Preplanned Studies

Changing Patterns in Digestive Diseases Mortality in Urban and Rural Areas — China, 1987–2021

Xinran Shen[1,&]; Feng Wang[2,&]; Yuling Li[1]; Binbin Su[1,#]; Zhiqiang Song[3,#]; Bin Cong[4,#]

Summary

What is already known about this topic?

Digestive diseases (DDs) are a global health concern with a substantial epidemiological and economic impact, given their high prevalence.

What is added by this report?

This study investigated the trends in mortality related to DDs in China from 1987 to 2021, focusing on the urban-rural divide. Additionally, it aimed to determine the specific impacts of age, period, and cohort on DDs mortality.

What are the implications for public health practice?

There is a need to prioritize and allocate more resources toward the future management of DDs in order to effectively address the challenges posed by urbanization and aging populations.

Digestive diseases (DDs) encompass gastrointestinal tract and accessory organ conditions, excluding infectious and malignant cases (*1*). These diseases impose a significant burden on public health and the economy due to their high prevalence and impact on individuals (*1*). Prior research has assessed the global burden of DDs and identified key contributing factors, but limited studies have focused on mortality trends in China from an urban-rural perspective. Therefore, using data from the *China Health Statistics Yearbook*, our study aimed to examine mortality trends from DDs in China from 1987 to 2021, analyzing the effects of age, period, and cohort on DDs mortality. Our findings demonstrated a decline in DDs mortality in China over the study period, with a gradual reduction in the urban-rural disparity, primarily driven by improved conditions in rural areas. Notably, DDs mortality among older adults in urban areas exhibited a sharp increase with age, surpassing that of rural areas. These results provide valuable insights into the effectiveness of past policies and offer evidence-based guidance for future DDs management.

This study utilized the cause-specific mortality dataset obtained from the *China Health Statistics Yearbook* spanning from 1987 to 2021. The dataset was constructed using information from the medical death certificate system, supplemented by data from the registered permanent resident cancellation system, whole population demographic information system, social security termination system, and cremation information system. After integrating the data using identity documents and removing duplicates and invalid entries, mortality data for DDs, including liver diseases, gastric and duodenal ulcers, and intestinal obstruction, were classified using the International Classification of Diseases and Injuries. The Ninth Revision (ICD-9) was used for the period from 1987 to 2001, and the Tenth Revision (ICD-10) was used for the period from 2002 to 2021 [DDs (ICD-9: 520–579, ICD-10: K00–K93)]. Age-standardized mortality rates were calculated using the direct method to examine the temporal trends of DDs, utilizing the World Standard Population reference (*2*). Temporal inflection points were identified using joinpoint analysis conducted with the Joinpoint Regression Program (version 4.9.1.0; National Cancer Institute, Bethesda, US). The role of age, period, and cohort effects on DDs mortality was assessed using the age-period-cohort (APC) model, with analysis conducted using the APC analysis web tool (National Cancer Institute, Bethesda, US). Data visualization was carried out using R software (version 4.2.1; R Core Team and the R Foundation for Statistical Computing, Vienna, Austria).

Both crude and age-standardized mortality rates showed a general decrease in urban and rural areas from 1987 to 2021. The urban-rural disparity in mortality due to DDs has significantly decreased or even disappeared over the past twenty years, with a more pronounced decline observed in rural areas. Throughout the study period, men consistently had higher DDs mortality rates compared to women (Figure 1).

Joinpoint analysis revealed significant decreases in mortality rates in both rural and urban populations

throughout the study period. The annual average percentage change was found to be –3.9% and –4.5% for rural and urban areas, respectively. Specifically, the mortality rate for DDs showed a more pronounced decline in urban areas between 1987 and 1996, whereas the reduction in mortality in rural areas was primarily observed between 2001 and 2009 (Table 1).

Figure 2A shows net drifts and local drifts for DDs mortality. Net drift refers to the changes in DDs mortality yearly for the whole population between 1987 and 2021, whereas local drift denotes changes in a particular age group. The overall net drift was favorable during the study period, and the improvement in mortality was significantly greater among the rural population and females compared to the urban population and males, respectively. Similar local drift patterns were observed between urban and rural areas. The overall reduction of mortality attenuated with increasing age after 30. In contrast, an enormous discrepancy between sexes in DDs mortality reduction occurred in the middle-aged groups, with women showing significantly greater mortality reductions than men.

