

# Trends and distribution of coronary heart disease mortality rate in Hexi Corridor, Gansu, China from 2006 to 2015

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This study described the trend and distribution of coronary heart disease (CHD) in the Hexi Corridor region of Gansu. The CHD mortality rates from 2006–2015 were obtained through the Death Reporting System of Gansu Centers for Disease Control (CDC) for 2006–2015. The overall mortality rate of CHD in the Hexi Corridor showed a decreasing trend, increasing in winter and spring and lowest in summer. The CHD mortality rate was higher in men than in women ( $P < 0.05$ ) and increased with age ( $P < 0.05$ ). The mortality rate was higher in rural areas than in urban areas ( $P < 0.05$ ). A ten-year mortality rate trend analysis showed that CHD mortality rate in women has significantly decreased. Specifically, women aged 18–39 years experienced increased There was little change in CHD mortality among women aged 40–59 years, and a declined in CHD mortality among women 60 years and older and women in urban areas. Further analysis showed that in the 18–39-year-old and 40–59-year-old groups and in urban areas, CHD mortality rate was higher in men than in women ( $P < 0.05$ ). From 2006 to 2015, the mortality rate of CHD in the Hexi Corridor of Gansu was lower than in the national average, but in certain populations such as men, young and middle-aged group and rural areas, the CHD mortality rate was gradually increased. There has been a gradual and progressive decline in CHD mortality rate compared to the rising trend in China. This is due to fewer risk factors in the region, effective drug treatment and improvements in environmental pollution. However, there is still a need to enhance the experience of effective prevention and control for specific subgroups such as men, young people and rural residents, and to take appropriate measures to prevent the occurrence of CHD.

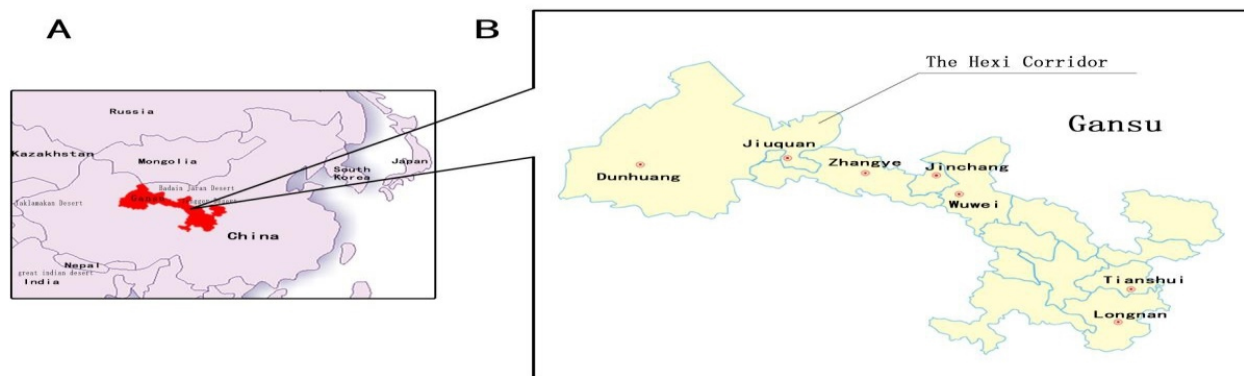
## Keywords

Mortality; Coronary heart disease; Hexi Corridor; Trends; Distribution

## 1. Introduction

The Hexi Corridor is a long, narrow passage stretching for some 1000 kilometres from the steep Wushaolin hillside near the modern city of Lanzhou to the Jade Gate at the border of Gansu and Xinjiang. The average annual life expectancy reached 73 years in 2015 (Available at: [http://www.zhanqye.gov.cn/zjzy/rkqy/201907/t20190704\\_239924.html](http://www.zhanqye.gov.cn/zjzy/rkqy/201907/t20190704_239924.html) (Accessed: 10 December 2019)) and the main cause of death

