

## ORIGINAL RESEARCH ARTICLE

# Household income, malnutrition, and mortality in China

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## Abstract

The study investigated the relationship between household income, malnutrition, and mortality in China based on longitudinal data collected at five-year intervals from 1995 to 2020. Accordingly, trends in adult female, adult male, and infant mortality were examined together with changes in household income and undernourishment prevalence. The results show a steady decline in mortality in every group, whereas malnutrition fell precipitously, especially after 2010. Household income was rather volatile but generally increased in later years, matching the decline in mortality. Graphical evidence suggests that there are inverse relationships between mortality and income, as well as between mortality and malnutrition. This is reflected in the correlation matrix, with all co-movements strong because of common downward trends over time. Overall, improved household welfare, enhanced nutritional status, and health system strengthening all seemed to contribute to the better health status of the population in China. Based on these results, the study recommends continued investment in nutrition programs, expanded social welfare measures to support household income, and further strengthening of maternal and child healthcare services to sustain progress in reducing mortality (*Afr J Reprod Health* 2026; 30 [3]: 183-192)

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**Keywords:** Income, undernourishment, mortality rate.

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## Résumé

L'étude a examiné la relation entre le revenu des ménages, la malnutrition et la mortalité en Chine à partir de données longitudinales collectées tous les cinq ans de 1995 à 2020. Ainsi, les tendances de la mortalité des femmes adultes, des hommes adultes et des nourrissons ont été analysées conjointement avec les variations du revenu des ménages et de la prévalence de la sous-alimentation. Les résultats montrent une baisse constante de la mortalité dans chaque groupe, tandis que la malnutrition a chuté de façon spectaculaire, surtout après 2010. Le revenu des ménages a connu une certaine volatilité, mais a généralement augmenté au cours des dernières années, en parallèle avec la baisse de la mortalité. Les graphiques suggèrent des relations inverses entre la mortalité et le revenu, ainsi qu'entre la mortalité et la malnutrition. Ceci se reflète dans la matrice de corrélation, où toutes les corrélations sont fortes en raison de tendances communes à la baisse au fil du temps. Globalement, l'amélioration du bien-être des ménages, l'amélioration de l'état nutritionnel et le renforcement du système de santé semblent tous avoir contribué à l'amélioration de l'état de santé de la population chinoise. Sur la base de ces résultats, l'étude recommande de poursuivre les investissements dans les programmes de nutrition, d'étendre les mesures de protection sociale pour soutenir le revenu des ménages et de renforcer davantage les services de santé maternelle et infantile afin de pérenniser les progrès réalisés en matière de réduction de la mortalité. (*Afr J Reprod Health* 2026; 30 [3]: 183-192)

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**Mots-clés:** revenu, sous-alimentation, taux de mortalité

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## Introduction

Mortality patterns have changed significantly in China during the last three decades because of rapid economic growth, health system reforms, poverty reduction, and increased access to medical services. Recent national estimates confirm that although overall mortality has declined, a substantial burden of disease continues, particularly from non-

communicable diseases such as cancer and cardiovascular conditions.<sup>1-3</sup>

The changing face of environmental exposure, climate-related risk, and disease profiles has further driven mortality trends.<sup>4, 5</sup> While the survival outcome has continued to improve, socioeconomic and regional inequalities in mortality persist, hence the need for continued empirical assessment is well founded<sup>6</sup>. Household income is central in shaping

mortality outcomes due to its implications for nutrition, sanitation, healthcare access, housing quality, and lifestyle behaviour. Evidence from China reflects the fact that household income is a significant determinant of dietary balance, particularly in vulnerable groups such as the elderly and rural households.<sup>7</sup> Income instability and negative income shocks have been strongly associated with greater all-cause mortality risks, with larger effects seen among low-wealth households.<sup>8</sup> Wider patterns of income distribution continue to reveal the inequality of economic opportunities across regions<sup>9</sup>, while income loss associated with disrupted labour markets has been demonstrated to exacerbate health and survival.<sup>10</sup> Moreover, family income has also been directly related to all-cause mortality through its interaction with lifestyle choices.<sup>4</sup> These findings confirm that income conditions act as an important structural cause of health and mortality in China.

