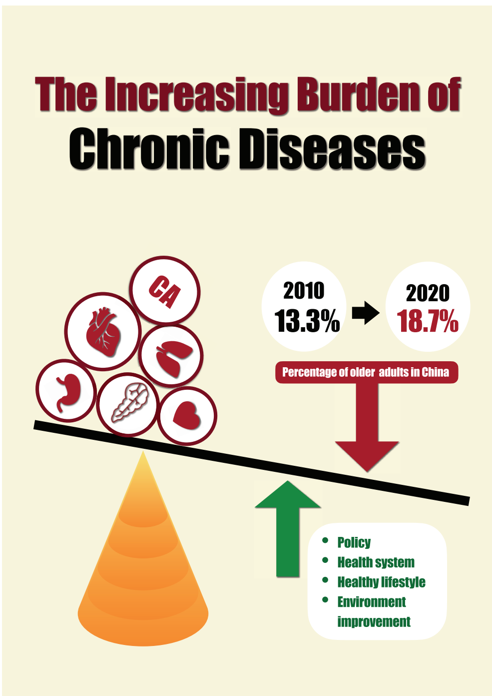
ISSN 2096-7071 (Print)
ISSN 2096-3101 (Online)
CN 10-1629/R1

CHINA CDC WEEKLY

Vol. 5 No. 50 Dec. 15, 2023

CCDC weekly

中国疾病预防控制中心周报



EVOLVING PATTERNS OF MORTALITY ISSUE

Preplanned Studies

Commentary

ISSN 2096-7071

Cover Image: credited from this week's author Binbin Su (data from sixth and seventh national population census).
This week's issue was organized by Guest Editor Xiaoying Zheng.

Preplanned Studies

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

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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

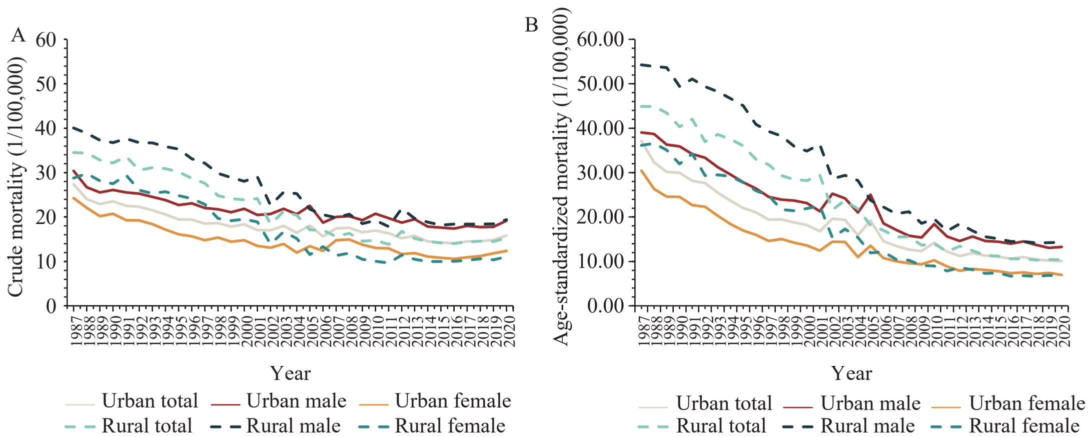

FIGURE 1. DDs mortality trends by sexes in urban and rural areas of China from 1987 to 2021. (A) Crude DDs mortality; (B) Age-standardized DDs mortality.
Abbreviation: DD=digestive disease.

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).

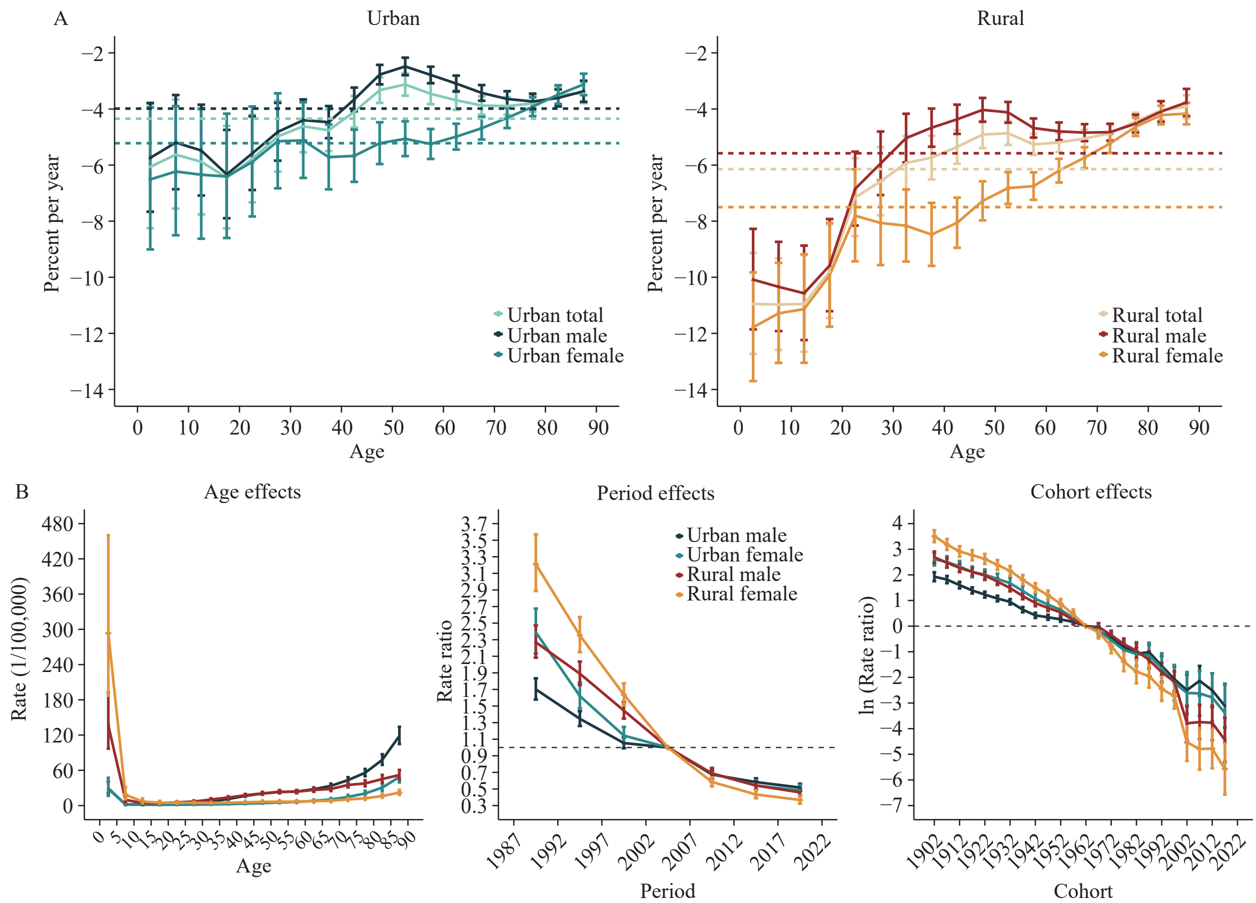

FIGURE 2. The results of the age-period-cohort analysis. (A) Net drift and local drift for DDs mortality in urban and rural areas of China from 1987 to 2021; (B) Parameter estimates of age, period, and cohort effects on DDs mortality in China from 1987 to 2021.
Abbreviation: DD=digestive disease.

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*).

Conflicts of interest: No conflicts of interest.