for residents is stomach cancer reaching 342.54 per 100,000 (Wuwei region, Available at: <https://www.laoziliao.net/heal/th/info/48219619> (Accessed: 1 December 2020)). With the social and economic reform, the changes of people's lifestyle and the aging process of the population in China, the risk factors of cardiovascular disease continue to increase, the morbidity and mortality of cardiovascular diseases are still on the rise [1]. Coronary Heart Disease (CHD) is one of the most important cardiovascular disease, which has a high mortality rate and affects the health of people in different countries of the world, a decline trend of CHD mortality rate has showed in developed countries, and many studies have documented the important contributions of both improvements in health care and management in risk factor levels [2]. However, CHD mortality rate in China is increasing, especially in rural areas [1]. In China, age-standardized stroke rates were reported to total 2.98% between July 2015 and September 2017, 3.42% for men and 2.69% for women, with a dramatic increase in the prevalence of CHD at age 50 years and older; thus, the overall prevalence was significantly higher in women (4.68%) than in men (4.01%) [3]. Understanding the trends in CHD mortality rate can help develop effective prevention and intervention strategies and support public health policies aimed at reducing disparities in CHD mortality rate. Many reports in this field are mostly found in large and medium-sized cities [4–7]. Hexi Corridor is located in the northwest of Gansu province, China, and west of the Yellow River, which is 1100 kilometers long and the narrowest place is only several kilometers, and covers Dunhuang, Jiuquan, Zhangye, Jinchang and Wuwei district (Fig. 1), with a total population of about 4.7 million, backward economic development, and inadequate health investment. This study retrospectively analyzed the CHD mortality rate its changing trend and characteristics among residents in Hexi Corridor region from 2006 and 2015 to provide basic data and scientific basis for the development of targeted prevention and control measures.



**Fig. 1. Maps of China and Gansu province, the Hexi Corridor.** (A) Location of Gansu Province in China. (B) Location of Hexi Corridor in Gansu Province.

## 2. Materials and methods

The deaths of cases of CHD in the Hexi Corridor from January 2006 to December 31, 2015 were studied using ICD-10 (I20, I21, I22, I23, I24, and I25) [8]. The demographic data were provided by Gansu Province, and death data were obtained from the National Death Cause Monitoring and Registration Information System. The underlying cause of death was determined to be CHD that triggered a series of events that led directly to the death, with details including the exact date of death, sex, age, place of residence, therapeutic hospital and etc. The data were regularly checked and proof-read by professionals at the Gansu CDC. Mortality rate and populations data were differentiated by sex, age and region, and the mortality rate was calculated using the direct method and normalized to the local population database. Three age groups: 18–39 years old, 40–59 years old,  $\geq 60$  years old, and 2 regional groups (urban and rural) were analyzed according to the jurisdiction of the local government. This investigation was approved by Ethics Committee of Gansu Provincial People's Hospital.

## 3. Statistical analysis

The data were analyzed by SPSS Software (version 20.0, IBM Corp., Chicago, IL, USA) [9]. Chi-square test compares the absolute counts of a cross-table. The relative mortality rate was calculated as the proportion of the sample size (/100,000) drawn from the total population of the area by means of a chi-square test for proportional trends.  $P < 0.05$  was considered to be statistically significant. A generic power analysis with a one-sample z-test was used to determine the sample size at  $\alpha = 0.05$  and  $1 - \beta = 0.80$ .

## 4. Results

The demographic composition ratio showed that the CHD mortality rate was higher in men than in women. The CHD mortality rate was higher in patients aged 60 years or older than in those aged 40–59 years and lowest in those aged 18–39 years. The CHD mortality rate was also higher in the rural population than in the urban population (Table 1).

**Table 1. Demographic Characteristics in Hexi Corridor from 2006 to 2015.**

CHD cases	Number of deaths (n (%))
Sex	
Men	16242 (60.93)
Women	10414 (39.07) <sup>a</sup>
Age group (years)	
18–39	341 (1.28)
40–59	6768 (25.39)
$\geq 60$	19547 (73.33) <sup>b</sup>
Area group	
Urban	11903 (44.65)
Rural	14753 (55.35) <sup>c</sup>

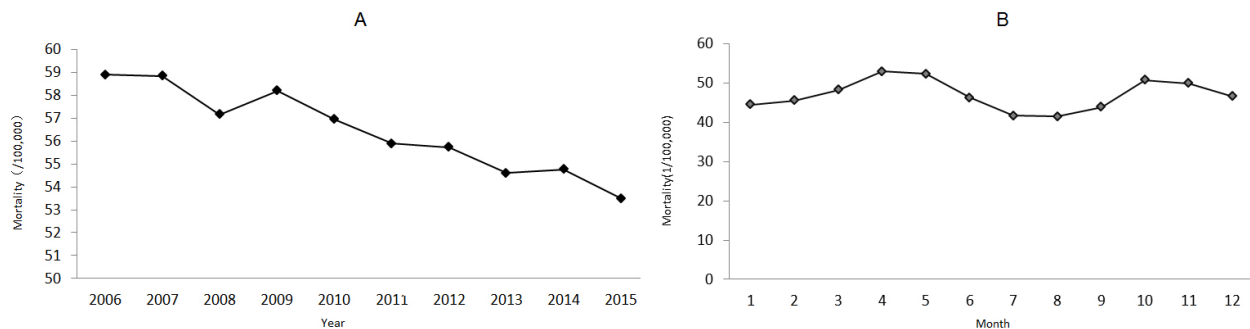
Compared with men, <sup>a</sup> $P < 0.05$ ; compared with 40–59 years old group, <sup>b</sup> $P < 0.05$ ; Compared with urban group, <sup>c</sup> $P < 0.05$ .