Beyond this, malnutrition continues to be another important cause of death in this country, particularly among infants, children, and older adults. However, while China has attained remarkable achievements in the improvement of undernutrition, recent research has continued to document its strong association with gross adverse health outcomes and death.<sup>11-13</sup> Malnutrition significantly raises all-cause mortality among the elderly<sup>14</sup> and patients with chronic conditions such as heart failure.<sup>11, 15</sup> Among patients with diabetes, malnutrition interacts with inflammation to amplify the risk of mortality.<sup>16</sup> At the population level, early-life undernutrition has been linked to higher adult mortality from chronic diseases.<sup>17</sup> Recent evidence also shows marked declines in child undernutrition between 2000 and 2019, although disparities persist across regions and socioeconomic groups.<sup>12, 18</sup> On a more macro level, malnutrition has been shown to exert a negative and statistically significant impact on life expectancy in China<sup>13</sup>, further cementing its status as a fundamental health determinant.

Despite the documented importance of household income and malnutrition in shaping health outcomes, existing empirical studies in China have remained largely fragmented. Recent studies investigate disease-specific or age-specific mortality; limited attention has been paid to the long-

term interaction between household income, malnutrition, and mortality across adult and infant populations. Moreover, there is a notable absence of recent studies providing graphical representations of the trends and correlations among these three critical variables over an extended time horizon. This methodological gap constrains the visual interpretation of how economic and nutritional shifts shape mortality dynamics in China. This study was carried out against this backdrop and thus investigated the correlations between household income, malnutrition, and mortality in China by analysing the long-term trends in adult male mortality, adult female mortality, and infant mortality. It also aims to study how changes in household income and malnutrition correlate with the mortality pattern changes and plot a graph of these relationships. The scope of this study is confined to China over the period 1995 to 2020. This period encapsulates key periods of China's socioeconomic transition, including market reforms, urbanisation, and improvements in food security, expansion of healthcare coverage, and sustained efforts toward poverty alleviation.

### *Literature review*

Chen *et al.*<sup>19</sup> studied the influence of malnutrition on mortality from all causes, which involved 21,479 elderly patients who underwent PCI for coronary artery disease between 2007 and 2017. The CONUT score measured nutritional status. Approximately two-thirds of the patients exhibited a certain degree of malnutrition. After a median follow-up of 5.16 years, 14.77 percent of patients died. With respect to mortality risk, there was increased risk related to the worsening of nutritional status. All levels of malnutrition were significantly associated with higher adjusted hazard ratios. The authors pointed out that malnutrition was common and substantially increased mortality risk and emphasized the importance of regular nutritional assessment and appropriate nutrition intervention in this population.

The study of Zhang *et al.*<sup>20</sup>, explored socioeconomic inequalities in mortality and life expectancy, using data from 21,133 adults who were followed from 1991 to 2011 in China. Indicators of individual and area-level socioeconomic status and

lifestyle risks were constructed. During the median follow-up of 15.2 years, 1,352 deaths were recorded. Mortality and life-year losses at age 50 were considerably higher in people with lower socioeconomic status. Only a small portion of lifestyle factors explained these disparities, but higher lifestyle risk scores consistently raised mortality within all groups. Individuals with both low socioeconomic status and multiple lifestyle risks faced the greatest mortality burden. The authors suggested that health promotion should be enhanced, socioeconomic inequalities reduced, and high-risk groups targeted through integrated policy interventions.

Wang *et al.*<sup>16</sup> examined whether malnutrition modified the effect of inflammation on mortality among 6,682 diabetic patients who underwent coronary angiography or percutaneous coronary intervention between 2007 and 2018. CONUT score and inflammation by high-sensitivity C-reactive protein levels assessed nutritional status. During the median five-year follow-up, 759 deaths took place. The prognosis was poorest for patients with both malnutrition and high inflammation. Neither condition significantly raised the risk of mortality when occurring in isolation, while their combined presence increased it by 51% compared to those without either condition. The interaction between nutritional status and inflammation was statistically significant. The authors concluded that the combined presence of inflammation and malnutrition substantially worsened the prognosis, recommending future clinical trials to confirm these findings.