Funding: Supported by the Population and Aging Health Science Program (WH10022023035) and the National Key Research and Development Program (SQ2022YFC3600291).

doi: 10.46234/ccdcw2023.208

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Submitted: November 09, 2023; Accepted: November 29, 2023

REFERENCES

1. Wang R, Li ZQ, Liu SJ, Zhang DC. Global, regional, and national burden of 10 digestive diseases in 204 countries and territories from 1990 to 2019. Front Public Health 2023;11:1061453. http://dx.doi.org/10.3389/fpubh.2023.1061453.
2. Ahmad OB, Boschi-Pinto C, Lopez AD, Murray CJL, Lozano R, Inoue M. Age standardization of rates: a new WHO standard. Geneva: WHO; 2001. https://www.researchgate.net/publication/284696312_Age_Standardization_of_Rates_A_New_WHO_Standard.
3. Jian WY, Chan KY, Reidpath DD, Xu L. China's rural-urban care gap shrank for chronic disease patients, but inequities persist. Health Aff 2010;29(12):2189 – 96. http://dx.doi.org/10.1377/hlthaff.2009.0989.
4. Wagstaff A, Lindelow M, Gao J, Xu L, Qian JC. Extending health insurance to the rural population: an impact evaluation of China's new cooperative medical scheme. J Health Econ 2009;28(1):1 – 19. http://dx.doi.org/10.1016/j.jhealeco.2008.10.007.
5. Witt M, Kvist N, Jørgensen MH, Hulscher JBF, Verkade HJ. Prophylactic dosing of vitamin K to prevent bleeding. Pediatrics 2016;137(5):e20154222. http://dx.doi.org/10.1542/peds.2015-4222.
6. Fischer Walker CL, Walker N. 2014. The Lives Saved Tool (LiST) as a model for diarrhea mortality reduction. BMC Med 2014;12(1):70. http://dx.doi.org/10.1186/1741-7015-12-70.
7. Black R, Fontaine O, Lamberti L, Bhan M, Huicho L, El Arifeen S, et al. Drivers of the reduction in childhood diarrhea mortality 1980-2015 and interventions to eliminate preventable diarrhea deaths by 2030. J Glob Health 2019;9(2):020801. http://dx.doi.org/10.7189/jogh.09.020801.
8. Ding JH, Jin Z, Yang XX, Lou J, Shan WX, Hu YX, et al. Role of gut microbiota via the gut-liver-brain axis in digestive diseases. World J Gastroenterol 2020;26(40):6141 – 62. http://dx.doi.org/10.3748/wjg.v26.i40.6141.
9. Nagata N, Nishijima S, Miyoshi-Akiyama T, Kojima Y, Kimura M, Aoki R, et al. Population-level metagenomics uncovers distinct effects of multiple medications on the human gut microbiome. Gastroenterology 2022;163(4):1038 – 52. http://dx.doi.org/10.1053/j.gastro.2022.06.070.
10. Yang M, Lu J, Hao QK, Luo L, Dong BR. Does residing in urban or rural areas affect the incidence of polypharmacy among older adults in western China? Arch Gerontol Geriatr 2015;60(2):328-33. http://dx.doi.org/10.1016/j.archger.2014.11.004.
11. Zheng XY, Guo C. Strengthening systematic research on aging: reflections from an omics perspective. China CDC Wkly 2022;4(39):875 – 8. http://dx.doi.org/10.46234/ccdcw2022.181.
12. Zheng XY, Luo YN, Su BB, He P, Guo C, Tian YH, et al. Developmental gerontology and active population aging in China. China CDC Wkly 2023;5(8):184 – 7. http://dx.doi.org/10.46234/ccdcw2023.033.

Preplanned Studies

Changing Patterns of Mortality in Diabetes Mellitus Among Older Adults — China, 1987–2021

Chen Chen[1,&]; Yihao Zhao[2,&]; Shangjun Liu[3,&]; Yu Wu[1]; Shan Yang[1]; Binbin Su[4,#]; Xiaoying Zheng[1,5,#]

Summary

What is already known about this topic?

Diabetes mellitus poses a significant public health concern for older adults in China, resulting in increased mortality rates.

What is added by this report?

This study investigates the evolving pattern of mortality associated with diabetes mellitus and analyzes the contributions of age, period, and cohort effects from 1987 to 2021. The results demonstrate a consistent rise in diabetes mellitus mortality over the last 30 years, notably in rural regions.

What are the implications for public health practice?

This research offers valuable insights to aid policymakers in developing targeted intervention strategies that address the specific needs of higher-risk populations, such as women, older adults, and individuals in rural areas.

Diabetes mellitus (DM) is a significant contributor to reduced global health-adjusted life expectancy, particularly among older adults (*1*). In China, the prevalence of DM has notably increased from 10.9% to 12.8% between 2013 and 2017, with a particularly high prevalence of 31.8% among older adults (*2*). China is currently undergoing a substantial demographic shift due to aging and has experienced significant transformations over the past three decades (*3–4*). However, research on the changing trend of DM, specifically in older adults and with a focus on urban-rural disparities, is scarce. Therefore, this study aimed to comprehensively examine the evolving trajectory of DM mortality from 1987 to 2021, with a specific focus on the influence of age, period, and cohort on shifting patterns. Our findings reveal distinct evolving patterns between urban and rural areas, with a significant increase in DM mortality among the oldest-old population. Addressing this trend should be a priority, and the government should implement measures to mitigate it.

Mortality data for Chinese older adults (age ≥60) with DM were collected from 1987 to 2021. The data were categorized by age, gender, and urban-rural areas, sourced from China's National Health Commission (1954–2013, Ministry of Health; 2013–2018, National Health and Family Planning Commission) death registration system. The age-standardized mortality rate per 100,000 was calculated using the direct standardization method with the World Standard Population as the reference (*5*). Significant fluctuations were identified using joinpoint regression analysis conducted with the Joinpoint Regression Software (v4.9.10, Statistical Research and Applications Branch, National Cancer Institute, Washington, USA). The independent effects of age, period, and cohort were determined using the age-period-cohort (APC) model, implemented with the Web Tool developed by the US National Cancer Institute (*6*). Statistical significance was determined with a two-tailed P-value <0.05.

Figure 1 delineates the trajectory of DM mortality from 1987 to 2021, showing an overall upward trend in the elderly populations of both urban and rural areas. However, distinct patterns emerge in the changing trajectories of urban and rural regions. The rural areas experienced a consistent rise, while urban areas initially increased and then gradually declined, resulting in a narrowed urban-rural discrepancy. Specifically, DM mortality in rural regions increased from 1.96 per 100,000 in 1987 to 8.52 per 100,000 in 2021. In contrast, urban areas saw an increase from 7.52 per 100,000 in 1987 to 14.28 per 100,000 in 2000, eventually decreasing to 10.49 per 100,000 in 2021. Regarding gender differences, higher DM mortality rates were consistently observed in men compared to women, regardless of whether they resided in urban or rural areas.

Table 1 shows periods of significant fluctuation identified through joinpoint regression analysis, revealing distinct evolving patterns in DM mortality. The results showcase a continuous increase [average annual percent change (AAPC)=4.8%, 95% confidence

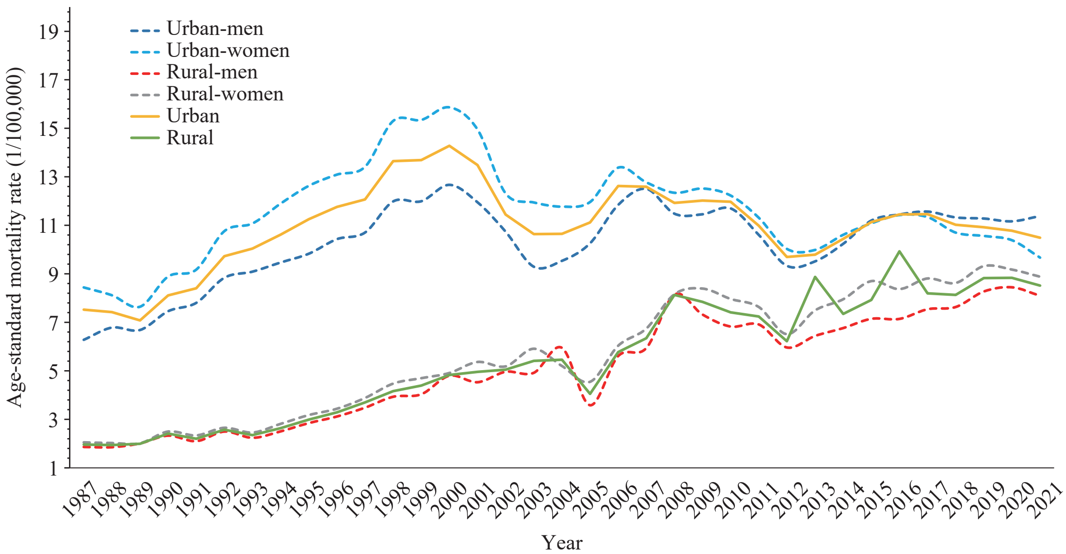

FIGURE 1. Trend of age-standardized mortality rate from diabetes mellitus in Chinese older adults from 1987 to 2021.

TABLE 1. Joinpoint analysis of age-standardized mortality rate of diabetes mellitus in Chinese older adults.

Diabetes mellitus	Total study period (1987–2021)		Period 1		Period 2	
	AAPC (%)	95% *CI*	Years	APC (%)	Years	APC (%)
Urban						
Total	1.1*	(0.6, 1.7)	1987–1998	5.7*	1998–2021	−1.0*
Men	1.6*	(1.0, 2.3)	1987–1997	6.0*	1997–2021	−0.1
Women	0.7*	(0.2, 1.3)	1987–1998	6.0*	1998–2021	−1.7*
Rural						
Total	4.8*	(4.0, 5.6)	1987–2008	6.6*	2008–2021	1.8*
Men	4.5*	(3.7, 5.3)	1987–2008	6.4*	2008–2021	1.4
Women	4.7*	(4.0, 5.4)	1987–2008	6.6*	2008–2021	1.6*

Abbreviation: AAPC=average annual percent change; APC=annual percent change; *CI*=confidence interval.
* Significant difference from zero (*P*<0.05).

interval (*CI*): 4.0%–5.6%] in rural areas. Conversely, urban areas display an upward trend from 1987 to 1998 (AAPC=5.7%), followed by a slow decline from 1998 to 2021 (AAPC=−1.0%). The table also provides a comprehensive overview of these trends across different periods.