As shown in Table 2, from January 1, 2006 to December 31, 2015, the average local population was about 4.743 million, of which 26,656 died of CHD. The average annual mortality rate was 56.42/100,000. We observed that the incidence of men was higher than that of women ( $P < 0.05$ ), and increased with age ( $P < 0.05$ ), while the ratio was higher in rural areas than in urban areas ( $P < 0.05$ ). It can also be seen that in the 18–39 age group and the 40–59 age group, the mortality rate of men was higher than that of women ( $P < 0.05$ ), but there was no significant difference between the ages of 60 and older ( $P > 0.05$ ). Similarly, the proportion of men in urban areas was higher than that in women ( $P < 0.05$ ), while there was no sex difference in rural areas ( $P > 0.05$ ). Fig. 2A showed a downward trend of mortality rate from 2006 to 2015. Compared with the month, the mortality rate was higher in winter and spring and the lowest in summer (Fig. 2B). The trend was clearly decreasing for women, but not for men (Fig. 3A). Population of the 18–39 years old subgroup was sparse, but still increasing. The population over the 60 years old was gradually decreasing, while the population of 40–59 years old was unchanged (Fig. 3B).

**Table 2. The distribution of CHD mortality stratified by sex, age and area in Hexi Corridor from 2006 to 2015.**

	Relative mortality	Number of men deaths	Number of women deaths
	(/10,000)/Year	(n (/10,000))/Year	(n (/10,000))/Year
Overall	56.42	16242 (34.38) <sup>a1</sup>	10414 (22.04)
18–39	0.72	317 (0.67) <sup>a2</sup>	24 (0.05)
40–59	14.33	5872 (12.43) <sup>a3</sup>	896 (1.90)
≥60	41.38 <sup>b</sup>	10053 (21.28)	9494 (20.10)
Urban	25.20	8641 (18.29) <sup>a4</sup>	3262 (6.91)
Rural	31.23 <sup>c</sup>	7601 (16.09)	7152 (15.14)

Compared with women, <sup>a1–4</sup> $P < 0.05$ ; compared with 18–39 years old and 40–59 years old groups, <sup>b</sup> $P < 0.05$ ; Compared with urban group, <sup>c</sup> $P < 0.05$ .



**Fig. 2. The trend distribution by time.** (A) Trend distribution of CHD mortality rate in Hexi Corridor from 2006 to 2015. (B) Monthly Trend distribution of CHD mortality rate in Hexi Corridor from 2006 to 2015.

The urban population seems to be declining, while the rural population was not significantly declining (Fig. 3C).