Wu and Hao<sup>13</sup> explored the impact of agricultural carbon footprint and malnutrition on life expectancy in China within the period between 2000 and 2021. Using data obtained from the World Bank through the Dynamic Ordinary Least Squares method, the study established that agricultural carbon footprints declined steeply in 2015, and food production increased per capita from 88.29 percent in 2011 to over 108 percent in 2021. The malnourished population in just a decade reduced by 78.8 percent. Per capita food production had a positive influence on improving life expectancy, while malnutrition had a strong negative effect on it.

Agricultural carbon footprints demonstrated a positive but insignificant effect. GDP growth of per capita also significantly improved life expectancy. The authors suggested that policymakers work toward strengthening food access to support longer and healthier lives.

## Methods

This paper applies a framework to investigate the relationship between household income, malnutrition, and mortality in China. Based on the longitudinal data during the period of 1995-2020, measured every five years and obtained from World Development Indicators (WDI) by the World Bank,<sup>21</sup> and Food and Agricultural Organization (FAO) database<sup>22</sup>, two major topics were covered within the study: (1) the relationship of household income and mortality and (2) the relationship of malnutrition to mortality.

### *Estimation procedures*

To examine the relationship between household income, malnutrition and mortality rate in China. Given the scope of the study, graphical analysis was employed for comparison as it gives a clear and comprehensive representation of the subject in question.

### *Data analysis*

In the analysis, the study's objectives were addressed through a correlation matrix and graphical techniques. While the correlation matrix presents the direction and strength of the relationships among the variables, the graphical analysis allows for the visual examination of patterns, trends, and temporal changes in the data. Combined, these methods offer a clear and comprehensive understanding of the variables under investigation.

### *Ethical considerations*

The study is based on publicly available statistical data from the WDI database. The data are aggregated, anonymized, and contain no personal or identifiable information; thus, there is no risk of harm.

**Table 1:** Measurement of variables

Variable	Code	Measurement	References	Source
Household income	HI	Households and NPISHs final consumption expenditure (% of GDP)	Gao et al. <sup>23</sup>	WDI
Malnutrition	MNT	Prevalence of undernourishment (percent) (3-year average)		FAO
<b>Mortality</b>				
Adult male mortality	MAM	Mortality rate, adult, male (per 1,000 male adults)	Jia et al. <sup>24</sup> and Ail. <sup>25</sup>	WDI
Adult female mortality	MAF	Mortality rate, adult, female (per 1,000 female adults)	Zheng et al. <sup>26</sup>	WDI
Infant mortality	MRI	Mortality rate, infant (per 1,000 live births)	Hao et al. <sup>27</sup> and Zhou et al. <sup>28</sup>	WDI

No individual-level datasets were used, and all analyses adhered to the terms of use of the data provider. The methodological approach guiding the analysis was systematic and transparent. Because the research did not involve human or animal subjects, it did not require ethical approval

## Results

### Correlation matrix

The correlation matrix shows strong and statistically significant relationships among all the variables. MAF, MAM, and MRI all have very high positive correlations. MNT is also strongly positively correlated with all measures of mortality.

Conceptually, HI should be negatively associated with mortality and malnutrition, but it shows positive correlations here.

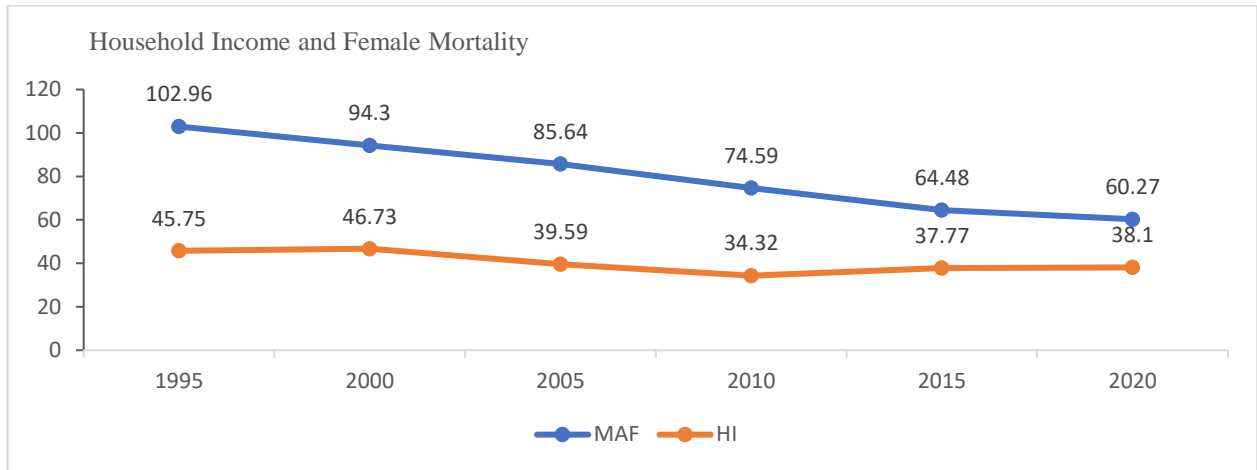
### Results of household income and female mortality