Figure 2 shows the effects of age, period, and cohort on DM mortality. For the age effect, both urban and rural areas exhibited a J-shaped distribution, with DM mortality escalating more rapidly in later years. Notably, women displayed a steeper upward trend compared to men, regardless of whether they resided in urban or rural areas. Regarding the period effect, a flat variation was observed throughout the study period in urban regions. Conversely, in rural regions, the period effect on DM mortality displayed a continuous upward trend, with the risk approximately twice as high as in urban regions. Concerning the cohort effect, significant disparities were also observed between urban and rural areas. In urban areas, the risk of DM mortality remained relatively stable across different cohorts, regardless of gender. Conversely, in rural areas, the cohort effect indicated that the risk of DM mortality was notably higher among more recently born cohorts, reaching its peak in the cohort born in 1957 [risk ratio (RR)=1.83, 95% *CI*: 1.54–2.16].

DISCUSSION

This study identified an increase in DM mortality among older adults in China from 1987 to 2021, with rural areas experiencing a particularly notable rise. Notably, there were distinct patterns observed between urban and rural areas. In rural areas, there was a

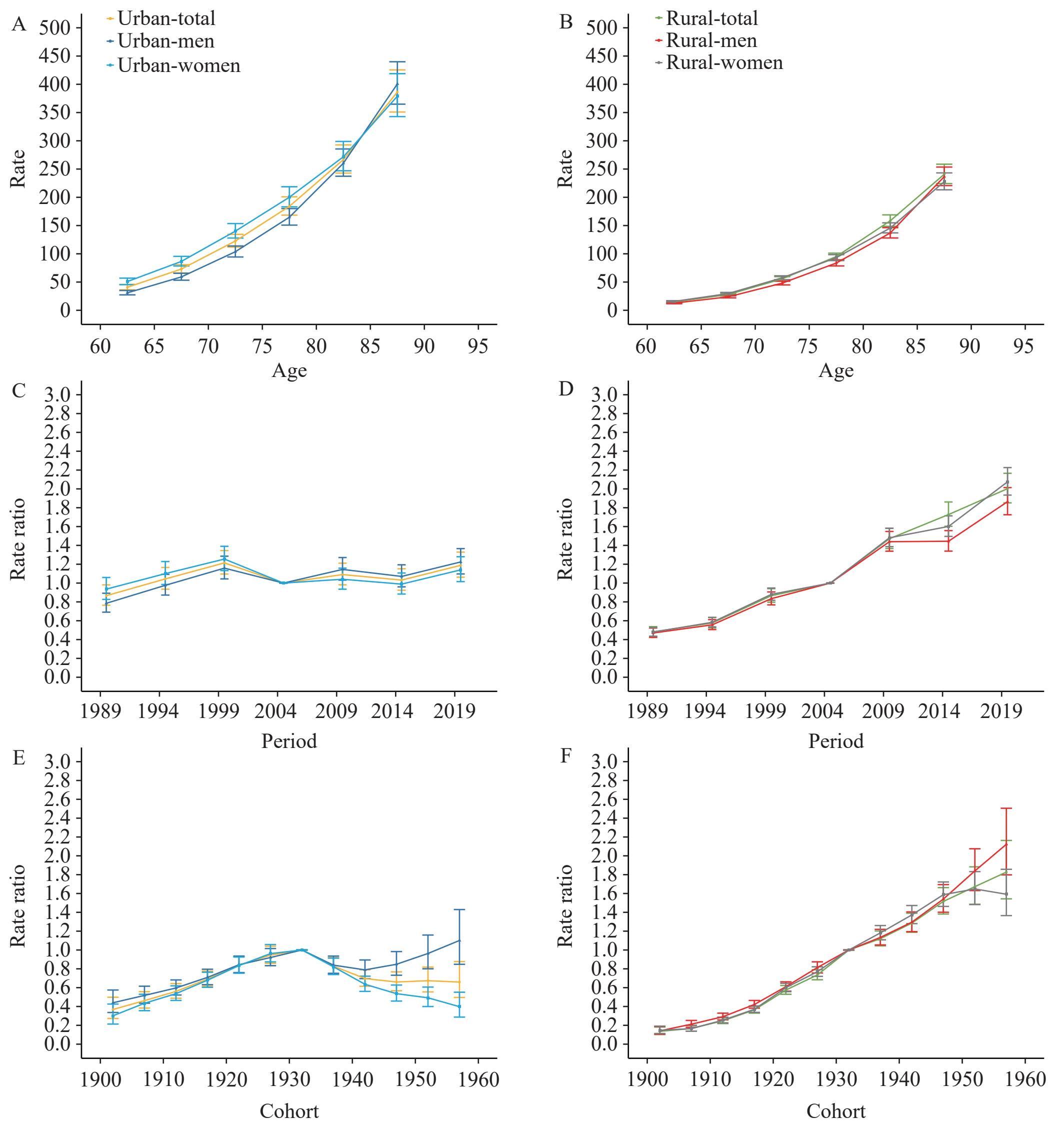

FIGURE 2. The effects of age, period, and cohort on age-standardized mortality rate of diabetes mellitus in Chinese older adults from 1987 to 2021. (A) Age effect in urban area; (B) Age effect in rural area; (C) Period effect in urban area; (D) Period effect in rural area; (E) Cohort effect in urban area; (F) Cohort effect in rural area.

consistent upward trend across all periods, while urban areas exhibited an increase in period 1 followed by a decrease in period 2, gradually narrowing the gap between them. DM mortality increased with age in both urban and rural areas across different age groups. In terms of period and cohort effects, urban areas showed relatively stable patterns, whereas rural areas exhibited J-shaped changing trends.

In the past three decades, China has experienced significant economic and societal changes, coinciding with an upward trend in mortality related to DM. This trend is consistent with global studies comparing DM mortality rates (*7*). Notably, developed countries like the United Kingdom and Germany have demonstrated a decline in DM mortality, whereas many developing nations undergoing an economic transition from low-income to middle-income status have observed a gradual increase in DM mortality. The difference in trends may be attributed, in part, to decreased exposure to risk factors and advances in medical management in developed countries.

The onset and progression of DM are closely associated with socioeconomic factors and lifestyle choices, including smoking, alcohol consumption, and unhealthy dietary habits. In the past three decades, the Chinese population has undergone significant changes in lifestyle and diet. According to the China Health and Nutrition Survey, the prevalence of obesity has increased from 4.0% to 16.4% between 1993 and 2019 (*8*). These changes have contributed to the rise in

DM mortality, as evidenced by the increase in DM-related deaths in both urban and rural areas from 1987 to 2021, as reported in this study. Notably, the Chinese government and researchers have recognized the health risks and burdens associated with non-communicable diseases, including DM, and have implemented preventive measures such as health education and non-communicable disease prevention and control programs.

Our analysis of urban-rural comparisons shows distinct trends in DM mortality. Before 2000, urban areas had a higher growth rate in DM mortality compared to rural areas. This could be due to factors such as higher economic status, a diet high in fat content, and better diagnosis rates in urban areas. However, after 2000, particularly in recent years, rural areas have experienced a significantly higher growth rate in DM mortality, with a stable or slightly declining trend. This aligns with a previous study that found a narrowing gap in DM mortality between urban and rural areas (*9*). The shift in this trend may be due to accelerated economic development, unfavorable lifestyle transitions, low health awareness, and lower standards of medical care in rural areas. The widening urban-rural disparity highlights the urgent need for increased attention and investment in strategies to prevent DM in rural areas.

In our analysis, we found that DM mortality rates were higher among women compared to men in both urban and rural areas. This gender disparity was more pronounced with increasing age. Potential factors contributing to this trend include the influence of sex hormones and possible physiological or biochemical effects on molecular pathways (*10*). It is also worth noting that women tend to live longer but may experience worse health outcomes. Additionally, DM affects a larger number of women than men (*11*). Examining the trend over time, we observed a greater decline in DM mortality among women in urban areas compared to men, while there was no significant gender difference in rural areas. This difference may be explained by economic factors, such as higher DM control rates, greater health awareness, and lower exposure to risk factors among women in urban areas. To mitigate this upward trend, targeted interventions for women, especially those in rural areas, are crucial. Furthermore, our study revealed that regardless of urban or rural areas, DM mortality increased at a higher rate among the oldest-old compared to the young-old. This highlights the heightened risk of DM mortality among the oldest-old population. These findings emphasize the need for increased attention to the risk of death from DM, particularly among the oldest-old population, especially in rural areas.