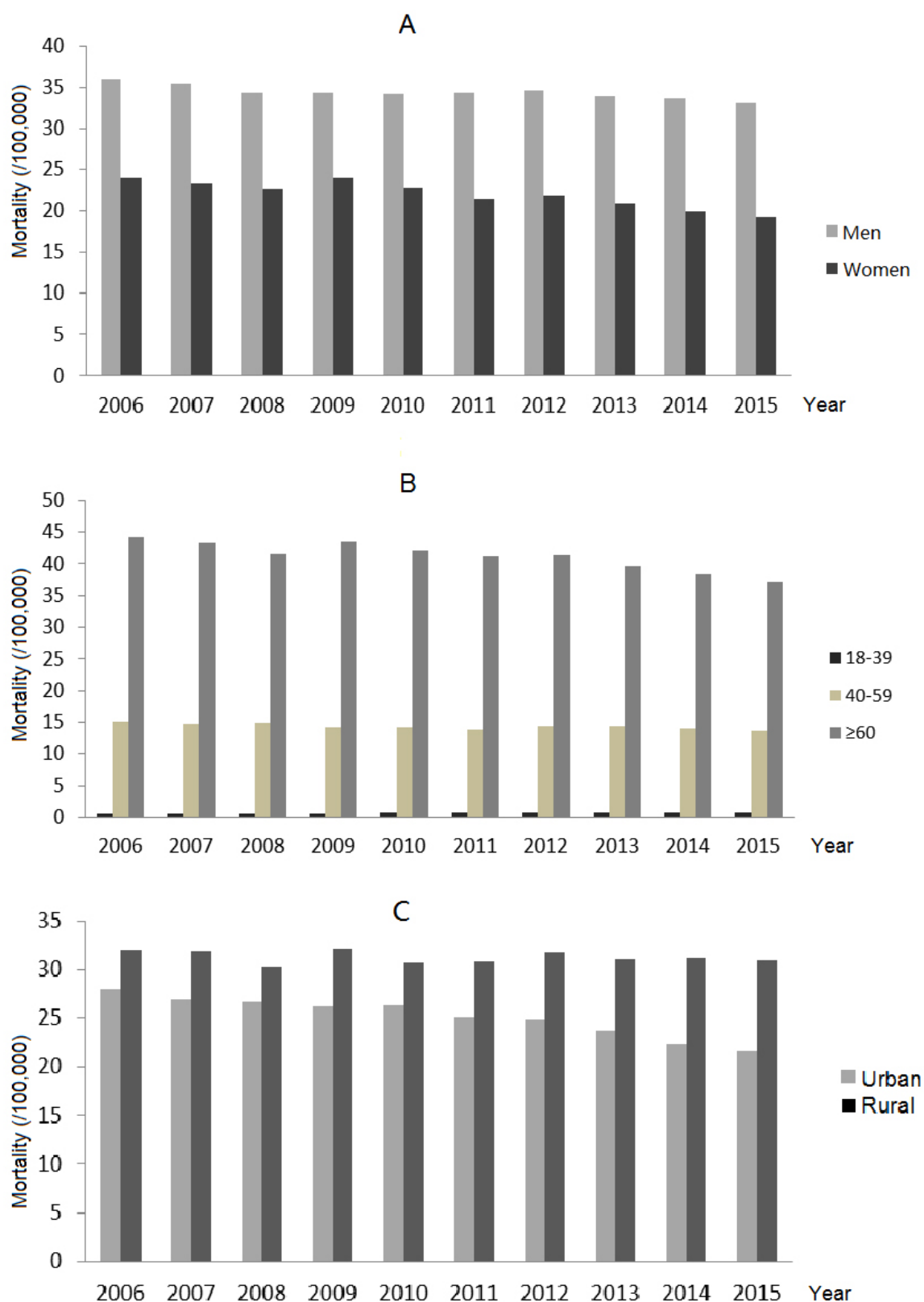
## 5. Discussion

According to the latest China Cardiovascular Disease Report 2018, the CHD mortality rate among urban and rural residents continues to increase, but was more obviously in rural areas, and CHD mortality rate in men was higher than in women [10]. The report also pointed out that the mortality rate of CHD in China from 2006 to 2015 was 57.1–110.67/100,000 in men and 33.74–110.91/100,000 in women [10]. Our results showed that the average total local population from year 2006–2015 was 4,724,300, 2,453,360 men and 2,270,940 women. The total number of deaths due to CHD during this period was 26,656, with a total mortality rate of 56.42 per 100,000, of which 35.96–33.08 per 100,000 were men and 23.96–19.26 per 100,000 were women. The mortality rate in this region was below the national average, and the overall trend had been gradually decreasing over the past decade. We speculated there are several possible reasons: Firstly, we know that the level of economic development is positively correlated with the incidence of CHD. From year 2006 to year 2015, the region's economic level was relatively underdeveloped, and there were fewer risk factors for CHD (smoking, obesity, low exercise, and hyperlipidemia), so the incidence of CHD itself was relatively low. Secondly, in recent years, with the improvement of medical diagnosis and treatment measures, many hospitals have actively

and standardized the establishment of “chest pain centers”, especially the implementation and development of percutaneous coronary intervention (PCI) and coronary artery bypass graft (CABG) surgery, which have also gradually reduced the CHD mortality rate. Thirdly, in the past, there had been many sandstorms in this area; however, with the improvement and strengthening of the government's environmental protection measures, the air pollution was significantly improved in recent years. It has been pointed out that the increase of environmental pollution, especially the increase of particulate matter (PM)2.5 in the atmosphere, can increase the mortality of ischemic heart disease [11–13], and its specific mechanism still needs to be further clarified [14, 15].

