Postprint: Trends in Disease Burden of Gout in China, 1990–2019, and Forecast for the Next Decade

Authors: Fang Jiawen, Feng Tianyuan, ZHOU Zhiheng, Li Ziyue, Yan Danhong, Lin Kaicheng, Lin Kaicheng

Date: 2023-09-13T00:00:00+00:00

Abstract

Background Gout is the most common inflammatory arthritis, causing substantial harm to public health; however, research on trend analysis and prediction of gout disease burden in China remains limited. Objective To analyze the changing trends of gout disease burden in China from 1990 to 2019 and to predict the standardized disability-adjusted life years (DALYs) rate, standardized incidence rate, and standardized prevalence rate for the next decade. Methods Data on gout disease burden indicators in China, including disability-adjusted life years (DALYs), incidence, and prevalence, were extracted from the Global Burden of Disease Study (GBD) 2019. The Joinpoint regression model was employed to calculate the annual percent change (APC) and average annual percent change (AAPC) of standardized DALYs rate, incidence rate, and prevalence rate. The autoregressive integrated moving average (ARIMA) model was utilized to forecast the standardized DALYs rate, standardized incidence rate, and standardized prevalence rate from 2020 to 2029. Results From 1990 to 2019, DALYs due to gout in China increased from 187,436 person-years to 510,485 person-years (a 172.35% increase), incident cases rose from 1,181,969 to 3,041,329 (a 157.31% increase), and prevalent cases grew from 5,864,143 to 16,161,325 (a 175.60% increase), with corresponding standardized rates increasing by 28.45%, 25.92%, and 28.63%, respectively. Joinpoint regression analysis revealed that from 1990 to 2019, the standardized DALYs rate, incidence rate, and prevalence rate exhibited an overall upward trend (AAPC: 0.9%, 0.8%, and 0.9%, respectively; $P<0.05$). Gout disease burden demonstrated significant gender and age disparities, with males bearing a higher burden than females. The male-to-female ratio ranged from 3.23-3.51 for standardized DALYs rate, 3.14-3.40 for standardized incidence rate, and 3.17-3.42 for standardized prevalence rate. The age peak for each indicator in females occurred later than in males overall; females' disease burden began to increase after age 45, while both sexes

experienced increased burden after age 90. ARIMA model projections indicated that by 2029, the standardized DALYs rate and standardized incidence rate attributable to gout would decrease by 0.33% and 0.45%, respectively, whereas the standardized prevalence rate would increase by 0.71%. Conclusion From 1990 to 2019, China' s gout disease burden exhibited a marked increasing trend with pronounced gender and age differences and a trend toward younger onset. The standardized prevalence rate attributable to gout is projected to increase slightly by 2029.

Full Text

Trend Analysis of Gout Burden in China from 1990 to 2019 and Prediction for the Next Ten Years

FANG Jiawen[1], FENG Tianyuan[2], ZHOU Zhiheng[2], LI Ziyue[1], YAN Danhong[1], LIN Kaicheng[3]*

[1]School of Health Management, Southern Medical University, Guangzhou 510515, China
[2]Shenzhen Pingshan District People' s Hospital, Shenzhen 518118, China
[3]Nanfang Hospital, Southern Medical University, Guangzhou 510515, China
*Corresponding author: LIN Kaicheng, Associate research fellow; E-mail: kanlpp@163.com

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Abstract

Background
Gout is the most common inflammatory arthritis, which causes great harm to people' s health; however, there are limited studies on the trend analysis and prediction of gout burden in China.

Objective
To analyze the changing trend of gout in China from 1990 to 2019, and predict the standardized DALYs rate, incidence rate, and prevalence rate of gout in the next 10 years.