The results of the analysis on the effects of age, period, and cohort on DDs mortality are presented in Figure 2B. The age effects exhibited a similar pattern in both urban and rural areas, with the highest mortality observed among children under 5 years of age and adults aged 65 or older. The mortality among individuals aged 5 to 24 remained low, while a slight increase was observed with advancing age after 30 years. Interestingly, under-five mortality in rural areas was significantly higher than in urban areas, and the mortality among urban populations surpassed that of rural populations after the age of 65. The period rate ratio showed a consistent decline across different areas

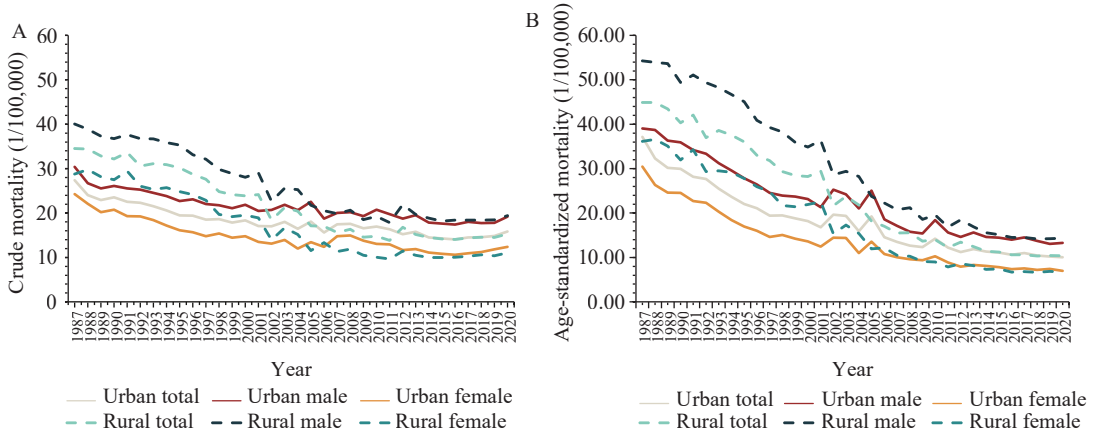

FIGURE 1. DDs mortality trends by sexes in urban and rural areas of China from 1987 to 2021. (A) Crude DDs mortality; (B) Age-standardized DDs mortality.
Abbreviation: DD=digestive disease.

TABLE 1. Joinpoint regression analysis of age-standardized mortality in DDs among urban and rural areas of China.

Sexes in different areas	Mortality Rate* (per 100,000)		1987–2021		Trend 1		Trend 2		Trend 3		Trend 4	
	1987	2021	AAPC (%)	95% *CI*	Period	APC (%)	Period	APC (%)	Period	APC (%)	Period	APC (%)
Urban												
Total	37.17	9.21	−3.9†	(−4.4, −3.4)	1987–1996	−5.6†	1996–2021	−3.3†				
Male	39.06	12.3	−3.3†	(−4.7, −1.9)	1987–1999	−4.5†	1999–2005	−0.3	2005–2008	−10.5	2008–2021	−1.8†
Female	30.45	6.31	−4.4†	(−4.9, −3.9)	1987–1997	−6.3†	1997–2021	−3.6†				
Rural												
Total	44.88	9.98	−4.5†	(−5.0, −4.0)	1987–2001	−3.8†	2001–2009	−8.3†	2009–2021	−2.7†		
Male	54.27	13.89	−4.2†	(−4.8, −3.6)	1987–2001	−3.5†	2001–2007	−8.4†	2007–2021	−3.1†		
Female	36.14	6.24	−5.2†	(−5.8, −4.6)	1987–2001	−4.4†	2001–2009	−9.8†	2009–2021	−2.9†		

Abbreviation: DD=digestive disease; AAPC=average annual percentage change; APC=annual percentage change; *CI*=confidence interval.
* Standardization by the world standardized population.
† Significantly different from zero (P<0.05).

