

Burden of non-communicable diseases in China and its provinces, 1990–2021: Results from the Global Burden of Disease Study 2021

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Abstract

Background: Non-communicable diseases (NCDs) are the primary causes of disability and death. The aim of this study is to analyze the disease burden of NCDs in China from 1990 to 2021.

Methods: This study used data on NCDs in China and its provinces from the Global Burden of Diseases, Injuries, and Risk Factors Study (GBD) 2021. The study analyzed the disease burden of NCDs in 2021 and its changes from 1990 to 2021 using indicators including deaths and disability-adjusted life years (DALYs).

Results: Between 1990 and 2021, the NCD burden in China exhibited an upward trend. In 2021, China had 10.6 (95% uncertainty interval [UI]: 9.0–12.2) million deaths and 349.3 (95% UI: 301.5–401.2) million DALYs due to NCDs, accounting for 91.0% (95% UI: 90.4–91.7%) of all deaths and 86.7% (95% UI: 86.0–87.4%) of all DALYs. NCDs caused a lower disease burden in females than in males. Cardiovascular diseases and neoplasms were the main NCD level 2 causes of deaths and DALYs, resulting in 5.1 (95% UI: 4.3–5.9) and 2.8 (95% UI: 2.3–3.4) million deaths and 100.2 (95% UI: 84.6–116.6) million and 71.2 (95% UI: 59.3–85.2) million DALYs in 2021, respectively. Chronic respiratory diseases were the third leading cause of NCD deaths, while musculoskeletal disorders were the third leading cause of NCD DALYs. Qinghai, Xizang, and Heilongjiang had the highest age-standardized mortality rates and age-standardized DALY rates (per 100,000) for NCDs, while Hong Kong Special Administration Region (SAR), Macao SAR, and Shanghai recorded the lowest age-standardized mortality rates and age-standardized DALY rates.

Conclusions: NCDs caused a high disease burden in China and exhibited heterogeneity across sexes and provinces. China needs to focus on addressing key NCDs and implement intervention measures tailored to the disease distribution characteristics to reduce the NCD burden.

Keywords: Non-communicable diseases; Disease burden; Deaths; Disability-adjusted life years; Cardiovascular disease; Neoplasms; Chronic respiratory disease; Musculoskeletal disorders

Introduction

Non-communicable diseases (NCDs) are the primary causes of disability and death. The Global Burden of Diseases, Injuries, and Risk Factors Study (GBD) 2021 estimated that NCDs already account for more than half of the global burden of disease.^[1,2] NCDs are also the leading causes of disease burden in China, and this burden is increasing due to the aging population and changes in lifestyles.^[3] In order to strengthen the prevention and treatment of NCDs and reduce the NCD burden, China has issued a series of policies such as the national Medium-to-Long Term Plan for the Prevention and Treatment of Chronic Diseases (2017–2025),^[4] and has also established a series of action targets for NCDs in Healthy China 2030.^[5] Accurate analysis of health data, accompanied

by an examination of trends in the burden of NCDs over time, can help to identify important health problems promptly, recognize diseases that may be underestimated or neglected, and allocate sufficient resources to address the primary causes of death and disability in the population.^[6] This is important for guiding disease interventions and achieving health goals.

Health equity is one of the core principles of health development in China,^[7] but health development in China varies from region to region, with differences in the major health problems and disease burden across provinces.^[3,8] Analyzing the burden of disease at the provincial level and studying the primary health problems in each province will facilitate the development of targeted interventions to prevent and reduce NCDs in each province.

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The GBD provides globally comparable estimates of disease burden and risk factors for different countries and regions, offering the latest findings in global disease burden research.^[1,2,9] Using data from GBD 2021, we analyzed deaths and disability-adjusted life years (DALYs) for NCDs in China and its provinces, while examining their changes from 1990 to 2021.

Methods

Overview

We utilized the data from the GBD 2021 to conduct this research and analysis. The study focused on the burden of NCDs, analyzing NCD deaths and DALYs in China from 1990 to 2021. We also conducted comparative analyses at the sex and regional levels.

Data sources

All data in this study were collected from the Chinese results of the GBD 2021, covering 33 provincial administrative regions in China (data from the Taiwan Province of China were not included). The GBD 2021 utilized the latest evidence and analytical framework from the GBD study, primarily employing three standardized tools, namely, Cause of Death Ensemble Model (CODEm), Spatiotemporal Gaussian Process Regression (ST-GPR), and Disease Model-Bayesian Meta-regression (DisMod-MR). It comprehensively analyzed and estimated disease burden indicators such as incidence, prevalence, mortality, years of life lost due to premature death, years lived with disability, and DALYs for 204 countries and territories and 811 subnational locations. Age-standardized rates were computed with the GBD standard population structure. To understand the changes over time, GBD 2021 presents percentage changes from 1990 to 2021, which were calculated as the difference between the values at the start and end of the time interval divided by the value at the beginning. The 95% uncertainty intervals (UIs) for all metrics were computed using the mean estimate across 1000 draws, and reported as the 2.5th and 97.5th percentiles of that distribution. Estimates of deaths and DALYs from NCDs at the provincial level in China were also included. The detailed background and methods of the GBD have been described in previously published papers.^[1,2,10] The GBD 2021 estimates of the disease burden in China were based on data from multiple sources, with mortality data mainly coming from the Disease Surveillance Point system, the Maternal and Child Surveillance System, censuses, surveys, the China Cancer Registry, the Chinese Center for Disease Control and Prevention cause-of-death reporting system, the death data of Macao Special Administration Region (SAR) and Hong Kong SAR, and some published papers or reports. For non-fatal outcomes, data were mainly collected from national surveys, the China Cancer Registry, hospital inpatient data, the Chinese Center for Disease Control and Prevention cause-of-death reporting system, and some published papers or reports.^[3,8]