This study has some limitations. First, our dataset does not include information on different types of DM and province-level administrative divisions, which restricts our ability to analyze the specific types of DM and geographical variations in more detail. Second, our data rely on reported statistics rather than individual-level data, which may underestimate the mortality associated with DM since there may be undiagnosed cases in China. Third, as the APC model used in this study is an ecological research method, it does not allow us to establish causal relationships. However, our main research objective is to examine changes in DM mortality among older adults in China over the past three decades and provide scientifically supported explanations based on relevant literature.

Conflicts of interest: No conflicts of interest.

Funding: Supported by the Population and Aging Health Science Program (WH10022023035) and the National Key Research and Development Program (SQ2022YFC3600291).

doi: 10.46234/ccdcw2023.209

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Submitted: November 13, 2023; Accepted: November 27, 2023

REFERENCES

1. Martinez R, Lloyd-Sherlock P, Soliz P, Ebrahim S, Vega E, Ordunez P, et al. Trends in premature avertable mortality from non-communicable diseases for 195 countries and territories, 1990-2017: a population-based study. Lancet Glob Health 2020;8(4):e511 – 23. http://dx.doi.org/10.1016/s2214-109x(20)30035-8.
2. Li YZ, Teng D, Shi XG, Qin GJ, Qin YF, Quan HB, et al. Prevalence of diabetes recorded in mainland China using 2018 diagnostic criteria from the American Diabetes Association: national cross sectional study. BMJ 2020;369:m997. http://dx.doi.org/10.1136/bmj.m997.
3. Zheng XY, Luo YN, Su BB, He P, Guo C, Tian YH, et al. Developmental gerontology and active population aging in China. China CDC Wkly 2023;5(8):184 – 7. http://dx.doi.org/10.46234/ccdcw2023.033.
4. Zheng XY, Guo C. Strengthening systematic research on aging:

reflections from an omics perspective. China CDC Wkly 2022;4(39):875 – 8. http://dx.doi.org/10.46234/ccdcw2022.181.

5. Ahmad OB, Boschi-Pinto C, Lopez AD, Murray CJL, Lozano R, Inoue M. Age standardization of rates: a new WHO standard. World Health Organization. 2001;9(10):1 – 14. https://www.researchgate.net/publication/284696312_Age_Standardization_of_Rates_A_New_WHO_Standard.
6. Zou ZY, Cini K, Dong B, Ma YH, Ma J, Burgner DP, et al. Time trends in cardiovascular disease mortality across the BRICS: an age-period-cohort analysis of key nations with emerging economies using the global burden of disease study 2017. Circulation 2020;141(10):790 – 9. http://dx.doi.org/10.1161/circulationaha.119.042864.
7. The Emerging Risk Factors Collaboration. Diabetes mellitus, fasting blood glucose concentration, and risk of vascular disease: a collaborative meta-analysis of 102 prospective studies. Lancet 2010;375(9733):2215 – 22. http://dx.doi.org/10.1016/s0140-6736(10)60484-9.
8. Wang LM, Peng W, Zhao ZP, Zhang M, Shi ZM, Song ZW, et al. Prevalence and treatment of diabetes in China, 2013-2018. JAMA 2021;326(24):2498 – 506. http://dx.doi.org/10.1001/jama.2021.22208.
9. Li YY, Kou CG, Bai W, Hua WQ, Yu WY, Song Y, et al. Trends in diabetes mortality by gender in urban and rural areas in China from 2003 to 2012: an age-period-cohort analysis. Asia Pac J Public Health 2019;31(3):238 – 45. http://dx.doi.org/10.1177/1010539519841288.
10. Muka T, Nano J, Jaspers L, Meun C, Bramer WM, Hofman A, et al. Associations of steroid sex hormones and sex hormone-binding globulin with the risk of type 2 diabetes in women: a population-based cohort study and meta-analysis. Diabetes 2017;66(3):577 – 86. http://dx.doi.org/10.2337/db16-0473.
11. Saeedi P, Petersohn I, Salpea P, Malanda B, Karuranga S, Unwin N, et al. Global and regional diabetes prevalence estimates for 2019 and projections for 2030 and 2045: results from the International Diabetes Federation Diabetes Atlas, 9th edition. Diabetes Res Clin Pract 2019;157:107843. http://dx.doi.org/10.1016/j.diabres.2019.107843.

Preplanned Studies

Urban-Rural Disparity in Mortality Patterns of Respiratory Diseases Among Older Adults — China, 1987–2021

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Summary

What is already known about this topic?

Respiratory diseases (RDs) are the primary cause of death in older adults in China. However, there is limited evidence regarding the disparity in mortality rates of RDs between urban and rural areas among the elderly population.

What is added by this report?

The age-standardized mortality rate (ASMR) due to RDs in the elderly population in both urban and rural areas of China has shown a consistent decrease. This trend is observed in both males and females. However, there was no significant change in the average annual percentage of ASMR for pneumonia among the urban elderly population and rural elderly men throughout the study period.

What are the implications for public health practice?

Efforts should be made in China to reduce mortality from chronic lower respiratory disease and pneumonia among the elderly, particularly in urban populations.

Respiratory diseases (RDs) are a significant cause of mortality in China, ranking fourth after heart disease, cancers, and cerebrovascular diseases. This burden is particularly prominent among the elderly population (*1*). However, there is limited evidence on the disparity in mortality patterns of RDs, pneumonia, and chronic lower respiratory disease (CLRD) between urban and rural areas among the elderly in China. This study aims to address this research gap by analyzing mortality trends of RDs among individuals aged 60 years or older in both urban and rural areas of China from 1987 to 2021. The study utilized joinpoint regression models and age-period-cohort (APC) models to assess the trends, revealing a decline in RDs mortality. However, there was no statistically significant average annual percentage change (AAPC) in the age-standardized mortality rate (ASMR) for pneumonia over the past 35 years. These findings highlight the importance of addressing pneumonia in the elderly population, while also emphasizing the need for preventative measures and treatment for CLRD and RDs as a whole.

Age-specific mortalities of RDs, pneumonia, and CLRD between 1987 and 2021 were obtained from China's National Health Commission (NHC) death registration system, which collects data from administrative organizations. The World Standard Population was used to calculate ASMRs (*2*). Joinpoint regression models using the Joinpoint Regression Program (version 4.9.10, Statistical Research and Applications Branch, National Cancer Institute, Washington, USA) were performed to identify years with significant changes in RD mortality trends during the study period. To address the exact collinearity among age effects, period effects, and cohort effects, APC models were employed (*3*). We used the web tool developed by the US National Cancer Institute (https://analysistools.cancer.gov/apc/). Statistical significance was determined at a *P*-value of <0.05 (two-tailed).

Figure 1 presents the long-term trends in ASMR for RDs, pneumonia and CLRD in China's elderly population, stratified by geographical area and sex. From 1987 to 2021, there was a decline in ASMR for the elderly in both urban and rural areas, as well as in both sexes. Old men consistently had higher ASMR than old women, regardless of their residential area. The ASMR was also consistently higher in rural areas compared to urban areas, although the gap between the two narrowed over time. The ASMR for CLRD followed a similar trend, while the ASMR for pneumonia showed a peculiar pattern where the ASMR in urban residents exceeded that in rural residents. Over the study period, there was a notable decline in ASMR for RDs in China's elderly population, with reductions of 78.29% in urban areas and 79.34% in rural areas, respectively.