The CHD mortality rate in winter and spring was higher than that in summer and autumn, which was consistent with the research results from China [16, 17]. It was speculated that the CHD mortality rate was related to the cold climate, air pollution, elevated blood pressure and high activity of sympathetic nerves in this season. Sympathetic excitation increases myocardial oxygen consumption and increases the relative morbidity and mortality of coronary heart disease [18].

Subgroup analysis showed that the CHD mortality rate was higher in men than in women, and the trend analysis showed that CHD mortality rate in women were significantly lower than in men. The possible reasons for this are that men are involved in more risk factors for CHD mortality such as obesity, smoking, drinking, high stress and less exer-



**Fig. 3. The subgroup analysis by gender, age and area.** (A) The sex distribution of CHD mortality rate in Hexi Corridor from 2006 to 2015. (B) The age distribution of CHD mortality rate in Hexi Corridor from 2006 to 2015. (C) The area distribution of CHD mortality rate in Hexi Corridor from 2006 to 2015.

cise. Mortality from CHD increases with age, with a ten-year trend showing an increase in CHD mortality in younger people, but little change in middle-aged people, and a decrease in older people.

Notably, the incidence of CHD has gradually tended to be younger in recent years [19]. Our study showed that although the mortality rate CHD in the 18–39 age groups was relatively low, it was on the rise year by year, therefore, early prevention and treatment should be strengthened. The decline in CHD mortality in older adults is evident because the awareness of personal self-care increases with age, but this personal self-care awareness, both active and passive participation, is lacking in young and middle-aged adults. When classified by region, the mortality rate was higher in rural areas than in urban areas, which was related to the relatively advanced medical resources available to urban residents in recent years, such as easier access to relatively high-level hospitals and better medical insurance system. In addition, the educational level, economic support and health consciousness are also helpful. On the contrary, the patients in the rural region were restricted for the reasons mentioned above, and their CHD mortality rate had not been correspondingly reduced. This finding is consistent with previous report [10]. Among young and middle-aged groups, CHD mortality rate is higher in men than in women, which made men more likely to be exposed to those risk factors, especially in urban areas [20]. Considering that estrogen can reduce the protective effect on CHD, the mortality rate in elderly women was close to that in men, and the mortality rate in rural women was similar [21]. A study has shown that most of the women with coronary atherosclerotic plaque formation and maturity are later than men [22].

There are some limitations in our study. One is that this study was a retrospective analysis, and there is no statistical data of the morbidity of CHD at that time. Secondly, there is no analysis on subgroup of CHD, such as acute myocardial infarction, angina pectoris, asymptomatic myocardial ischemia and sudden death. Finally, Patient clinical characteristics, household income, health insurance status, education level, and history of smoking and alcohol use were not analyzed. Although the data were obtained from the National Cause of Death Surveillance and Registration Information System and all patients who died had a hospital death certificate, the possibility of misclassification of the cause of death should be considered.

## 6. Conclusions

This is the first analysis of the trend and characteristics of CHD mortality rate among people living in Hexi Corridor of Gansu province. The prevention and treatment of cardiovascular diseases in China has achieved initial results, but at the same time, it is facing new and severe challenges [23, 24]. Our study showed that CHD mortality rate was lower in Hexi Corridor than in the national average from 2006 to 2015. Comparing with the rising trend in China, and there is a grad-

ual decline of CHD mortality rate in Hexi Corridor. This discrepancy is due to fewer risk factors in the Hexi Corridor region, and perhaps the incidence of CHD in the Hexi Corridor region has decreased over the years with improved medical treatment and improved environmental pollution. However, there is still a need to strengthen the effective prevention and control experience for the special subgroups such as men, young people, and rural residents and to take appropriate measures to prevent the occurrence of CHD and reduce future mortality rate.

## Author contributions

XHL conceived the study, contributed to its design and drafted the manuscript. ZHD contributed to the study design and performed the analysis. XLR contributed to the study design and critically reviewed draft versions. YQ and PX contributed to the hospital medical record data collection and statistical analysis. XLS, LJW, JXH and YFH contributed to the demographic data collection and quality control of death population. All authors read and approved the final manuscript.

## Ethics approval and consent to participate

This study was approved by the Ethics Committee of Gansu People's Hospital. No patients need to give informed written consent to participate in the study.

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## Conflict of interest

The authors declare no conflict of interest.

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