Statistical analysis

Using the data on disease burden in China from GBD 2021, including the number of deaths, mortality rate, age-standardized mortality rate, the number of DALYs, DALY rate, and age-standardized DALY rate, this study analyzed the causes of disease burden, and examined their changes from 1990 to 2021 using the indicator of percentage change. From the GBD report: “GBD classifies diseases and injuries into a hierarchy with four levels that include both fatal and non-fatal causes”. Based on the GBD classification, we analyzed four level 1 causes: communicable, maternal, neonatal, and nutritional (CMNN) diseases, NCDs, injuries, and other diseases. Specifically, we focused on analyzing 12 level 2 causes of NCDs, including neoplasms, cardiovascular diseases (CVDs), chronic respiratory diseases (CRDs), digestive diseases, neurological disorders, mental disorders, substance use disorders, diabetes and kidney diseases, skin and subcutaneous diseases, sense organ diseases, musculoskeletal disorders, and other NCDs. Of these, sense organ diseases did not result in any deaths. This study ranked the NCD level 2 causes according to mortality and DALY rates. To understand the differences in the burden of NCDs between the sexes and regions, the study further analyzed the disease burden among males and females and compared the age-standardized rates of NCDs across the different provinces.

Results

Between 1990 and 2021, the number of deaths and DALYs caused by NCDs in China exhibited an upward trend [Figure 1A, B]. Until 2021, China had 11.7 (95% UI: 10.0–13.4) million deaths and 402.6 (95% UI: 348.1–461.1) million DALYs [Supplementary Table 1, <http://links.lww.com/CM9/C127>]. Among these, there were 10.6 (95% UI: 9.0–12.2) million deaths and 349.3 (95% UI: 301.5–401.2) million DALYs due to NCDs, accounting for 91.0% (95% UI: 90.4–91.7%) of all deaths and 86.7% (95% UI: 86.0–87.4%) of all DALYs, far more than deaths and DALYs caused by CMNN diseases, injuries, and other diseases [Figure 2 and Supplementary Table 1, <http://links.lww.com/CM9/C127>]. From 1990 to 2021, the mortality rate and the DALY rate increased from 534.6 (95% UI: 481.4–589.9) to 748.0 (95% UI: 636.0–858.7) per 100,000 and from 21,852.4 (95% UI: 19,275.4–24,442.9) to 24,550.2 (95% UI: 21,188.5–28,195.6) per 100,000, respectively, while the age-standardized mortality rate and DALY rate decreased from 967.5 (95% UI: 881.2–1054.2) to 575.5 (95% UI: 493.4–656.9) per 100,000 and 28,586.2 (95% UI: 25,514.1–31,633.2) to 18,784.9 (95% UI: 16,256.5–21,690.2) per 100,000, respectively [Figure 1C–F].

In 2021, the age-standardized mortality rate and DALY rate for NCDs among males were 765.9 (95% UI: 634.2–916.2) per 100,000 and 21,467.4 (95% UI: 18,020.0–24,893.2) per 100,000; while for females, they were 438.2 (95% UI: 363.7–528.5) per 100,000 and 16,604.0 (95% UI: 13,777.1–19,624.6) per 100,000, respectively [Figure 1E, F]. NCDs caused less disease burden in females than in males, but accounted for a large proportion of the total burden in females, with