Figure 1 shows the relationship between household income and the mortality of adult females in China between 1995 and 2020. The trend reflects a steady, significant drop in the number of deaths, starting from around 103 deaths per 1,000 female adults back in 1995 to about 60 deaths in 2020. Household income, proxied by household final consumption expenditure, demonstrates a mild decline from 2000 to 2010 and then a gradual increase thereafter.

**Table 2:** Correlation matrix

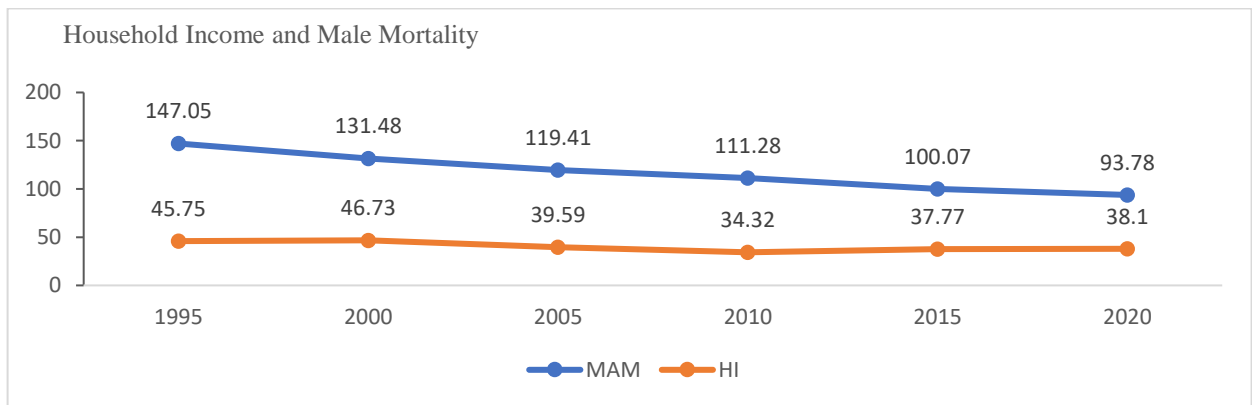
Correlation Probability	MAF	MAM	MRI	MNT	HI
MAF	1.000000 -----				
MAM	0.984017 0.0000	1.000000 -----			
MRI	0.977219 0.0000	0.984446 0.0000	1.000000 -----		
MNT	0.942210 0.0000	0.901413 0.0000	0.949973 0.0000	1.000000 -----	
HI	0.769991 0.0000	0.761719 0.0000	0.861105 0.0000	0.906132 0.0000	1.000000 -----