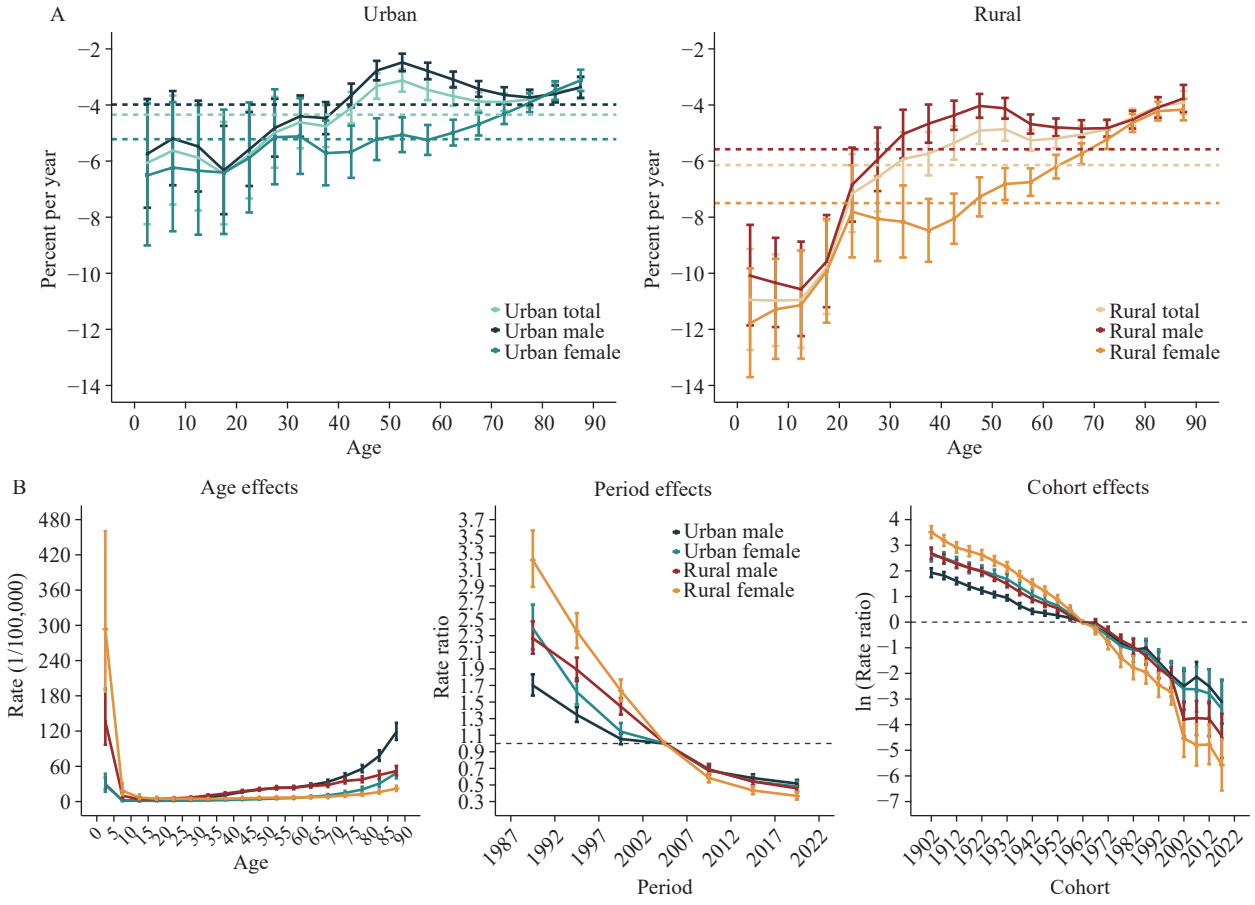

FIGURE 2. The results of the age-period-cohort analysis. (A) Net drift and local drift for DDs mortality in urban and rural areas of China from 1987 to 2021; (B) Parameter estimates of age, period, and cohort effects on DDs mortality in China from 1987 to 2021.
Abbreviation: DD=digestive disease.

and sexes, suggesting that China experienced a consistent reduction in DDs mortality over the study period. Notably, rural areas exhibited greater period effects on DDs mortality compared to urban areas. Furthermore, there was a more pronounced improvement in mortality rate among women compared to men, with rural women showing the most significant progress. The analysis of the cohort rate ratio demonstrated a declining trend in DDs mortality in China from 1900 onwards, regardless of geographic location or sex.

DISCUSSION

Our study revealed a decline in mortality related to DDs in China between 1987 and 2021. We observed a gradual reduction in the urban-rural disparity, which we attribute to significant improvements in rural areas. The reduction in DDs mortality can be attributed to both period and cohort effects. Additionally, we found that DDs mortality among rural children under 5 years old was higher compared to urban children, whereas DDs mortality among older adults in urban areas surpassed that of their rural counterparts at a rapid rate.