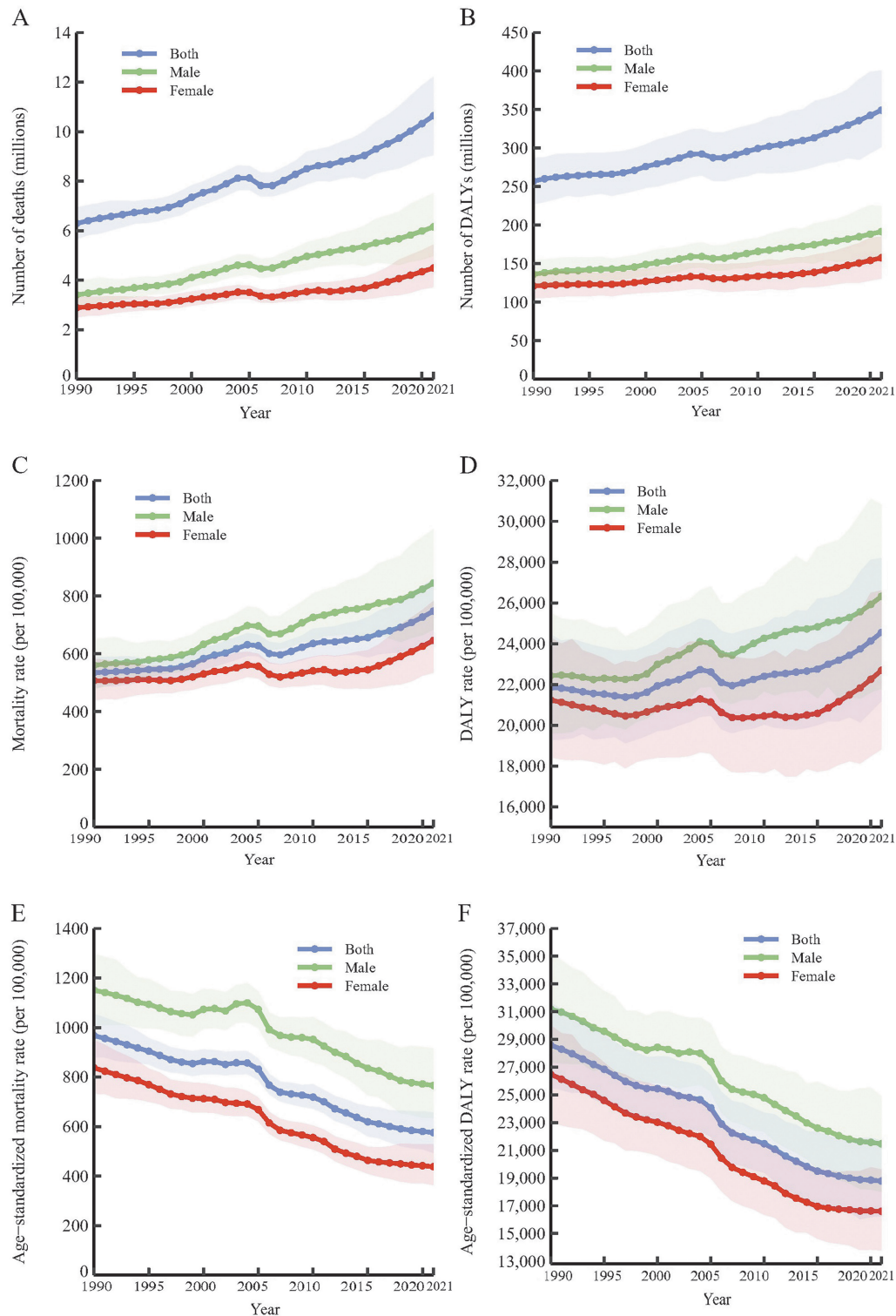


Figure 1: Trend of changes in death and DALYs for NCDs in China from 1990 to 2021. (A) Absolute deaths (millions). (B) Absolute DALYs (millions). (C) Mortality rate (per 100,000). (D) DALY rate (per 100,000). (E) Age-standardized mortality rate (per 100,000). (F) Age-standardized DALY rate (per 100,000). Shaded regions are 95% UIs. DALYs: Disability-adjusted life years; NCDs: Non-communicable diseases; UIs: Uncertainty intervals.

NCD-related deaths accounting for 92.4% (95% UI: 91.7–93.4%) of total deaths and NCD-related DALYs accounting for 89.1% (95% UI: 88.4–89.8%) of total DALYs [Figures 1 and 2 and Supplementary Table 1, <http://links.lww.com/CM9/C127>].

From 1990 to 2021, CVDs remained the leading cause of level 2 NCD deaths in China, accounting for almost half of NCD deaths [Table 1 and Figure 3A]. In 2021, CVDs contributed to 5.1 (95% UI: 4.3–5.9) million deaths, showing an increase of 103.7% (95% UI: 69.0–149.9%)

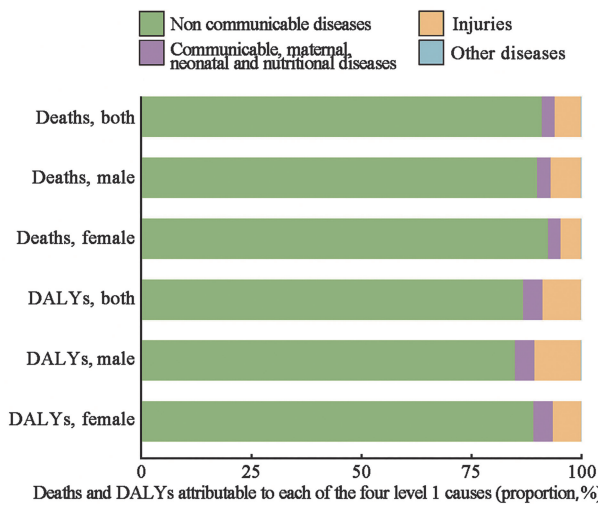


Figure 2: Proportion of deaths and DALYs attributable to each of the four level 1 causes in China, 2021. DALYs: Disability-adjusted life years.