Table 1 presents the findings of the joinpoint regression analysis. Among rural residents, there was a consistent declining trend in ASMR of RDs, with an AAPC of −4.62%. In urban residents, although the

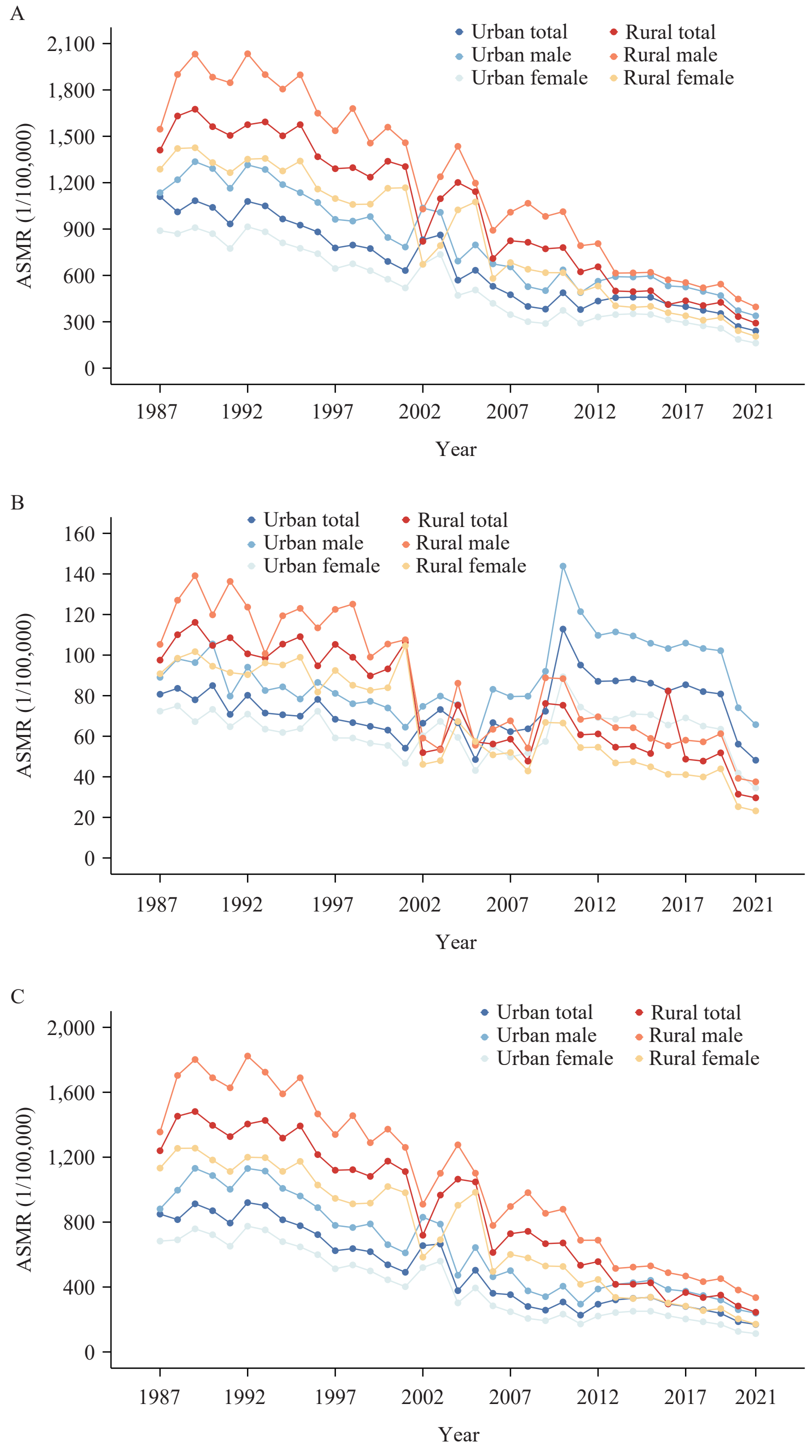

FIGURE 1. Trends in ASMR of the elderly in urban and rural China by sex, 1987–2021. (A) From RDs; (B) from pneumonia; (C) from CLRD.
Abbreviation: ASMR=age-standardized mortality rate; CLRD=chronic lower respiratory disease; RDs=respiratory diseases.

ASMR of RDs also decreased with an AAPC of −4.30% per year, there was a non-significant upward trend between 2008 and 2016, with an annual percentage change (APC) of 1.21% per year. No significant changes were observed in ASMR of pneumonia among urban residents and rural males from 1987 to 2021. However, in rural residents and rural females, there was a consistent downward trend. In terms of CLRD, the ASMR for the entire population showed a decreasing trend throughout the

TABLE 1. Joinpoint analysis of ASMR of the elderly in China from RDs, pneumonia, and CLRD in urban and rural areas.

Categories	ASMR (per 100,000)		Total study period		Period 1		Period 2		Period 3		Period 4	
	1987	2021	AAPC (%)	95% *CI*	Years	APC (%)	Years	APC (%)	Years	APC (%)	Years	APC (%)
Urban												
RDs												
Total	1,109.77	240.93	−4.30*	(−5.82, −2.74)	1987–2003	−2.71*	2003–2008	−10.50*	2008–2016	1.21	2016–2021	−11.21*
Male	1,135.18	338.67	−3.79*	(−5.49, −2.05)	1987–2003	−2.51*	2003–2009	−8.44*	2009–2015	2.70	2015–2021	−8.56*
Female	889.29	162.30	−4.88*	(−6.47, −3.28)	1987–2003	−2.74*	2003–2008	−12.32*	2008–2016	1.46	2016–2021	−13.33*
Pneumonia												
Total	93.62	48.18	−1.67	(−4.17, 0.89)	1987–2007	−1.74*	2007–2010	18.49	2010–2019	−2.24	2019–2021	−23.17*
Male	89.02	65.72	−1.28	(−2.79, 0.26)	1987–2005	−2.14*	2005–2010	12.17*	2010–2019	−1.88	2019–2021	−20.17*
Female	72.35	34.50	−2.35	(−5.00, 0.37)	1987–2007	−1.96*	2007–2010	15.03	2010–2019	−2.05	2019–2021	−27.56*
CLRD												
Total	849.29	169.42	−4.82*	(−6.83, −2.77)	1987–2003	−3.25*	2003–2009	−12.21*	2009–2015	5.05	2015–2021	−10.49*
Male	881.1	239.09	−3.95*	(−6.35, −1.48)	1987–1993	2.61	1993–2011	−6.27*	2011–2015	6.68	2015–2021	−9.78*
Female	682.84	113.04	−5.43*	(−7.44, −3.38)	1987–2003	−3.37*	2003–2009	−13.77*	2009–2015	5.74	2015–2021	−12.42*
RDs												
Total	1,410.73	291.47	−4.62*	(−5.38, −3.86)	1987–2000	−1.66	2000–2021	−6.41*	–	–	–	–
Male	1,546.07	396.05	−4.01*	(−4.83, −3.18)	1987–1995	0.91	1995–2021	−5.48*	–	–	–	–
Female	1,287.15	205.73	−5.26*	(−6.08, −4.42)	1987–2004	−2.87*	2004–2021	−7.58*	–	–	–	–
Rural												
Pneumonia												
Total	97.52	29.63	−4.15*	(−7.01, −1.20)	1987–2019	−2.69*	2019–2021	−24.82	–	–	–	–
Male	105.27	37.54	−3.06	(−6.74, 0.78)	1987–2000	−0.78	2000–2003	−20.17	2003–2010	4.66	2010–2021	−5.28*
Female	90.82	23.20	−4.65*	(−7.19, −2.03)	1987–2019	−3.07*	2019–2021	−26.63	–	–	–	–
CLRD												
Total	1,239.77	244.72	−5.10*	(−5.89, −4.29)	1987–2004	−2.69*	2004–2021	−7.44*	–	–	–	–
Male	1,355.28	334.68	−4.15*	(−5.04, −3.25)	1987–1995	1.04	1995–2021	−5.69*	–	–	–	–
Female	1,132.66	171.22	−5.44*	(−6.28, −4.60)	1987–2004	−2.91*	2004–2021	−7.92*	–	–	–	–

Note: "–" means no joinpoints identified.

Abbreviation: RDs=respiratory diseases; CLRD=chronic lower respiratory disease; ASMR=age-standardized mortality rate; APC=annual percent change; AAPC=average annual percent change; *CI*=confidence interval.

* *P*<0.05.