Methods
Indicators of disability-adjusted life years (DALYs), incidence, and prevalence of gout in China were extracted from the Global Burden of Disease Study (GBD 2019). The annual percentage change (APC) and average annual percentage change (AAPC) of the age-standardized DALYs rate, age-standardized incidence rate, and age-standardized prevalence rate were calculated using the Joinpoint regression model. An autoregressive integrated moving average model (ARIMA model) was used to predict the age-standardized DALYs rate, age-standardized incidence rate, and age-standardized prevalence rate from 2020 to 2029.

Results
From 1990 to 2019, DALYs due to gout in China increased from 187,436 to 510,485 person-years (a 172.35% increase), the number of incident cases increased from 1,181,969 to 3,041,329 (a 157.31% increase), and the number of prevalent cases increased from 5,864,143 to 16,161,325 (a 175.60% increase). The corresponding standardized rates increased by 28.45%, 25.92%, and 28.63%, respectively. Joinpoint regression results showed an overall increasing trend in the age-standardized DALYs rate, incidence rate, and prevalence rate (AAPC = 0.9%, 0.8%, and 0.9%, respectively; $P < 0.05$). The gout burden exhibited significant gender and age differences, with men experiencing a higher burden than women. The male-to-female ratios ranged from 3.23–3.51 for the standardized DALYs rate, 3.14–3.40 for the standardized incidence rate, and 3.17–3.42 for the standardized prevalence rate. The age peaks for each indicator were generally delayed in females compared to males; the burden began to increase in females after age 45, while both sexes showed increased burden after age 90. The ARIMA model projected that by 2029, the age-standardized DALYs rate and incidence rate would decrease by 0.33% and 0.45%, respectively, while the age-standardized prevalence rate would increase by 0.71%.

Conclusion
From 1990 to 2019, the gout burden in China showed a significant increasing trend with marked gender and age differences and a trend toward younger onset. The age-standardized prevalence rate is expected to increase slightly by 2029.

Keywords
Gout; Incidence; Prevalence; Burden of illness; Trend analysis; ARIMA model; Prediction

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Introduction

Gout is a crystal-related arthropathy caused by monosodium urate deposition, directly associated with hyperuricemia resulting from purine metabolism disorders and/or reduced uric acid excretion. As the disease progresses, attacks become more prolonged and frequent. Gout patients often have comorbidities such as hypertension, cardiovascular disease, and chronic kidney disease, which complicate treatment and increase mortality risk. In recent years, global gout incidence and prevalence have continued to rise. Compared with 1990, the global age-standardized DALYs rate, incidence rate, and prevalence rate increased by 7.22%, 5.52%, and 7.22% respectively in 2017, while China' s rates increased by 6.92%, 6.16%, and 6.88%, respectively. China' s higher incidence rate than the global average indicates a growing gout patient population. Moreover, the high cost of gout treatment imposes a heavy economic burden on patients and their families. With China' s rapid economic development, dietary habits and lifestyles have changed considerably, and accelerated population aging has further increased the gout disease burden, seriously affecting residents' health and

quality of life. This study utilized Global Burden of Disease Study 2019 (GBD 2019) data to evaluate trends in DALYs, incidence, and prevalence of gout in China from 1990 to 2019 and predict the next 10-year trends using an autoregressive integrated moving average (ARIMA) model, aiming to understand the epidemiological characteristics of gout in China and provide evidence for prevention and control policy development.

Methods

1.1 Data Sources This study extracted data from the GBD 2019 database (https://vizhub.healthdata.org/gbd-results/), which systematically assesses disease burden for 369 diseases across 204 countries and territories, including 87 risk factors. When selecting data from GBD 2019, we chose "gout (B.11.5)" as the disease, "China" as the region, "1990–2019" as the time period, "both sexes," "male," and "female" as gender categories, and 17 age groups spanning 5-year intervals from 15–19 years to $ $95 years. The ICD-9 code for gout is 274, and the ICD-10 code is M10.

1.2 Indicator Selection We used DALYs, incidence, prevalence, and their age-standardized rates to assess China' s gout disease burden. DALYs consist of years of life lost (YLLs) and years lived with disability (YLDs). Since gout is a non-fatal disease, DALYs are essentially composed of YLDs. The GBD database calculates age-standardized rates based on the world standard population.