compared with 1990. The mortality rate of CVDs was 357.4 (95% UI: 303.0–415.0) per 100,000, showing an increase of 68.4% (95% UI: 39.8–106.6%) compared to 1990. The problem of CVDs was followed by neoplasms, which caused 2.8 (95% UI: 2.3–3.4) million deaths in 2021, with a mortality rate of 198.1 (95% UI: 165.0–236.2) per 100,000. CRDs were the third leading cause of death, resulting in 1.3 (95% UI: 1.1–1.6) million deaths in 2021, with a mortality rate of 93.7 (95% UI: 76.1–112.1) per 100,000. These three diseases caused the majority of

deaths due to NCDs, especially among males, causing nearly 90% of all deaths [Supplementary Figure 1, <http://links.lww.com/CM9/C127>]. Between 1990 and 2021, the mortality rates for diabetes and kidney diseases, and neurological disorders increased by 74.9% (95% UI: 37.9–117.8%) and 184.7% (95% UI: 117.6–241.4%), respectively. However, the mortality rates and rankings of digestive diseases and other NCDs declined significantly. In 2021, the age-standardized mortality rates for CVDs, neoplasms, CRDs, diabetes and kidney diseases, digestive diseases, other NCDs, substance use disorders, and skin and subcutaneous diseases all decreased compared with 1990. However, the age-standardized mortality rate for mental disorders increased by 514.0% (95% UI: 232.3–1658.1%) per 100,000.

CVDs and neoplasms were also the main causes of DALYs, resulting in 100.2 (95% UI: 84.6–116.6) million and 71.2 (95% UI: 59.3–85.2) million DALYs in 2021, respectively [Table 1]. Musculoskeletal disorders exhibited a notable increase in DALYs, with a rate of 2138.1 (95% UI: 1528.9–2925.2) per 100,000 in 2021, surpassing CRDs to become the third leading cause of DALYs [Figure 3]. These three major causes accounted for more than half of the NCD DALYs [Supplementary Figure 1, <http://links.lww.com/CM9/C127>]. Between 1990 and 2021, the ranking of DALY rates for neurological disorders, diabetes and kidney diseases, and sense organ diseases also increased. Specifically, compared with 1990, the DALY rates in 2021 for these diseases increased by 61.2% (95% UI: 35.8–103.1%), 68.2% (95% UI: 47.0–91.6%), and 97.7% (95% UI: 89.0–106.3%), respectively.

Table 1: Numbers of deaths and DALYs from NCD level 2 causes in China in 1990 and 2021, and the percentage changes from 1990 to 2021.

Level 2 causes	Deaths			DALYs		
	1990	2021	Percentage change, 1990–2021 (%)	1990 (thousands)	2021 (thousands)	Percentage change, 1990–2021 (%)
Neoplasms	1,529,050.6 (1,339,075.8–1,725,700.0)	2,817,757.7 (2,347,976.6–3,360,869.5)	84.3 (47.4–134.2)	48,653.3 (42,701.2–54,818.3)	71,222.9 (59,322.0–85,195.0)	46.4 (15.9–86.4)
CVDs	2,497,062.2 (2,206,620.8–2,780,394.8)	5,085,457.9 (4,311,063.4–5,904,298.4)	103.7 (69.0–149.9)	63,253.8 (56,338.6–70,379.4)	100,208.7 (84,648.3–116,556.0)	58.4 (31.9–92.9)
CRDs	1,288,319.2 (1,107,561.0–1,438,043.7)	1,332,534.8 (1,082,020.8–1,594,526.7)	3.4 (–18.4 to 30.8)	29,148.1 (25,556.9–32,644.4)	25,828.7 (21,878.8–30,468.7)	–11.4 (–28.1 to 8.5)
Digestive diseases	327,387.2 (281,001.2–375,996.3)	282,321.4 (225,806.5–340,830.6)	–13.8 (–35.6 to 12.8)	13,363.3 (11,651.4–15,256.6)	10,376.4 (8661.1–12,257.5)	–22.4 (–36.8 to –4.8)
Neurological disorders	176,196.1 (86,691.3–376,504.9)	606,647.5 (241,671.6–1,447,914.7)	244.3 (163.1–312.8)	11,303.0 (6347.5–18,231.4)	22,031.4 (13,162.3–35,423.0)	94.9 (64.3–145.7)
Mental disorders	4.4 (1.4–8.1)	27.0 (16.0–37.6)	514.1 (231.6–1661.3)	17,105.6 (12,822.2–21,627.8)	23,208.9 (17,695.8–29,428.3)	35.7 (30.2–41.6)
Substance use disorders	41,015.4 (35,176.8–47,558.7)	30,087.8 (21,002.4–38,499.1)	–26.6 (–47.5 to –4.5)	5508.5 (4347.7–6641.1)	4335.8 (3335.3–5387.4)	–21.3 (–30.5 to –12.2)
Diabetes and kidney diseases	183,665.8 (162,841.4–210,379.4)	388,442.0 (322,594.6–460,027.1)	111.5 (66.8–163.4)	8845.6 (7628.9–10,238.5)	17,991.3 (14,806.1–21,897.8)	103.4 (77.8–131.7)
Skin and subcutaneous diseases	6510.7 (5622.5–7451.1)	6378.1 (5230.6–7666.1)	–2.0 (–25.2 to 28.4)	6220.8 (4105.7–8987.5)	7478.4 (4833.4–10,992.1)	20.2 (16.5–23.7)
Sense organ diseases	–	–	–	8280.3 (5654.9–11,661.1)	19,801.2 (13,434.5–28,140.8)	139.1 (128.5–149.5)
Musculoskeletal disorders	10,055.8 (8354.0–12,212.7)	19,446.0 (15,146.0–24,480.3)	93.4 (36.7–151.3)	16,629.5 (12,164.7–22,138.1)	30,419.4 (21,752.7–41,618.8)	82.9 (73.4–93.7)
Other NCDs	230,066.4 (166,768.9–294,014.8)	73,331.2 (63,001.9–83,954.8)	–68.1 (–75.8 to –53.1)	28,771.9 (22,243.4–35,706.6)	16,383.6 (12,351.7–21,777.9)	–43.1 (–56.4 to –25.3)

Data are shown as N (95% uncertainty interval). CRDs: Chronic respiratory diseases; CVDs: Cardiovascular diseases; DALYs: Disability-adjusted life years; NCDs: Non-communicable diseases; –: Not available.

