the health effects of gender. J Epidemiol Community Health 2008;62:368–71.
16 Hammarström A, Johansson K, Annandale E, et al. Central gender theoretical concepts in health research: the state of the art. J Epidemiol Community Health 2014;68:185–90.
17 Zhao Y, Hu Y, Smith JP, et al. Cohort profile: the China health and retirement longitudinal study (CHARLS). Int J Epidemiol 2014;43:61–8.
18 Wang Z, Zou Z, Yang Z, et al. Association between exposure to the Chinese famine during infancy and the risk of self-reported chronic lung diseases in adulthood: a cross-sectional study. BMJ Open 2017;7:e015476.
19 Yu T, Jiang Y, Gamber M, et al. Socioeconomic status and self-rated health in China: findings from a cross-sectional study. Medicine 2019;98:e14904.
20 Li W, Kondracki A, Gautam P, Rahman A, et al. The association between sleep duration, napping, and stroke stratified by self-health status among Chinese people over 65 years old from the China health and retirement longitudinal study. Sleep Breath 2021;25:1239–46.
21 Haseli-Mashhadi N, Pan A, Ye X, et al. Self-Rated health in middle-aged and elderly Chinese: distribution, determinants and associations with cardio-metabolic risk factors. BMC Public Health 2009;9:368.
22 Chang X, Song P, Wang M, et al. The risks of overweight, obesity and abdominal obesity in middle age after exposure to famine in early life: evidence from the China’s 1959-1961 famine. J Nutr Health Aging 2018;22:1198–204.
23 Substance Abuse and Mental Health Services Administration. Binge drinking: terminology and patterns of use, 2016. Available: https://www.samhsa.gov/capt/tools-learningresources/binge-drinking-terminology-patterns [Accessed Nov 2020].
24 Joslin Diabetes Center, Asian American Diabetes Initiative. What is body mass index (BMI)? 2020. Available: https://aadi.joslin.org/en/am-i-at-risk/asian-bmi-calculator [Accessed Nov 2020].
25 Orozco-Solís R, Matos RJB, Guzmán-Quevedo O, et al. Nutritional programming in the rat is linked to long-lasting changes in nutrient sensing and energy homeostasis in the hypothalamus. PLoS One 2010;5:e13537.
26 Hochberg Z, Feil R, Constancia M, et al. Child health, developmental plasticity, and epigenetic programming. Endocr Rev 2011;32:159–224.
27 Li Y, Zhao L, Yu D, et al. Exposure to the Chinese famine in early life and depression in adulthood. Psychol Health Med 2018;23:952–7.
28 Zajacova A, Huzurbazar S, Todd M. Gender and the structure of self-rated health across the adult life span. Soc Sci Med 2017;187:58–66.
29 Sandman D, Simantov E, An C. Out of touch: American men and the health care system, David Sandman, Elisabeth Simantov, and Christina an. The Commonwealth fund, 2000. Available: https://www.commonwealthfund.org/publications/fund-reports/2000/mar/out-touch-american-men-and-health-care-system [Accessed Nov 2020].
30 Moriconi PA, Nadeau L. A cross-sectional study of self-rated health among older adults: association with drinking profiles and other determinants of health. Curr Gerontol Geriatr Res 2015;2015:352947.
31 Lang I, Wallaces RB, Huppert FA, et al. Moderate alcohol consumption in older adults is associated with better cognition and well-being than abstinence. Age Ageing 2007;36:256–61.
32 Jacoby E, Goldstein J, López A, et al. Social class, family, and lifestyle factors associated with overweight and obesity among adults in Peruvian cities. Prev Med 2003;37:396–405.
33 Puhl RM, Heuer CA. The stigma of obesity: a review and update. Obesity 2009;17:941–64.