1.3 Statistical Methods 1.3.1 Joinpoint Regression Model
We used Joinpoint Regression Program 4.9.0.0 to analyze temporal trends, calculating the annual percentage change (APC) and average annual percentage change (AAPC) with 95% confidence intervals (CI) for China' s gout DALYs rate, incidence rate, prevalence rate, and their age-standardized rates by year, sex, and age from 1990 to 2019. APC or AAPC > 0 with 95% CI indicated an increasing trend, while APC or AAPC < 0 indicated a decreasing trend. APC = AAPC indicated a monotonic trend. The significance level was set at $\alpha = 0.05$ ($P < 0.05$).

1.3.2 ARIMA Model
The ARIMA(p,d,q) model is a commonly used time series forecasting model that can predict future observations based on past values and describe non-stationary time series data, where p, d, and q represent the orders of autoregression (AR), differencing required for stationarity, and moving average (MA), respectively. ARIMA modeling involves four main steps: stationarity testing, parameter determination, model validation, and forecasting. We used data from 1990–2009 as the training set to build ARIMA models for China's age-standardized DALYs rate, incidence rate, and prevalence rate due to gout, and data from 2010–2019 as the test set for model evaluation. Model performance was assessed using mean absolute percentage error (MAPE), mean absolute error (MAE), and root mean square error (RMSE). MAPE $<$ 10–15% indicated good predictive accuracy.

1.4 Statistical Analysis We used Excel 2016 to organize and analyze China' s gout DALYs, incidence, and prevalence data from 1990 to 2019. Joinpoint Regression Program 4.9.0.0 was employed to analyze trends in DALYs, incidence, prevalence, and their age-standardized rates by year, sex, and age. R version 4.1.1 was used to construct ARIMA models for predicting China' s age-standardized DALYs rate, incidence rate, and prevalence rate from 2020 to 2029.

Results

2.1 Trends in Gout Disease Burden in China, 1990-2019 From 1990 to 2019, DALYs due to gout in China increased from 187,436 to 510,485 person-years (a 172.35% increase), and the age-standardized DALYs rate increased from 19.72/100,000 to 25.33/100,000 (a 28.45% increase). Incident cases rose from 1,181,969 to 3,041,329 (a 157.31% increase), with the age-standardized incidence rate increasing from 121.37/100,000 to 152.83/100,000 (a 25.92% increase). Prevalent cases grew from 5,864,143 to 16,161,325 (a 175.60% increase), with the age-standardized prevalence rate rising from 624.53/100,000 to 803.31/100,000 (a 28.63% increase) .

2.2 Gender-Specific Trends in Gout Disease Burden, 1990-2019 From 1990 to 2019, age-standardized DALYs rate, incidence rate, and prevalence rate among Chinese men showed a gradual upward trend, accelerating after 2015 and peaking in 2017 before declining. Women exhibited a fluctuating upward trend, with all standardized rates remaining lower than men' s. Over the 30-year period, the male-to-female ratios ranged from 3.23–3.51 for the standardized DALYs rate, 3.14–3.40 for the standardized incidence rate, and 3.17–3.42 for the standardized prevalence rate [Figure 1: see original paper].

2.3 Age-Specific Gout Disease Burden, 1990-2019 The gout burden across age groups showed an overall upward trend from 1990 to 2019, increasing markedly with age. The burden was nearly zero in those under 15 years and remained low in those under 30, after which the rate of increase accelerated. In 2019, the age-specific DALYs rate peaked in the 80–84 age group before declining but remained higher than in the 15–69 age groups. Age-specific incidence and prevalence showed similar trends but peaked at different ages—75–79 years for incidence and 80–84 years for prevalence—both declining after their peaks but rising again after age 95, though remaining below the peak values [Figure 2: see original paper]. The age peak for DALYs rate shifted from 75–79 years (80.08/100,000) in 1990 to 80–84 years (115.27/100,000) in 2019. The age peaks for incidence and prevalence shifted from $ $95 years (492.35/100,000 for both) in 1990 to 75–79 years (585.93/100,000) and 80–84 years (4,016.34/100,000), respectively, in 2019.