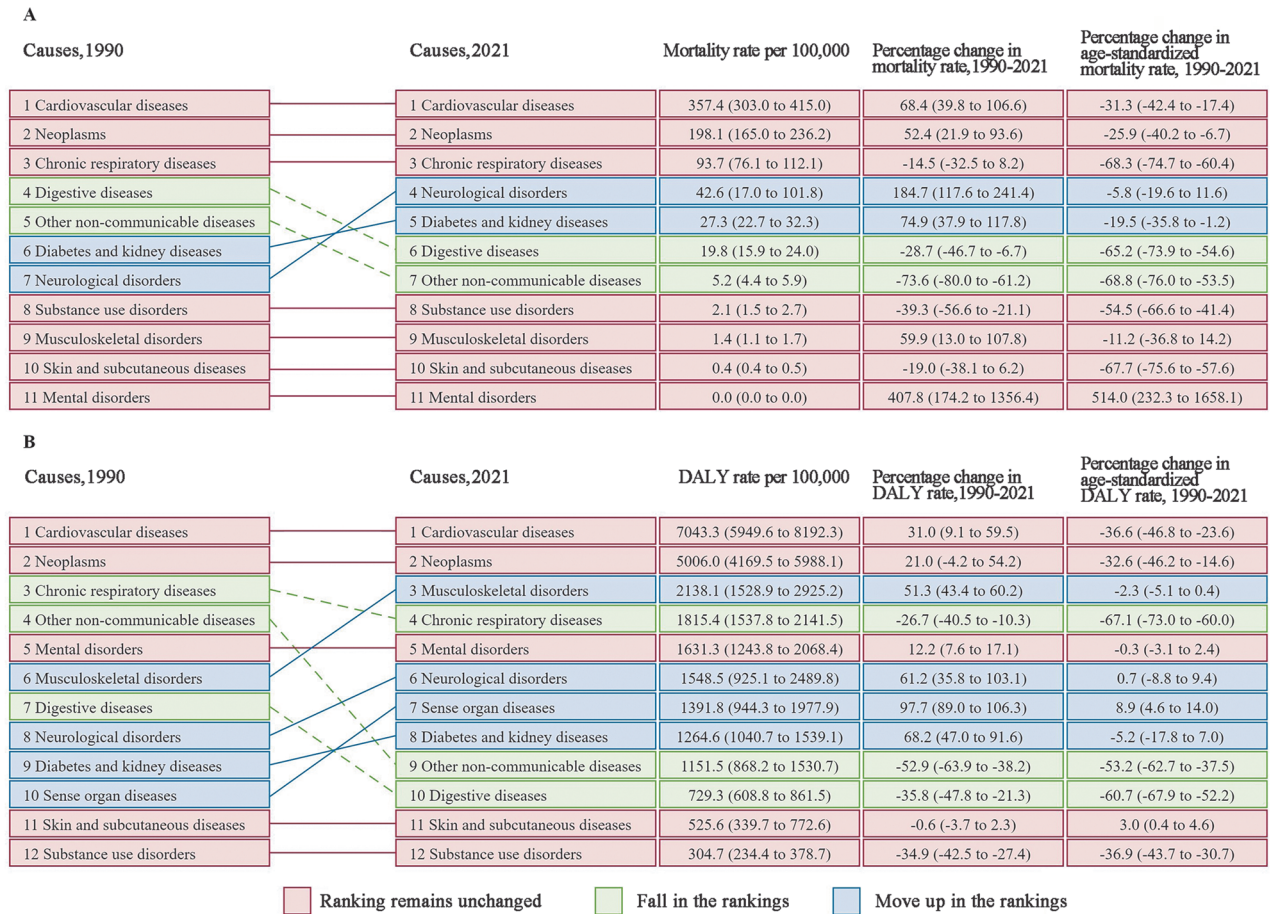


Figure 3: Ranking of NCD level 2 causes by mortality rate (A) and DALY rate (B) in China from 1990 to 2021. DALY: Disability-adjusted life year; NCD: Non-communicable disease.

However, the DALY rates and age-standardized DALY rates of CRDs, other NCDs, and digestive diseases showed significant declines [Figure 3].