Source: Authors' computation

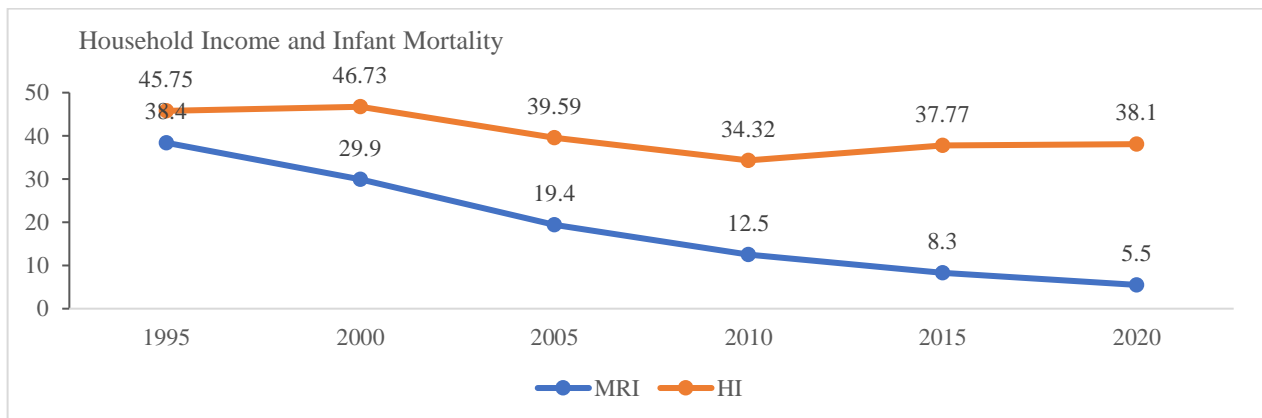


Source: Authors` Computation

**Figure 1:** Relationship between household income and female mortality in China

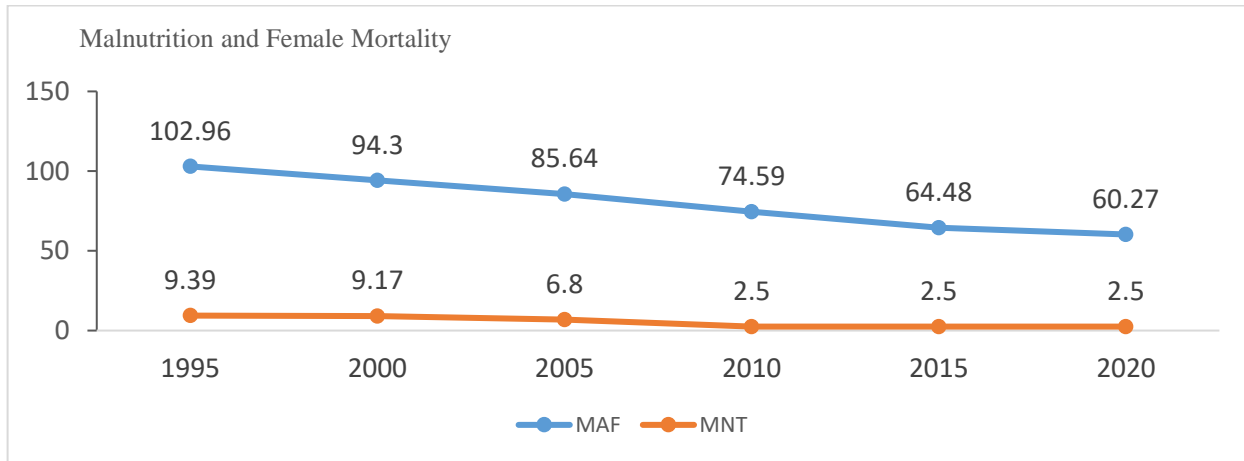


**Figure 2:** Relationship between household income and male mortality in China



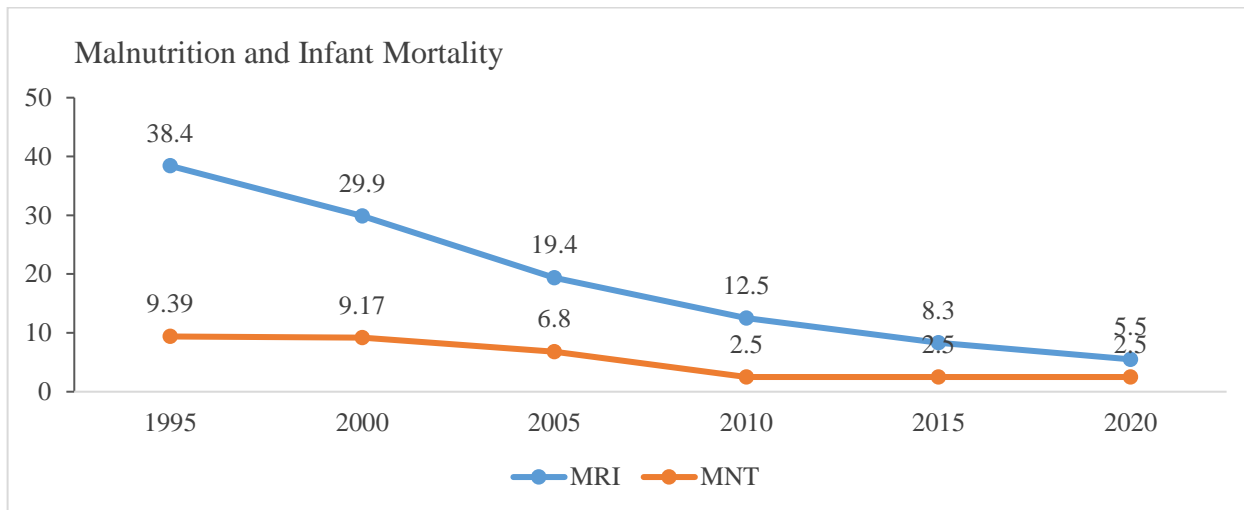
Source: Authors` Computation

**Figure 3:** Relationship between household income and infant mortality in China



Source: Authors` computation

**Figure 4:** Relationship between malnutrition and Female Mortality in China



While the trend in household income is less dramatic than the decline in mortality, the overall pattern indicates a rise in household income generally coincides with lower levels of female mortality.

**Results of household income and male mortality**

Figure 2 presents the relationship between household income and the mortality of adult males in China from 1995 to 2020. The clear trend of continuous decline for male mortality is evident from about 147 deaths per 1,000 male adults in 1995 to roughly 94 in 2020.

Household income, which is measured by household final consumption expenditure, has a mild downward trend from 2000 up to 2010 and then an upward, gradual rise starting in 2015.

**Results of household income and infant mortality**

Figure 3 presents the trend of household income and infant mortality in China between 1995 and 2020. Infant mortality (MRI) has been falling very steeply and uninterruptedly from 38.4 deaths for each 1,000 live births in 1995 to only 5.5 in 2020.

HI ranges slightly, increasing from 1995 to 2000, then decreasing until 2010 and increasing again toward 2020. At any rate, the overall relationship suggests that improvements in the welfare of households support infant mortality reductions.

### ***Results of malnutrition and female mortality***

Figure 4 shows the relationship between malnutrition and adult female mortality in China, from 1995 to 2020.

Female mortality exhibits a steady and significant drop across the whole period, falling from approximately 103 deaths per 1,000 female adults in 1995 to about 60 in 2020. Malnutrition also declines steeply, from 9.39 percent in 1995 to 2.5 percent from 2010 onward.