All age-specific disease burden indicators were higher in men than women. The age peaks for women were generally delayed compared to men, with men' s burden concentrated in the 45–69 age groups and women' s in the 50–74 age

groups. Men' s DALYs rate more than doubled after age 30 compared to the 25-29 age group, while incidence and prevalence rates increased rapidly after age 20. Women' s burden remained low before age 45 but increased significantly thereafter. Both sexes showed increased burden after age 90, peaking at $ $95 years [Figure 3: see original paper].

2.4 Joinpoint Regression Analysis of Gout Disease Burden Trends
Overall trends from 1990-2019 showed significant increases in the age-standardized DALYs rate, incidence rate, and prevalence rate (AAPC = 0.9%, 0.8%, and 0.9%, respectively; all $P < 0.05$). The upward trends in age-standardized DALYs and prevalence rates were consistent across sexes, while the increase in incidence rate was slightly faster in men ($P < 0.05$). The age-standardized DALYs and prevalence rates showed similar patterns: decreasing from 1990-1994 (APC = -1.4%, $P < 0.05$), stable from 1994-2000 (APC = 0.2%, $P < 0.05$), rising from 2000-2009 (APC = 1.8% and 1.9%, respectively; $P < 0.05$), slowly increasing from 2009-2014 (APC = 1.3% and 1.2%, respectively; $P < 0.05$), peaking from 2014-2017 (APC = 4.7% and 4.8%, respectively; $P < 0.05$), then declining significantly from 2017-2019 (APC = -3.2% and -3.1%, respectively; $P < 0.05$). The age-standardized incidence rate showed six distinct segments: decreasing by 1.3% annually from 1990-1994 ($P < 0.05$), stable from 1994-2000, increasing by 1.7% annually from 2000-2010 ($P < 0.05$), rising by 1.1% annually from 2010-2014 ($P < 0.05$), accelerating to 4.5% annually from 2014-2017 ($P < 0.05$), then falling by 2.8% annually from 2017-2019 ($P < 0.05$) .

2.5 ARIMA Model Prediction 2.5.1 Model Construction
The auto.arima function identified the optimal models as ARIMA(1,2,0) for age-standardized DALYs rate (AIC = -50.24, BIC = -48.46), and ARIMA(2,2,0) for both age-standardized incidence rate (AIC = 8.73, BIC = 11.4) and age-standardized prevalence rate (AIC = 70.65, BIC = 73.32). Ljung-Box tests on residual sequences showed no significant differences, indicating white noise: for the DALYs rate model at lag 6 ($^2 = 7.423$, $P = 0.284$) and lag 12 ($^2 = 10.640$, $P = 0.560$); for the incidence rate model at lag 6 ($^2 = 7.401$, $P = 0.285$) and lag 12 ($^2 = 11.116$, $P = 0.519$); and for the prevalence rate model at lag 6 ($^2 = 7.201$, $P = 0.303$) and lag 12 ($^2 = 10.672$, $P = 0.557$). The models showed good predictive performance, with actual values from 2010-2019 falling within the 95% CI of predictions. Training set MAPE, MAE, and RMSE values indicated good model accuracy .

2.5.2 Prediction Results for 2020-2029
The model predicted that China' s age-standardized DALYs rate and incidence rate would show slight declines from 2020-2029, reaching 24.44/100,000 and 148.33/100,000 by 2029, representing decreases of 0.33% and 0.45%, respectively. The age-standardized prevalence rate was projected to increase slightly, reaching 768.18/100,000 by 2029, a 0.71% increase .