Sex differences for NCD level 2 causes of mortality rate and DALY rate are reported in Figure 4. The mortality rate per 100,000 varied by sex, with the most notable differences observed in substance use disorders (3.6 [95% UI: 2.4–4.8] for males *vs.* 0.5 [95% UI: 0.4–0.7] for females), mental disorders (0.001 [95% UI: 0–0.001] *vs.* 0.003 [95% UI: 0.002–0.004]), and musculoskeletal disorders (0.9 [95% UI: 0.5–1.2] *vs.* 1.8 [95% UI: 1.4–2.4]), respectively. Excluding neurological disorders, musculoskeletal disorders, and mental disorders, the mortality rates of other level 2 causes were higher in males than in females. Sex differences also existed in the DALY rate per 100,000, with the most differences observed for substance use disorders (461.2 [95% UI: 355.7–573.7] for males *vs.* 140.8 [95% UI: 104.9–177.3] for females), other NCDs (837.4 [95% UI: 634.8–1095.0] *vs.* 1480.9 [95% UI: 1088.5–2012.1]), and neoplasms (6306.0 [95% UI: 4907.6–8010.9] *vs.* 3643.4 [95% UI: 2865.4–4554.3]) [Supplementary Table 2, <http://links.lww.com/CM9/C127>].

In 2021, Qinghai (868.9 [95% UI: 707.1–1024.4] per 100,000), Xizang (823.7 [95% UI: 664.7–999.6] per 100,000), and Heilongjiang (731.7 [95% UI: 599.4–883.3] per 100,000) had the highest age-standardized

mortality rates for NCDs. Meanwhile, Hong Kong SAR (251.2 [95% UI: 200.0–314.4] per 100,000), Macao SAR (293.9 [95% UI: 245.0–353.3] per 100,000), and Shanghai (419.3 [95% UI: 337.7–507.1] per 100,000) recorded the lowest rates. Similarly, Qinghai (24,794.2 [95% UI: 20,945.4–28,724.3] per 100,000), Xizang (26,481.7 [95% UI: 22,331.0–30,901.5] per 100,000), and Heilongjiang (22,739.6 [95% UI: 19,283.8–26,269.0] per 100,000) also had the highest age-standardized DALY rates for NCDs, whereas Hong Kong SAR (12,658.1 [95% UI: 10,590.1–15,351.4] per 100,000), Macao SAR (13,485.8 [95% UI: 11,061.7–16,125.3] per 100,000), and Shanghai (15,140.5 [95% UI: 12,685.8–18,041.2] per 100,000) had the lowest DALY rates. Between 1990 and 2021, all provinces witnessed a decline in both age-standardized mortality rates and DALY rates, with Jiangxi province experiencing the most significant reductions in both mortality rate (56.0% [95% UI: 45.0–64.4%]) and DALY rate (48.7% [95% UI: 38.9–55.7%]) [Figure 5 and Supplementary Table 3, <http://links.lww.com/CM9/C127>].

The age-standardized rates of NCD level 2 causes in various provinces are shown in Figure 5. In the vast majority of provinces, CVDs were the leading cause of death and DALYs with neoplasms as the second leading cause. However, in Hong Kong SAR, neoplasms were the

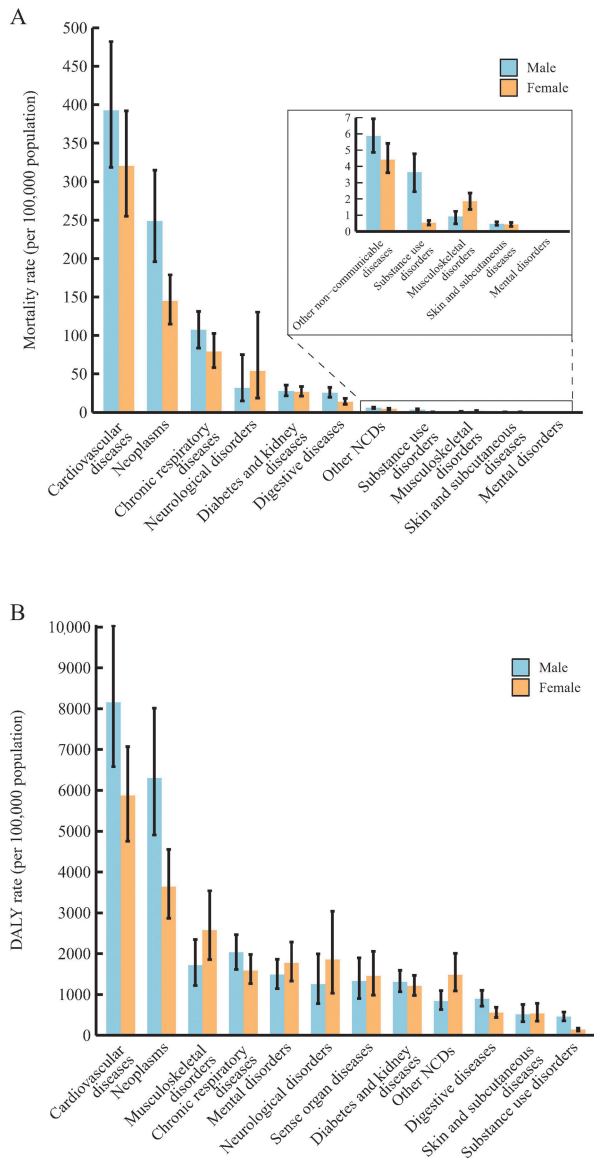


Figure 4: Mortality rate (A) and DALY rate (B) due to NCD level 2 causes in China, by sex, in 2021. Error bars show 95% UIs. DALY: Disability-adjusted life years; NCD: Non-communicable disease; UIs: Uncertainty intervals.