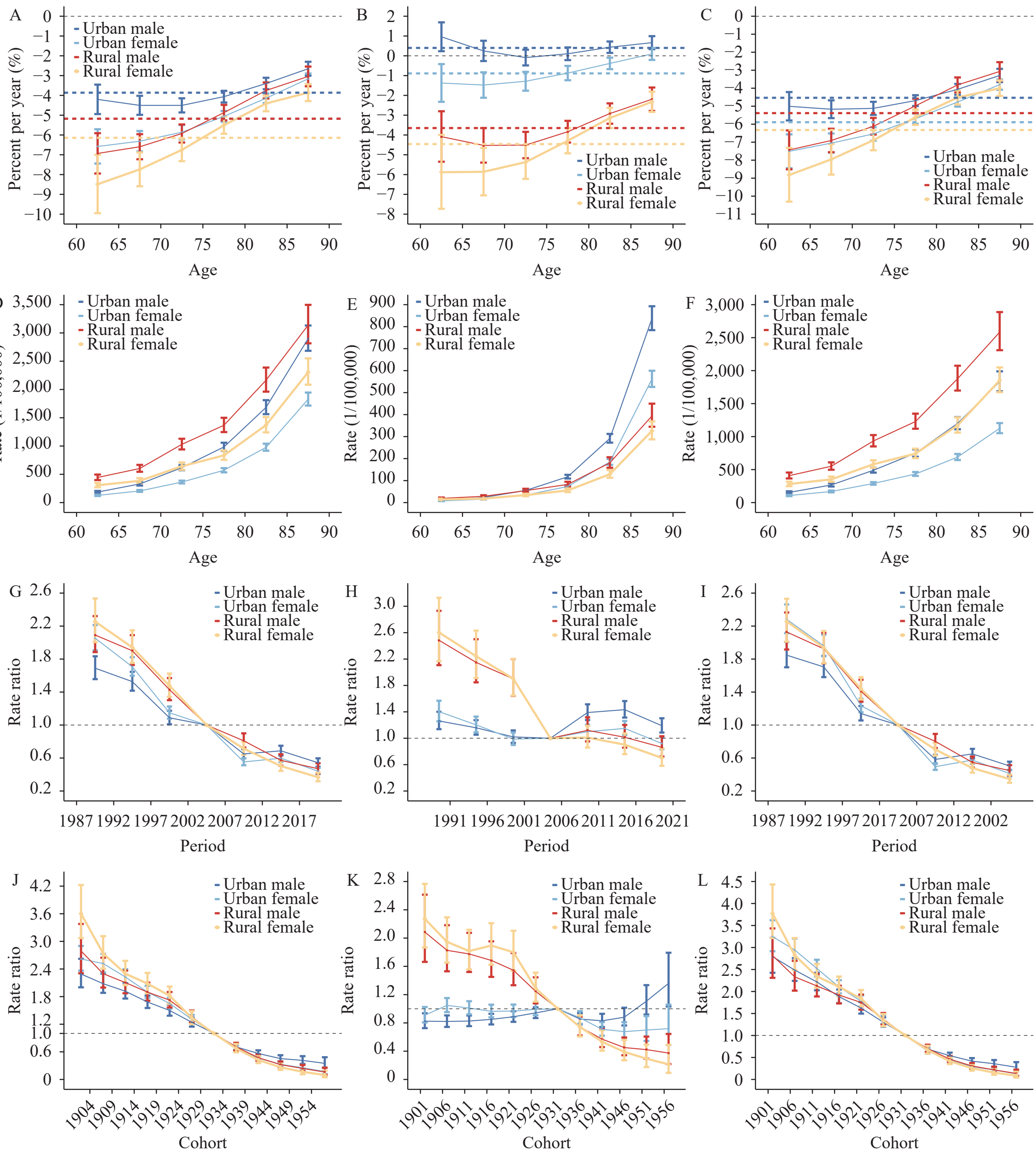

FIGURE 2. Local drifts with net drifts and age-period-cohort effects for mortality from RDs and selected RDs of the elderly in China from 1987 to 2021. (A) Local drifts with net drifts for mortality from RDs; (B) local drifts with net drifts for mortality from pneumonia; (C) local drifts with net drifts for mortality from CLRD; (D) age effects for mortality from RDs; (E) age effects for mortality from pneumonia; (F) age effects for mortality from CLRD; (G) period effects for mortality from RDs; (H) period effects for mortality from pneumonia; (I) period effects for mortality from CLRD; (J) cohort effects for mortality from RDs; (K) cohort effects for mortality from pneumonia; (L) cohort effects for mortality from CLRD.
Abbreviation: RDs=respiratory diseases; CLRD=chronic lower respiratory disease.

study period from 1987 to 2021.

Figure 2A–C illustrates the netdrift and localdrift for RDs. In the entire urban population, the netdrift was −4.35% [95% confidence interval (*CI*): −4.59, −4.12]. Among rural residents, the netdrift was −5.53% (95% *CI*: −5.87, −5.19). Notably, females and rural residents experienced greater declines in RDs. Across all age groups, the local drifts were negative, indicating improvements. The most significant improvements were observed in rural women aged 60 to 65 years, with a netdrift of −8.49% per year (95% *CI*: −9.95, −7.00). The netdrift and localdrifts for CLRD followed similar trends as RDs. However, pneumonia showed a different pattern. In urban males, the netdrift for pneumonia was positive at 0.40% per year (95% *CI*: 0.13, 0.67), and the local drifts for urban males aged 60 to 65 years and 80 years and older were also positive.

The age, period, and cohort effects on mortality from RDs are illustrated in Figure 2D–L. After adjusting for period effects, RDs mortality increased with age in the reference cohort, with a more rapid increase in older age groups. Males consistently had higher mortality rates across all age groups. Rural residents had higher rates of RDs and CLRD compared to urban residents, while pneumonia exhibited a different pattern (Figure 2D–F). Regarding period effects, both males and females in urban and rural areas experienced a decline of RD mortality over time. The period from 1987 to 1991 had the highest risk in each subgroup (Figure 2G–I). Cohort effects revealed that older birth cohorts had a higher risk across most subgroups (Figure 2J–L).

DISCUSSION

This study utilized mortality data from China's NHC to analyze the mortality patterns of RDs among individuals aged 60 years or older in urban and rural areas of China over a 35-year period. The findings demonstrate a consistent decline in RDs mortality among the elderly population in both urban and rural areas, irrespective of gender. The study also observed that although the ASMR was lower for the urban elderly population compared to the rural elderly population throughout the study period, the rural elderly population witnessed a more significant reduction, resulting in a narrowing of the disparity between the two groups. Additionally, elderly women, who initially had a lower RDs ASMR, experienced greater improvements in mortality rates from RDs compared to elderly men. The analysis of age-period-cohort effects revealed that individuals in younger age groups, later study periods, and younger birth cohorts had a lower risk of RDs mortality.

The declining trend in RDs ASMR among Chinese elderly individuals across all age groups, accompanied by a decrease in risk among different time periods and birth cohorts, signifies notable achievements in the prevention and treatment of RDs in China, especially considering the aging population. The diminishing urban-rural disparity in RDs mortality may be attributed to improvements in the rural healthcare system and the quality of illness prevention and control efforts (*4*). In contrast to the urban-rural disparities, males continue to experience higher RDs mortality rates and have derived fewer benefits from 1987 to 2021, likely due to the high smoking prevalence among Chinese men (*5*). In order to further reduce RDs mortality rates and accomplish the goals outlined in Healthy China 2030, it is imperative to reduce smoking rates, particularly among Chinese men. Strong national tobacco control regulations and strict adherence to the WHO Framework Convention on Tobacco Control could facilitate this process.

The relatively stable trend in ASMR for RDs and CLRD among the urban elderly population in China from 2008 to 2016 can be attributed to multiple factors. These include the worsening aging situation (*6*–*7*) and increasing air pollution in urban areas (*8*), which may also explain the higher ASMR for pneumonia in the same population during the later study period. Additionally, the implementation of the Environmental Protection Law of the People's Republic of China, effective from January 1, 2015 (*9*), may have contributed to the subsequent decline in ASMR for RDs and CLRD after 2016.

The pneumonia ASMR in the urban elderly population and rural elderly men did not show significant differences during the study period. This finding highlights the need for increased attention to pneumonia in the elderly. Prior research has shown a substantial decline in mortality from lower respiratory infections (LRI) in children under 5 years old from 1990 to 2019; however, progress in reducing LRI mortality among older age groups has been more limited (*10*).

This study has certain limitations. First, the data analyzed in this study were monitoring data rather than cohort data. Second, the categorization of deaths was coded using ICD-9 prior to 2002, and transitioned to ICD-10 from 2002 onwards. However, a previous study has demonstrated that the impact of these coding changes on the results is minimal (*11*).

Conflicts of interest: No conflicts of interest.