The overall mortality trends for DDs in China experienced a decline from 1987 to 2021, likely owing to the country's economic growth. Nonetheless, the unequal development between urban and rural areas exacerbated the urban-rural disparity in DDs mortality (*3*). Despite this initial disparity, recent research indicates that the gap between urban and rural areas has diminished or even disappeared in the past two decades. This positive change can be attributed to the combined influence of the period and cohort on mortality rates. The study findings suggest that the health reform implemented in 2002 played a significant role in narrowing the urban-rural disparity. This reform involved increased investment in rural healthcare, the establishment of a rural health service

system, and the implementation of the New Cooperative Medical Scheme (*3*–*4*).

Mortality rates due to DDs were found to be higher among children under 5 years of age, particularly in rural areas compared to urban areas. This disparity in mortality can be partially attributed to the prevalence of gastrointestinal hemorrhage and diarrhea (*5*–*6*). These two common symptoms of DDs share risk factors in this age group, such as poorly constructed health facilities, malnutrition, and limited access to healthcare, which contribute significantly to the higher mortality rates among rural children (*5*–*6*). The Chinese government has taken measures to address this issue and reduce DDs mortality in children, including promoting breastfeeding and distributing nutrition packages containing zinc and vitamin supplements to children aged 6–12 months in impoverished counties (*7*).

Notably, mortality from DDs increases with age in urban areas, surpassing rural areas (*1*). The higher prevalence of unhealthy lifestyles in urban areas likely contributes to this disparity. As urbanization continues, the prevalence of these unhealthy lifestyle factors is expected to rise, further impacting DDs mortality. Interventions focused on lifestyle modification are key to reducing DDs mortality and addressing the challenges associated with social development and urbanization. Additionally, the use of multiple medications may also affect DDs through interactions with the gut microbiome (*8*–*9*). The high prevalence of polypharmacy among older adults in urban areas may also explain the differing age effects on DDs mortality between rural and urban populations (*10*). To address these issues, a shift towards person-centered medical management is necessary to ensure appropriate treatment and care for older adults with complex conditions. In summary, the differences in age-related mortality between urban and rural older adults underscore the growing burden of DDs attributable to urbanization and aging. Prioritizing efforts in DDs management and addressing these disparities is vital in addressing the challenges arising from urbanization.

The study had several limitations. First, the broad coverage of the medical certificate information system may have led to underreporting, delayed reporting, and misclassification of death causes. Additionally, the change in cause of death classification criteria from ICD-9 to ICD-10 could have affected the accuracy of DDs mortality data. However, the similarity of the trends observed in this study to the 2019 Global Burden of Disease (GBD) study provides some confidence in the reliability of the data source. Second, the APC model was constructed based on cross-sectional data on DDs mortality rather than cohort data. Lastly, the inclusion of various specific DDs with different incidence and prevalence trends in this study weakens the characterization of individual diseases. It is recommended to conduct further studies on clusters of DDs with similar characteristics.

In conclusion, there has been a significant decline in the mortality rate of DDs over the past 35 years, particularly in rural areas where there have been notable improvements. This has led to a narrowing of the urban-rural disparity. The favorable period effect observed suggests that the health reforms implemented in China have contributed to this positive trend and could serve as a valuable lesson for other developing countries struggling with urban-rural health disparities. However, it is important to note that there has been a rapid increase in DDs mortality among older adults in urban areas as they age, surpassing the rates in rural areas. This finding highlights the need for further investigation into the population-level study of human aging omics (HAO). Specifically, it identifies urban older adults as a group at high risk for DDs (*11*). Additionally, the differences in the age effect on DDs mortality between urban and rural areas underscore the importance of directing more attention and resources toward managing DDs in the future. This is crucial to address the challenges posed by urbanization and aging and to lay a solid foundation for healthy and active aging (*12*).

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[#] Corresponding authors: Binbin Su, subinbin@sph.pumc.edu.cn; Zhiqiang Song, szqinputh@163.com; Bin Cong, hbydcongbin @hebmu.edu.cn.

[1] School of Population Medicine and Public Health, Chinese Academy of Medical Sciences/Peking Union Medical College, Beijing, China; [2] Department of Endoscopy Center, Peking University First Hospital, Beijing, China; [3] Department of Gastroenterology, Peking University Third Hospital, Beijing, China; [4] Department of Forensic Medicine, Hebei Medical University, Hebei Key Laboratory of Forensic Medicine, Collaborative Innovation Center of Forensic Medical Molecular Identification, Shijiazhuang City, Hebei Province, China.
[&] Joint first authors.

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