### ***Results of malnutrition and male mortality***

Figure 5 presents the relationship between MNT and MAM in China from 1995 to 2020. Male mortality does fall steadily across the period, from about 147 deaths per 1,000 male adults in 1995 to approximately 94 in 2020. Malnutrition also drops sharply, from about 9.39 percent in 1995 to 2.5 percent by 2010 and remaining stable thereafter.

### ***Results of malnutrition and infant mortality***

Figure 6 presents the relationship of MNT and MRI in China from 1995 to 2020. Infant mortality demonstrates a sharp and continuous decline, falling from 38.4 deaths per 1,000 live births in 1995 to 5.5 in 2020.

Malnutrition also shows a significant decline: from 9.39 percent in 1995, it drops to 2.5 percent in 2010 and remains constant thereafter

## **Discussion**

Figure 1 indicates a steady drop in adult female mortality between 1995 and 2020, while household income sees a modest variation. The continued decline in mortality indicates improvements in access to healthcare, nutrition, women's health, and standards of living. While household income has seen only moderate variation, the general trend of the series suggests that when income has risen,

mortality has been lower. Such a pattern corroborates the argument that improved economic conditions raise living standards and, thus, access to basic services that will lead to better survival outcomes for women.

Adult male mortality follows a similar trend, continuously declining across the period, as depicted in Figure 2. Household income also portrays a soft U-shaped pattern, with drops until 2010 and thereafter gradually rising. Similar to female mortality, the decline in male mortality reflects improvement in health systems, better disease control, and stronger socioeconomic conditions. The tendency for declining mortality to correlate with rising income in later years perhaps indicates that heightened welfare at home feeds positively into male survival prospects.