Funding: Supported by the Population and Aging Health Science (No. WH10022023035) and the National Key Research and Development Program

(No. SQ2022YFC3600291).

doi: 10.46234/ccdcw2023.210

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Submitted: November 10, 2023; Accepted: November 27, 2023

REFERENCES

1. Bai JJ, Zhao YD, Yang DH, Ma YDY, Yu CH. Secular trends in chronic respiratory diseases mortality in Brazil, Russia, China, and South Africa: a comparative study across main BRICS countries from 1990 to 2019. BMC Public Health 2022;22(1):91. http://dx.doi.org/10.1186/s12889-021-12484-z.
2. Ahmad OB, Boschi-Pinto C, Lopez AD, Murray CJL, Lozano R, Inoue M. Age standardization of rates: a new who standard. Geneva: World Health Organization; 2001. Report No.: GPE Discussion Paper Series: No.31. https://www.researchgate.net/publication/203609941_Age_Standardization_of_Rates_A_New_WHO_Standard.
3. Dinas E, Stoker L. Age-period-cohort analysis: a design-based approach. Elect Stud 2014;33:28 – 40. http://dx.doi.org/10.1016/j.electstud.2013.06.006.
4. Zhang YG, Dong D, Xu L, Miao ZW, Mao WH, Sloan F, et al. Ten-year impacts of China's rural health scheme: lessons for universal health coverage. BMJ Glob Health 2021;6(4):e003714. http://dx.doi.org/10.1136/bmjgh-2020-003714.
5. Jin L, Tao L, Lao XQ. Diverging trends and expanding educational gaps in smoking in China. Int J Environ Res Public Health 2022;19(8):4917. http://dx.doi.org/10.3390/ijerph19084917.
6. Zheng XY, Guo C. Strengthening systematic research on aging: reflections from an omics perspective. China CDC Wkly 2022;4(39):875 – 8. http://dx.doi.org/10.46234/ccdcw2022.181.
7. Zheng XY, Luo YN, Su BB, He P, Guo C, Tian YH, et al. Developmental gerontology and active population aging in China. China CDC Wkly 2023;5(8):184 – 7. http://dx.doi.org/10.46234/ccdcw2023.033.
8. Yin P, Brauer M, Cohen AJ, Wang HD, Li J, Burnett RT, et al. The effect of air pollution on deaths, disease burden, and life expectancy across China and its provinces, 1990-2017: an analysis for the global burden of disease study 2017. Lancet Planet Health 2020;4(9):e386 – 98. http://dx.doi.org/10.1016/S2542-5196(20)30161-3.
9. Xinhua News Agency. Environmental protection law of the People's Republic of China 2014. 2014. https://www.gov.cn/zhengce/2014-04/25/content_2666434.htm. [2022-10-27]. (In Chinese).
10. GBD 2019 LRI Collaborators. Age-sex differences in the global burden of lower respiratory infections and risk factors, 1990-2019: results from the global burden of disease study 2019. Lancet Infect Dis 2022;22(11):1626 – 47. http://dx.doi.org/10.1016/S1473-3099(22)00510-2.
11. Anderson RN, Miniño AM, Hoyert DL, Rosenberg HM. Comparability of cause of death between ICD-9 and ICD-10: preliminary estimates. Natl Vital Stat Rep 2001;49(2):1-32. https://pubmed.ncbi.nlm.nih.gov/11381674/.

Commentary

Transitions in Chronic Disease Mortality in China: Evidence and Implications

Binbin Su[1]; Shuai Guo[2,&]; Xiaoying Zheng[2,3,#]

In China, there has been a significant transition in mortality trends, shifting from infectious diseases to non-communicable diseases (NCDs) over the last forty years. This shift has been primarily influenced by risk factors such as smoking, poor diet, and physical inactivity. Notably, cardiovascular diseases (CVD), cancers, chronic respiratory disorders (CRD), and diabetes have emerged as leading causes of death. Moreover, injuries, particularly road accidents and falls among older adults, also contribute significantly to the disease burden. Given the increasing aging population, there is a growing concern regarding age-related conditions and falls. To effectively address these challenges, China must prioritize chronic disease prevention throughout the lifespan and strengthen primary healthcare capabilities.

Over the past four decades, China has experienced significant changes in its mortality patterns, with a shift from infectious diseases to NCDs due to socio-economic growth and demographic shifts (*1*). This transition has been driven by the widespread presence of risk factors such as smoking, alcohol abuse, poor diet, and physical inactivity, leading to CVD, cancer, CRD, and diabetes becoming the leading causes of death in the country. Meanwhile, the burden from suicides, drownings, and other types of injuries has decreased, but there has been a rise in the burden from road injuries and falls. Therefore, it is crucial to reevaluate the relationship between socio-economic development and environmental risk factors. Analyzing the levels and trends of NCD mortality will help identify areas with high disease burden, inform evidence-based health policies, and allocate medical resources effectively.

CURRENT TRENDS IN CHRONIC DISEASE BURDEN

Major Chronic Diseases

China exhibits a higher prevalence of CVD, cancer, CRD, and diabetes compared to countries and regions with similar social development levels. These NCDs account for 88.5% of total deaths and contribute to 84.9% of the disease burden [disability-adjusted life years (DALYs)] (*2*). From 1990 to 2017, there was an upward trend in the prevalence and incidence of major NCDs, except for CRD, which showed improvement. Of concern is the substantial increase in cancer incidence and prevalence, with age-standardized rates rising by 27.9% and 135.2% respectively. While overall NCD mortality has been controlled, the diabetes mortality rate remains around 0.08‰ with a slight increase (6.1%) (*3*). The leading causes of premature mortality, measured by years of life lost (YLLs), in 2017 were stroke, ischemic heart disease (IHD), lung cancer, chronic obstructive pulmonary disease (COPD), and liver cancer. Mortality rates for IHD and lung cancer increased significantly, contributing to an increase in YLLs (*1*). The rising prevalence of cancer poses a future challenge for China's healthcare system in the future — on one hand, since 2010, five out of the top 15 causes leading to YLLs were cancers (lung, liver, stomach, esophagus, and rectum), and this situation persisted until 2017 (*4*), and lung and liver cancers currently cause a significant disease burden, ranking 4th and 7th respectively in driving DALYs in 2017, with liver cancer's DALY rate being more than double the predicted value based on Social Development Index (SDI) in all provincial-level administrative divisions (*1*). Although the mortality rate of diabetes is low, its high prevalence combined with low treatment and control rates results in many patients living with the disease and disabilities, leading to a substantial disease burden. In 2018, the diabetes prevalence rate among Chinese adults was 11.9%, while the treatment and control rates were 34.1% and 33.1%, respectively (*3*).

Age-Dependent Diseases

The elderly population is growing due to declining birth and death rates, resulting in increased health issues and medical expenses related to age-dependent diseases. Dementia, particularly Alzheimer's Disease (AD), is a major cause of disability in low- and middle-income countries (LMICs). Recent data from China (2015–2018) indicate that the prevalence of dementia among individuals aged 60 and above was 6.0%, with AD accounting for 3.9% of cases, consistent with global levels (*5*). Given China's rapid aging population, dementia has become the fastest-growing contributor to the disease burden in the country. YLLs due to AD and other types of dementia have risen in rank from 28th place in 1990 to 8th in 2017, with DALYs increasing by 157.0% over nearly three decades, moving from 29th place to 14th place (*5*). In 2010, 66% of the global disease burden from musculoskeletal disorders among the elderly originated from LMICs (*6*). Analysis of five major musculoskeletal diseases in China demonstrates that the burden increases with age, with the 40–80 age group contributing the most, accounting for 70.1%, 77.1%, and 74.3% of total incidence, prevalence, and DALYs, respectively (*7*). Therefore, population aging is the primary factor driving the increasing burden of musculoskeletal diseases in China. Sensory organ diseases, leading to vision and hearing loss, become more prevalent with age. China's elderly population has a higher rate of sensory decline compared to Western countries, with vision and hearing decline rates at 80.2% and 64.9% in 2013, respectively, and a dual sensory decline rate of 57.2%. In 2017, sensory organ diseases ranked as the third leading cause of Years Lived with Disability (YLDs) in China (*1*).

Road Injuries and Falls

In China, injuries, particularly road injuries and falls among the elderly population, are a substantial contributor to the country's disease burden. While road injuries consistently ranked among the top ten causes of disease burden from 1990 to 2017, the rates of disease burden declined over time, but their contribution to DALYs remained stable. On the other hand, drowning and self-harm, which ranked 8th and 9th in 1990, significantly dropped in rank by 2017 (*1*). YLLs from road injuries showed a declining trend, whereas YLDs increased by 32.1% from 1990 to 2017 (*1*), indicating the significant impact of road injuries on disability across all age groups. Falls, in particular, not only accounted for a high number of injury-related deaths among the elderly but also were the primary cause of traumatic fractures and injury-related medical visits (*8*). The incidence rate of falls among Chinese elderly individuals aged 60 and above was 3.8%. Although the mortality rate from falls was low (0.39‰) and remained relatively stable from 1990–2019, the significant increase in incidence (79.2%) led to a rapid rise in disease burden from this cause, moving from 27th place in 1990 to 17th in 2017, with DALYs increasing by 51.9% (*1*).

ISSUES AND CHALLENGES

Increasing Complexity of Morbidity Risks

An individual's health is influenced by various factors that accumulate over time. Early life adverse factors in China, such as neonatal diseases and congenital malformations, have been effectively controlled, resulting in a decline in YLLs. However, chronic diseases are now primarily driven by health behaviors, lifestyles, and dietary habits during adolescence and later adulthood. The physical environment, including air quality and urban transportation infrastructure, further complicates morbidity risks and prevention efforts. Urbanization, while providing opportunities for improving health, also introduces health risks such as air pollution, occupational hazards, and poor dietary habits. In China, the leading risk factors for mortality and disease burden in 2017 were hypertension, smoking, high sodium diet, and environmental particulate pollution. Although survey results showed a gradual decline in smoking rates in China (27.3% in 2013 to 26.2% in 2018) (*2*), diseases associated with smoking, such as lung cancer and COPD, have not reduced, possibly due to environmental pollution from industrialization. Excessive sodium and red meat consumption, coupled with sedentary lifestyles due to reliance on public transportation, have led to increases in overweight, obesity, hypertension, and diabetes (*9*). Notably, children and adolescents aged 6–17 years have experienced the highest increase in overweight and obesity rates in recent years, and they will face a more complex risk factor environment in the future (*9*).

