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Exposure to famine in early life and self-rated health status among Chinese adults: a cross-sectional study from the Chinese Health and Retirement Longitudinal Study (CHARLS)

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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.

Strengths and limitations of this study

- This is the first study to investigate the associations between early life (eg, during infancy) exposure to Chinese famine and self-rated health (SRH) in adulthood.
- Using the China Health and Retirement Longitudinal Study, a nationally representative study with a large sample size from China, our findings may be generalisable to the entire country, indicating that early life environment played a vital role in SRH in adulthood.
- Selection bias from male survivors may underestimate the impact of famine exposure on SRH in males.
- Other potential confounders (eg, diet and nutrition), though not available in this dataset, may result in a distortion in the measure of association between famine exposure and SRH. Future studies should consider these potential factors.

INTRODUCTION

China's Great Famine that occurred between 1959 and 1961 resulted in 30 million Chinese citizens starving to death.[1] The effects of this historical famine have been investigated in common adverse health outcomes among elderly Chinese in the last decades.[2–7] 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.[2–7] Although the relationships between the famine and cause-specific diseases have been reported recently,[2–5] there is a lack of large-scale studies on the impact of famine on self-rated health (SRH) later in life.

Health refers not only to normal biological mechanisms but also to healthy mental status, self-esteem and cognitive well-being.[8] SRH is a simple and reliable measure of health that predicts morbidity, mortality and quality of life.[9] It has been extensively reported that SRH is associated with various health-related outcomes such as cardiovascular disease, diabetes mellitus, functional disability and

mental health illness,[10–12] especially among older adults. Moreover, social and environmental factors have been documented to influence individuals' health status.[13 14] For example, lack of physical activity, obesity and lower socioeconomic status were related to poor SRH.[13 14]

Biological sex is an obvious yet often-ignored social determinant of health.[15] Central sex/gender theoretical concepts that considered a sex-gender perspective have been introduced in health science research to avoid sex bias.[16] A previous study observed an association between famine and elevated risk of diabetes in both males and females.[4] In contrast, another study found an increased risk of dyslipidaemia only in females exposed to famine during the early stages of life.[5] 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.[17] 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.[17]

Famine cohorts

We categorised famine exposure into four groups based on previous literature.[6 18] 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 4418 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=very good, 2=good, 3=fair, 4=poor and 5=very poor, which is consistent with prior studies.[19–21] 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'.[20 21]

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).[6 18 20]

Covariates

Covariates were also selected according to previous studies.[6 18 20 22] 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 (≥5 drinks per month) drinking, never-drinker or quitter, consistent with the Substance Abuse and Mental Health Services Administration report.[23] 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/m^2)] 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.[24]

Statistical analyses

Numbers and percentages were presented for the variables related to famine exposure. Since all included variables were categorical variables, χ^2 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 (0.56)	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

Table 1 Continued

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.

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 underweight (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 comparing 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.[4 5 25] During early life, malnutrition could change

Table 2 Multivariate logistic regression assessing the association between famine and SRH (n=3864)

	Model A†	Model B‡	Model C§
Variables	**Adjusted OR (95% CI)**	**Adjusted OR (95% CI)**	**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.

Continued

Table 2 Continued

Variables	Model A† Adjusted OR (95% CI)	Model B‡ Adjusted OR (95% CI)	Model C§ 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.
*P<0.05, **p<0.01.
†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.

certain gene expressions in regulating nutrient sensing and energy homeostasis in the hypothalamus, leading to abnormal growth and metabolic function in adulthood.[4 5 25] Moreover, epigenetic changes involved in normal development and human diseases[4 5 26] 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.[26] 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.[3 5 27] First, females having greater body fatness and lower metabolism, compared with males, had a better outcome during the famine period resulting in lower mortality.[3 5 27] Therefore, surviving males were less likely to develop disease and report poor SRH in later life because they were healthier than the surviving females.[3 5 27] 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.[3 5 27] 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.[3 5 27] Lastly, compared with males, females were more likely to report a lower SRH.[28] While females were more inclined to report a health problem compared with males, they usually live longer than males.[28] This could be explained by females being more susceptible to chronic diseases and more likely to seek preventive medical care than males.[29] 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.[30] 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.[31] Interestingly, unlike normal weight, abnormal weight (ie, underweight, overweight and obese) is less likely to be associated with poor SRH. After stratification by sex, these results were only consistent with findings among males. The reasons behind these findings are complicated. It is probably that excess weight might be perceived as wealth or health among males, especially during the famine period or in undernourished areas.[32] However, females may be more likely than males to consider being overweight or obese as a health problem since they face greater societal pressures than males, which is a deeply rooted and documented prejudice worldwide.[33] Further studies underlying these observed differences among males and females are warranted. It is essential to understand the effects of famine exposure among males and females to deliver

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.[4] 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 emphasises 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.

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Contributors WL, NS and WS contributed to the conception and design of the study, contributed to the interpretation of the data and critically revised the manuscript for important intellectual content. NS and WL performed the initial analyses and drafted the initial manuscript. AJK and SK contributed to the interpretation of the data and critically revised the manuscript for important intellectual content. OO, MEK, RJ and ZW critically revised the manuscript for important intellectual content. All authors reviewed and approved the final draft. This manuscript was written by WL with input from all coauthors who read and approved the final version.

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Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval The Medical Ethics Committee of Peking University granted the present study exemption from review.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available in a public, open access repository. Our data are from the China Health and Retirement Longitudinal Study (CHARLS), a public data. You may access it and download it from http://charls.pku.edu.cn/index/en.htmlhttp://charls.pku.edu.cn/index/en.html.

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