primary cause of death. In Fujian, Shanghai, Hong Kong SAR, and Zhejiang, the age-standardized DALY rate for neoplasms was higher than that for CVDs. In Qinghai, Guizhou, Yunnan, Xinjiang, and Gansu, CRDs were the second leading cause of death. In Xizang, CRDs were the second leading cause of death and DALYs. CVDs, neoplasms, and CRDs were the three leading causes of death in all provinces except Jilin and Hong Kong SAR, where neurological disorders were the third leading cause. In Qinghai, Guizhou, Yunnan, Xinjiang, Chongqing, Gansu, Sichuan, Hainan, and Jiangxi, CRDs were the third leading cause of DALYs. In Xizang, neoplasms were the third leading cause of DALYs. In Hunan, Shandong, and Zhejiang, mental disorders were the third leading cause. Musculoskeletal disorders were the third leading cause in other provinces [Figure 5 and Supplementary Figure 2, <http://links.lww.com/CM9/C127>].

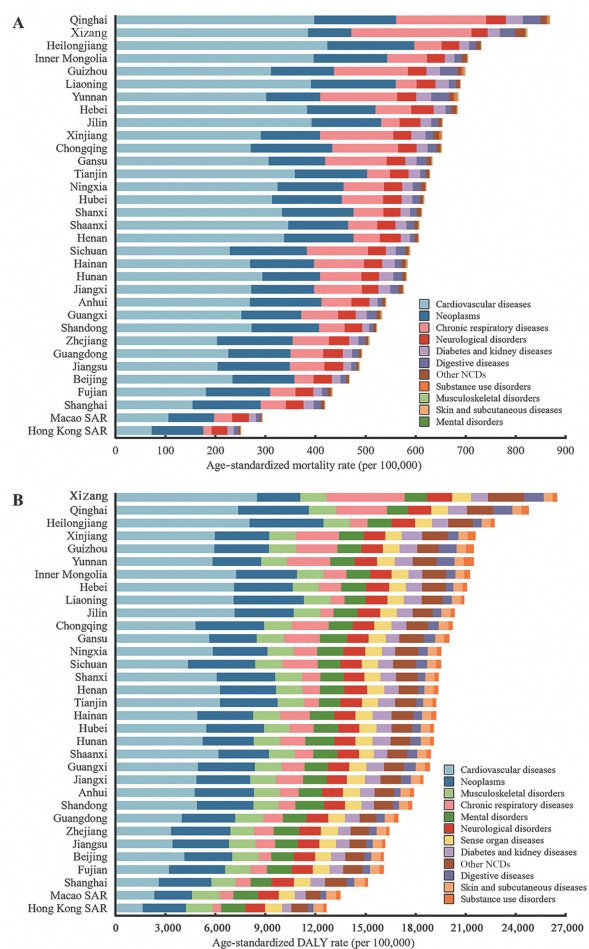


Figure 5: Age-standardized mortality rate (A) and age-standardized DALY rate (B) due to NCD level 2 causes by province in China in 2021 (data from the Taiwan Province of China were not included). DALY: Disability-adjusted life year; NCD: Non-communicable disease; SAR: Special administration region.

Discussion

Our findings show that NCDs accounted for the majority of the disease burden in China, with 91.0% of deaths and 86.7% of DALYs attributed to NCDs in 2021. Between 1990 and 2021, both the absolute number and rate of NCD deaths and DALYs continuously increased. As previous articles have pointed out, the decrease in premature mortality caused by CMNN diseases has led to an extension of life expectancy, which has partly caused the growth in NCDs.^[6] Although the age-standardized mortality rate and DALY rate from NCDs were declining, we should not overlook the increasing number of deaths and DALYs, as they represent the disease burden that the health system has to deal with.^[11] Our study also reveals that CVDs and neoplasms were the leading causes of deaths and DALYs from NCDs. CRDs were the third leading cause of NCD deaths, while musculoskeletal disorders were the third leading cause of NCD DALYs.

CVDs accounted for nearly half of all NCD deaths. In 2021, the mortality rate of CVDs (357.4 [95% UI: 303.0–415.0] per 100,000) and the DALY rate (7043.3 [95% UI: 5949.6–8192.3] per 100,000) were higher than

the global levels (mortality rate of 258.8 per 100,000, and DALY rate of 5347.6 per 100,000).^[12] Hypertension, as the most significant influencing factor of CVDs,^[13] has presented challenges to the prevention and treatment of CVDs due to the increasing prevalence of hypertension and the low awareness and control rates in China.^[14] Diet is also a major influencing factor of CVDs. Although the amount of salt used in Chinese household cooking has decreased, it still exceeds the recommended level.^[15] With changes in population, environment, lifestyle, and healthcare, the epidemiology of CVDs is also evolving, necessitating us to stay updated on the current major CVDs and their characteristics, and implement preventive measures accordingly.^[16]

Between 1990 and 2021, the age-standardized mortality rate and DALY rate for neoplasms decreased. China has made significant efforts in neoplasm prevention and control. China has established a systematic cancer surveillance network and implemented various cancer prevention and control measures. As of July 2019, there were 574 cancer registries in China. Population-based cancer registries provide data support for cancer-related research and policymaking.^[17] Since 2005, the Chinese government has established four organized cancer screening programs, screening for eight of the most common cancers, with the screening coverage continuously expanding.^[18] However, the burden from neoplasms in China remains heavy. The main risk factors for neoplasms are behavioral factors, indicating that a large part of the burden could potentially be avoided through modifiable behavioral factors.^[19] However, according to surveys, the decline in smoking rates in China is slow, the alcohol consumption of adult residents in China is increasing, and the lack of physical activity is becoming more serious.^[20] China still needs to make more efforts to control many NCD risk factors, including smoking and alcohol consumption, in order to reduce the disease burden caused by neoplasms.