It can be observed from Figure 3 that the infant mortality rate has drastically fallen from 38.4 deaths per 1,000 live births in the year 1995 to only 5.5 in 2020. Although household income has varied over time, the greater decline in mortality follows periods of rising socioeconomic well-being. This strongly suggests that greater access to maternal health care, vaccinations, better sanitation, and nutrition have a direct impact on infant survival. The figure shows how sensitive child health outcomes are to income conditions and improvements in public health.

Figure 4 shows a steady decline in both malnutrition and female mortality. The trend of parallel drops indicates that better nutrition probably improved health outcomes for women. Lower levels of malnutrition improve immunity, reduce disease susceptibility, and contribute to overall well-being. The relationship presented here underlines the importance of nutrition-based intervention for the reduction of mortality among females.

Figure 5 shows that male mortality and malnutrition fell together over the period. As malnutrition fell dramatically, especially by 2010, male mortality also fell substantially. This corroborates the biological and economic reasoning that proper nutrition enhances health because it reduces vulnerability to illness and bolsters physical hardiness among men.

Figure 6 shows that the level of malnutrition is inversely related to infant mortality. While malnutrition fell dramatically from 1995 to 2010 and

then leveled off, infant mortality continued to fall throughout the period. This relationship is particularly strong because infants are highly susceptible to inadequate nutrition.

Comparing the graphical and correlation results, it is clear from the graphs that there are inverse movements between mortality and income, as well as between mortality and malnutrition, all consistent with underlying theory. Meanwhile, the correlation matrix shows strong positives since both mortality and malnutrition have fallen over time, thereby creating movements in the same direction within the dataset. It is this temporal alignment that explains why positives appear when the conceptual expectation would be inverse.

The figure shows that reductions in infant deaths have been driven by improved dietary conditions, maternal nutrition, and child-feeding practices. Taking altogether, these graphical patterns support the correlation matrix, where the strong positive co-movements among the mortality and malnutrition variables are indeed observed. While the correlations look positive because of the concurrent downward movements over time, the graphs reveal what is really going on conceptually: income is improving and malnutrition is lowering, hence mortality is reduced..

### **Strengths and limitations**

The study has clearly and systematically evaluated the connections between mortality, household income, and malnutrition in China. Based on two decades of data at five-year intervals, long-term trends and patterns are captured remarkably well. Graphic analysis enhances understanding as a result of depicting the movements of the variables in an understandable way, with the correlation results providing statistical support for the observed relationships. Yet, there are also some limitations to this approach. Reliance on graphical and correlational methods limits the depth of analysis, since such methods cannot enable causal inferences. Besides, some important determinants like lifestyle behaviors, availability of health care, and biological factors have not been covered. Finally, one of the limitations is that any potential confounding variable cannot be appropriately accounted for. The findings

should thus be interpreted with caution and further rigorous studies systematically conducted to evaluate or discard the association observed.

### **Policy implications**

These findings suggest several practical policy actions that could help sustain the decline in mortality in China. First, investment in nutrition-focused programs, particularly for women and children, will be important. Increasing access to fortified foods, school feeding schemes, maternal nutrition interventions, and community education can further reduce malnutrition and strengthen immunity.

Second, policies that raise household welfare should be a priority. Income-support measures, such as social protection schemes and rural development initiatives aimed at job creation, would support households in maintaining a better living standard, which ultimately improves survival outcomes.

Lastly, targeted interventions for vulnerable groups, such as low-income households and remote communities, are necessary to prevent widening disparities. All these measures would reinforce the positive trends observed and ensure sustained reductions in mortality across all population groups

### **Conclusion**

This study investigated the relationships among household income, malnutrition, and mortality in China based on long-term data presented at five-yearly intervals. The findings have consistently demonstrated that improvements in socioeconomic conditions and reductions in malnutrition resulted in substantial declines in mortality for adult females, adult males, and infants during the period 1995-2020. The graphical trends indicated clear inverse movements of mortality against income and nutritional status. The results for the correlation showed strong co-movements driven by simultaneous long-term declines. Together, these results emphasize the centrality of economic well-being, adequate nutrition, and strengthened health systems to population health outcomes. Given that, the study had to rely on descriptive and correlation methods, evidence supported established theory and

thus provided broad but informative insights into the mechanisms underlying mortality reduction in China. Strengthening nutrition programs, improving household welfare, and increasing access to quality health care remain fundamental for sustaining these gains and promoting further improvement in national health and longevity.

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