Discussion

Our findings show that in 2019, China experienced 510,485 person-years of DALYs, 3,041,329 incident cases, and 16,161,325 prevalent cases due to gout. From 1990–2019, China' s gout DALYs rate, incidence rate, and prevalence rate showed upward trends consistent with global patterns, though China's incidence growth rate exceeded the global average. While China' s disease burden remains relatively lower than developed countries like the US and UK, the accelerating trend indicates a growing public health challenge.

The rising burden may reflect multiple factors. First, rapid urbanization has dramatically shifted dietary patterns from traditional carbohydrate- and vegetable-based diets to high-purine animal foods. Excessive intake of high-purine foods can cause metabolic dysfunction and increase gout risk, with meta-analyses showing that red meat, seafood, and alcohol consumption elevate gout risk. Second, improved medical care and diagnostic technologies have enhanced gout detection rates. Third, accelerated population aging and increased life expectancy have expanded the elderly population, among whom gout is more common.

Significant gender and age differences were evident, with men experiencing higher burden than women. The burden peaked in men aged 45–69 and women aged 50–74. The burden was low before age 30 but accelerated thereafter. Notably, women' s burden remained low before age 45 but increased markedly afterward, likely due to estrogen' s role in promoting renal uric acid excretion. Postmenopausal estrogen decline suppresses uric acid excretion, and studies show gout incidence in women increases progressively after menopause and continues rising in old age ($ $75 years). Men' s greater social activity exposes them more to risk factors like alcohol consumption and high-purine diets, further increasing their burden. Both sexes showed increased burden after age 90, likely due to the high prevalence of comorbidities like hypertension and obesity in the elderly, which are risk factors for gout. The forward shift in age peaks for incidence and prevalence indicates gout is affecting younger populations, consistent with previous research.

Joinpoint analysis revealed distinct phases. From 1990–2017, China' s age-standardized DALYs rate, incidence rate, and prevalence rate rose significantly, likely due to urbanization and dietary transitions. The burden decreased from 2017–2019, possibly reflecting improved health awareness and lifestyle changes. The "Healthy China 2030" initiative has prioritized health promotion, leading to greater health literacy and dietary shifts toward low-fat, low-salt, low-purine patterns. Additionally, new gout treatment guidelines, integrative medicine approaches, and novel medications have contributed to this improvement.

The ARIMA model's projection of slight declines in age-standardized DALYs and incidence rates may reflect improved healthcare and health consciousness. The DALYs rate decrease may also result from gout patients' heightened attention to diet and exercise due to painful symptoms, and the inclusion of febuxostat (a novel urate-lowering drug) in the national insurance formulary, which reduces

recurrence and improves quality of life with fewer side effects. However, despite these slight declines, the large population base, aging demographics, and disease 年轻化趋势 (younger onset trend) mean the absolute burden remains substantial. The projected slight increase in prevalence may relate to suboptimal treatment adherence, with studies showing only 41% of patients receiving urate-lowering therapy, and the growing proportion of elderly individuals with comorbidities that trigger gout.

In conclusion, China' s gout DALYs rate, incidence rate, and prevalence rate increased significantly from 1990–2019, with marked gender and age differences and a trend toward younger onset. Projections for 2020–2029 suggest slight decreases in standardized DALYs and incidence rates but a slight increase in prevalence. This study has limitations: it is descriptive rather than analytical, and database constraints prevented analysis of provincial or regional variations.

Author Contributions

FANG Jiawen, FENG Tianyuan, and ZHOU Zhiheng conceptualized the study and designed the research. FANG Jiawen collected data, performed analysis, and drafted the manuscript. LI Ziyue created figures and tables. YAN Danhong conducted literature review. LIN Kaicheng supervised manuscript revision and quality control. The authors declare no conflicts of interest.

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Received: July 26, 2023; Revised: September 5, 2023
(Edited by: MAO Yamin)

Note: Figure translations are in progress. See original paper for figures.