The mortality rate ranking of CRDs remained high. However, optimistically, the ranking of its DALY rate declined between 1990 and 2021, with significant decreases in the DALY rate, age-standardized mortality rate, and age-standardized DALY rate. This may be related to the Chinese government's efforts to control air pollution. Air pollution is a significant risk factor for CRDs.^[21] In 2013, China issued the Air Pollution Prevention and Control Action Plan,^[22] which successfully improved air quality.^[23] It is worth noting that CRDs were the second leading cause of death and DALYs in Xizang. This is likely closely related to its unique geographical environment. Xizang is situated on a plateau with high altitude and low oxygen levels, which have an impact on CRDs.^[24] Furthermore, the widespread use of solid cooking fuels in western provinces like Xizang, Qinghai, and Gansu results in substantial household air pollution, potentially contributing to the high mortality rates due to CRDs in these regions.^[24,25]

Between 1990 and 2021, the DALY rate for musculoskeletal disorders increased significantly. Compared to death, disability from musculoskeletal disorders poses a greater burden as it seldom leads to death and consequently

receives less attention.^[26] Musculoskeletal diseases are age-dependent, and with the aging of the population, the government should pay more attention to addressing them. Meanwhile, the prevalence of work-related musculoskeletal disorders is high among the Chinese working population, so it is also necessary to formulate relevant policies to prevent occupational hazards.^[27]

Between 1990 and 2021, the burden of diseases caused by neurological disorders, diabetes and kidney diseases, and sense organ diseases has increased in ranking. There are fewer established modifiable risks for most neurological disorders, which requires us to further research effective prevention and treatment measures.^[28] The increase in the burden of diabetes may be attributed to diet-related risks and lifestyle changes.^[3] Research predictions indicate that the disease and economic burden of diabetes in China will continue to grow significantly from 2020 to 2030.^[29] China must take continuous action to address the burden caused by diabetes. Sense organ diseases not only affect patients' quality of life but also impact their communication and interaction with society, leading to psychological problems. Therefore, it is crucial to provide effective treatment for patients.^[30,31]

In terms of sex, the burden of NCDs was heavier for males than for females, and the distribution of the burden of NCD level 2 causes varied between the sexes. This has much to do with the different physiological characteristics and behaviors of males and females. For example, male smoking rates are significantly higher than female smoking rates, while female drinking rates are lower. Females are also more sensitive to their own health conditions and tend to follow doctors' advice more closely. However, females tend to have more severe mental health problems. The burden of musculoskeletal disease in females was higher than in males, which may be related to female physiological structure, hormone levels, pregnancy, and childbirth.^[32,33] Therefore, prevention and control measures for NCDs need to take full account of differences between males and females in order to improve the impact of interventions. In terms of region, there were variations in the burden of NCDs among provinces. In economically developed provincial administrative regions such as Hong Kong SAR, Macao SAR, and Zhejiang, the burden of NCDs was relatively low. Conversely, in economically less developed provincial administrative regions like Qinghai, Xizang, and Heilongjiang, the burden of NCDs was higher. In economically developed regions, health resources are more abundant, the healthcare system is more comprehensive, and people's health literacy is generally higher.^[34] In contrast, regions with lower economic levels face the opposite situation. Health disparities between different regions continue to exist. The key diseases that provinces need to focus on vary, and provincial governments must carry out NCD prevention and control efforts based on their specific conditions.

Our study utilized the latest data from the GBD study to analyze the burden of NCDs in China, comparing them across sex and regional levels. This analysis provides valuable data references for NCD prevention and control efforts. However, the study has several limitations. First,

the research data are sourced from GBD 2021, thus it is subject to all the limitations of GBD studies.^[1,2] Most GBD data are model-estimated, introducing a level of uncertainty in the results. The inconsistency in the availability of primary epidemiological data also affects the accuracy of the estimates. Second, in the GBD 2021, global parameters were used rather than Chinese-specific parameters, and fewer data sources from counties and regions in remote and impoverished provinces of China both affected the accuracy of the results on disease burden in China. Third, this study only analyzed the burden of NCDs, but did not investigate the NCD risk factors.

NCDs impose a heavy disease burden on China. As the world's most populous country, the disease burden of China has a significant global impact. Our research can assist the government in prioritizing intervention measures and providing evidence for policymaking. In future health efforts, China should focus not only on diseases with heavy burdens such as CVDs, neoplasms, CRDs, and musculoskeletal disorders but also consider diseases with increasing burdens such as neurological disorders, diabetes and kidney diseases, and sense organ diseases. Additionally, the burden of NCDs varies by sex and province. China needs to allocate health resources scientifically and take continuous, targeted, and more effective action to address the burden of NCDs.

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Conflicts of interest

None.

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