Aging Impact on Disease and Death Patterns

The aging population has led to an increased prevalence of age-dependent diseases and falls. With extended life expectancy and advancements in medical technology, the management of comorbidities and chronic disabilities requires more robust models and healthcare systems. A recent meta-analysis of mainland China residents from 1998 to 2019 showed a significant upward trend in comorbidity rates. Prior to 2004, the rate was 14.5%, which increased to 35.2% from 2004 to 2014 and further accelerated to 40.4% after 2014 (*10*). According to GBD 2019 data, the proportion of YLDs in DALYs caused by chronic diseases and injuries among those aged 55 and above increased from 21.9% in 1990 to 31.2% in 2019, indicating a growing contribution of YLDs to the disease burden. Therefore, prioritizing the maintenance of physical function in individuals with one or more chronic diseases is crucial for healthy aging.

Socioeconomic Disparities in Disease Burden

The emergence of NCDs has led to heightened health disparities in terms of gender, urban-rural divide, and socio-economic status. Women, who generally have a lower socio-economic status but longer life expectancy, face elevated risks of chronic diseases, especially as they age. While urban areas with higher income levels, better access to medical resources, and higher education levels tend to have lower prevalence of chronic diseases, there is evidence suggesting that the urban-rural disparity in diseases such as obesity and hypertension is diminishing due to rapid urbanization and economic development. In contrast to high-income countries (HICs), China's high-income population is more susceptible to chronic diseases. Urbanization could exacerbate income inequalities in the risk of chronic diseases, with unhealthy dietary patterns and low levels of physical activity being significant contributing factors.

POLICY IMPLICATIONS

Disease Prevention and Control from a Life-Cycle Perspective

Evidence indicates that individual health is primarily influenced by lifestyle, health behaviors, and socio-economic factors, with clinical medicine playing a secondary role. Therefore, it is crucial to prioritize population health from a life-cycle perspective (*11–12*). In the case of children, efforts should be directed towards improving nutrition and providing health literacy education. For adolescents, there should be an intensified focus on health education, promoting healthy lifestyles, establishing sound dietary patterns, and implementing effective smoking control measures. Moreover, for adults, external environmental modifications should be implemented to enhance their self-care ability, which is integral to maintaining cognitive and physical functionality.

Enhancing Primary Healthcare Service Capabilities and Accelerating the Construction of General Medicine

China's current healthcare system primarily emphasizes hospital-based and specialist treatment, which does not align well with the increasing burden of chronic diseases. Evidence suggests that effective management and post-disease care play a crucial role in reducing mortality rates, especially in conditions such as IHD, as demonstrated by many HICs. Therefore, it is crucial to strengthen the capabilities of primary healthcare institutions in order to mitigate the future disease burden, particularly in light of the rising incidence of CVD in China. Additionally, given the anticipated increase in comorbidity cases, the prompt establishment of a comprehensive general medicine service system is essential.

Strengthening the Construction of Talent Teams Related to Chronic Disability

The transition from chronic diseases to chronic disabilities in China necessitates a shift in the healthcare workforce. To address this, it is imperative for the government and society to allocate additional resources towards specialties such as rehabilitation medicine, geriatrics, rheumatology, audiology, and ophthalmology, as these fields offer high cost-effectiveness. Recognizing the significance of this undertaking, China has already taken steps to enhance the training of healthcare professionals in rehabilitation medicine and geriatrics.

Conflicts of interest: No conflicts of interest.

Funding: Supported by the Population and Aging Health Science Program (WH10022023035) and the National Key Research and Development Program (SQ2022YFC3600291).

doi: 10.46234/ccdcw2023.211

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Submitted: November 12, 2023; Accepted: November 27, 2023

REFERENCES

1. Zhou MG, Wang HD, Zeng XY, Yin P, Zhu J, Chen WQ, et al. Mortality, morbidity, and risk factors in China and its provinces, 1990–2017: a systematic analysis for the Global Burden of Disease Study 2017. Lancet 2019;394(10204):1145 – 58. http://dx.doi.org/10.1016/S0140-6736(19)30427-1.
2. Chinese Center for Disease Control and Prevention, The National Center for Chronic and Noncommunicable Disease Control and Prevention. Report on chronic disease risk factor surveillance in China 2018. Beijing: People's Medical Publishing House. 2021. http://product.dangdang.com/29356233.html. (In Chinese)
3. Yin P, Qi JL, Liu YN, Liu JM, You JL, Wang LJ, et al. Incidence, prevalence, and mortality of four major chronic non-communicable diseases — China, 1990-2017. China CDC Wkly 2019;1(3):32 – 7. http://dx.doi.org/10.46234/ccdcw2019.012.
4. Yang GH, Wang Y, Zeng YX, Gao GF, Liang XF, Zhou MG, et al. Rapid health transition in China, 1990-2010: findings from the Global Burden of Disease Study 2010. Lancet 2013;381(9882):1987 – 2015. http://dx.doi.org/10.1016/S0140-6736(13)61097-1.
5. Jia LF, Du YF, Chu L, Zhang ZJ, Li FY, Lyu DY, et al. Prevalence, risk factors, and management of dementia and mild cognitive impairment in adults aged 60 years or older in China: a cross-sectional study. Lancet Public Health 2020;5(12):e661 – 71. http://dx.doi.org/10.1016/S2468-2667(20)30185-7.
6. Prince MJ, Wu F, Guo YF, Robledo LMG, O'Donnell M, Sullivan R, et al. The burden of disease in older people and implications for health policy and practice. Lancet 2015;385(9967):549 – 62. http://dx.doi.org/10.1016/S0140-6736(14)61347-7.
7. Wu DZ, Wong P, Guo C, Tam LS, Gu JR. Pattern and trend of five major musculoskeletal disorders in China from 1990 to 2017: findings from the Global Burden of Disease Study 2017. BMC Med 2021;19(1):34. http://dx.doi.org/10.1186/s12916-021-01905-w.
8. Yao Y, Yin PB, Liu XY. Falls prevention in China: time for action. Lancet Public Health 2021;6(12):e875 – 6. http://dx.doi.org/10.1016/S2468-2667(21)00251-6.
9. Wang Y, Wang L, Qu W. New national data show alarming increase in obesity and noncommunicable chronic diseases in China. Eur J Clin Nutr 2017;71(1):149 – 50. http://dx.doi.org/10.1038/ejcn.2016.171.
10. He L, Zhang YF, Shen XC, Sun Y, Zhao Y. Prevalence trends of multimorbidity among residents in mainland China: a meta-analysis. Chin Gen Pract 2023;26(29):3599 – 607. http://dx.doi.org/10.12114/j.issn.1007-9572.2023.0217. (In Chinese).
11. Zheng XY, Guo C. Strengthening systematic research on aging: reflections from an omics perspective. China CDC Wkly 2022;4(39):875 – 8. http://dx.doi.org/10.46234/ccdcw2022.181.
12. Zheng XY, Luo YN, Su BB, He P, Guo C, Tian YH, et al. Developmental gerontology and active population aging in China. China CDC Wkly 2023;5(8):184 – 7. http://dx.doi.org/10.46234/ccdcw2023.033.

Indexed by Science Citation Index Expanded (SCIE), Social Sciences Citation Index (SSCI), PubMed Central (PMC), Scopus, Chinese Scientific and Technical Papers and Citations, and Chinese Science Citation Database (CSCD)

The inauguration of *China CDC Weekly* is in part supported by Project for Enhancing International Impact of China STM Journals Category D (PIIJ2-D-04-(2018)) of China Association for Science and Technology (CAST).

CCDC weekly

Vol. 5 No. 50 Dec. 15, 2023

Published since November, 2019

Responsible Authority

National Health Commission of the People's Republic of China

Sponsor

Chinese Center for Disease Control and Prevention

Editing and Publishing

China CDC Weekly Editorial Office
No.155 Changbai Road, Changping District, Beijing, China
Tel: 86-10-63150501, 63150701
Email: weekly@chinacdc.cn

Printing

Beijing Kexin Printing Co., Ltd

CSSN

ISSN 2096-7071 (Print)
ISSN 2096-3101 (Online)
CN 10-1629/R1