

Trend Analysis and Prediction of Disease Burden of Rheumatoid Arthritis in China, 1990–2021: Postprint

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Abstract

Rheumatoid arthritis (RA) is a common chronic autoimmune disease. Its treatment and care require long-term investment, including drug therapy, surgical treatment, and rehabilitation therapy, etc., which imposes a heavy economic burden and social burden on patients' families and society. Analyzing the changing trends and predictions of disease burden can provide references for the formulation of relevant prevention and treatment strategies.

Objective: To understand the changing trends of RA disease burden in China from 1990 to 2021 and to predict the incidence rate, prevalence rate, and disability-adjusted life years (DALYs) rate of RA in China from 2022 to 2042.

Methods: Disease burden indicators related to RA from 1990 to 2021, including DALYs, incidence, and prevalence, were extracted from the Global Burden of Disease Study 2021 (GBD2021). SPSS 27.0 was used to calculate the change rates and estimated annual percentage changes (EAPC). The autoregressive integrated moving average (ARIMA) model was used to predict the incidence rate, prevalence rate, and DALYs rate from 2022 to 2042.

In 2021, the incidence rate, prevalence rate, and DALYs rate of RA in China were 17.38/100,000, 334.25/100,000, and 58.61/100,000, respectively, representing increases of 59.89%, 92.61%, and 71.07% compared with 1990. From 1990 to 2021, the incidence rate, prevalence rate, and DALYs rate of RA in China all showed an upward trend, with EAPCs of 1.61%, 2.33%, and 2.02%, respectively ($P < 0.05$). In 2021, the incidence rate, prevalence rate, and DALYs rate of RA among females in China (22.55/100,000, 460.19/100,000, and 78.25/100,000) were all higher than those among males (12.45/100,000, 214.09/100,000, and 39.87/100,000) ($P < 0.05$). In 2021, the incidence rate of RA in China reached its highest value in the 75-79 age group (34.37/100,000), the prevalence rate reached

its highest value in the \$ \$80 age group (836.13/100,000), and the DALYs rate reached its highest value in the \$ \$80 age group (223.81/100,000). The ARIMA model results showed that by 2042, the incidence rate, prevalence rate, and DALYs rate of RA in China are projected to be 20.26/100,000, 468.60/100,000, and 82.09/100,000, respectively, representing increases of 15.57%, 37.94%, and 37.90% compared with 2022, with obvious gender and age differences.

Conclusion: The disease burden of RA in China showed a significant increasing trend from 1990 to 2021, with age and gender differences. It is projected that by 2042, the incidence rate, prevalence rate, and DALYs rate of RA will continue to rise. This suggests that relevant departments should implement corresponding primary and secondary prevention measures for key populations such as the elderly and postmenopausal women.

Full Text

Trend Analysis and Forecasting Study on the Changing Disease Burden of Rheumatoid Arthritis in China, 1990-2021

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Abstract

Background: Rheumatoid arthritis (RA) is a common chronic autoimmune disease requiring long-term treatment and care, including drug therapy, surgical intervention, and rehabilitation. This imposes substantial economic and social burdens on both patients' families and society at large. Analyzing trends in disease burden and making predictions can provide valuable references for developing prevention and treatment strategies.

Objective: To examine the changing disease burden of rheumatoid arthritis in China from 1990 to 2021 and to forecast the incidence, prevalence, and disability-adjusted life years (DALYs) rates for RA in China from 2022 to 2042.

Methods: Disease burden indicators for RA—including DALYs, incidence, and prevalence—were extracted from the Global Burden of Disease Study 2021 (GBD 2021) for the period 1990–2021. The rate of change and estimated annual percentage change (EAPC) were calculated using SPSS 27.0. An autoregressive integrated moving average (ARIMA) model was employed to project incidence, prevalence, and DALYs rates for 2022–2042.

Results: In 2021, RA incidence, prevalence, and DALYs rates in China were 17.38/100,000, 334.25/100,000, and 58.61/100,000, respectively—representing increases of 59.89%, 92.61%, and 71.07% over 1990 levels. Between 1990 and 2021, all three metrics showed upward trends, with EAPCs of 1.61%, 2.33%, and 2.02%, respectively ($P < 0.05$). In 2021, women exhibited significantly higher rates than men: incidence (22.55/100,000 vs. 12.45/100,000), prevalence (460.19/100,000 vs. 214.09/100,000), and DALYs rate (78.25/100,000 vs. 39.87/100,000) ($P < 0.05$). Age-specific analysis revealed that incidence peaked at ages 75–79 years (34.37/100,000), while prevalence and DALYs rates peaked at age ≥ 80 years (836.13/100,000 and 223.81/100,000, respectively). ARIMA projections indicate that by 2042, RA incidence, prevalence, and DALYs rates will reach 20.26/100,000, 468.60/100,000, and 82.09/100,000, representing increases of 15.57%, 37.94%, and 37.90% from 2022 levels, with persistent gender and age disparities.

Conclusion: The disease burden of rheumatoid arthritis in China increased significantly from 1990 to 2021, with notable age and gender differences. Incidence, prevalence, and DALYs rates are expected to continue rising through 2042. These findings suggest that targeted primary and secondary prevention measures should be implemented for high-risk populations, particularly the elderly and menopausal women.

Keywords: Arthritis, rheumatoid; Global Burden of Disease; Disability-adjusted life years; Incidence; Prevalence; Trend analysis; Autoregressive moving average model

Introduction

Rheumatoid arthritis (RA) is a chronic inflammatory and systemic autoimmune disease characterized by progressive symmetric inflammation of affected joints, leading to cartilage destruction, bone erosion, and disability, with extra-articular symptoms being common. Global studies show that RA incidence increased from 567,500 to 1,074,400 cases between 1990 and 2019—a rise of 89.33%—with this trend projected to continue. RA severely restricts joint mobility and can cause physical disability, profoundly impacting quality of life and reducing life expectancy while imposing heavy medical and economic burdens on families and society. Clarifying China's RA disease burden and accurately predicting its future trajectory is therefore crucial for prevention and control efforts.

Domestic research on RA disease burden remains limited. This study utilizes data from the Global Burden of Disease 2021 (GBD 2021) to analyze RA disease burden and trends in China from 1990 to 2021, employing an autoregressive integrated moving average (ARIMA) model to forecast overall incidence, prevalence, and DALYs rates for 2022–2042, thereby providing scientific evidence for RA prevention and control strategies.

The GBD database is a comprehensive resource organized by global health research institutions. Led by the Institute for Health Metrics and Evaluation (IHME) at the University of Washington, it systematically evaluates disease burden for 369 diseases and injuries across 204 countries and territories using all available epidemiological data (published and unpublished) and routinely collected information (hospitalization records, medical data, etc.), applying cause-of-death ensemble models, spatiotemporal Gaussian process regression, and Bayesian meta-regression tool DisMod-MR 2.1. China's data primarily derive from published literature, medical insurance records, and cause-of-death registration data. The database includes all GBD disease categories, risk factors, etiologies, injuries, and sequelae; burden metrics include deaths, years of life lost (YLLs), years lived with disability (YLDs), DALYs, prevalence, incidence, and mortality, stratified by age, gender, and year.

Methods

Data Sources

Data on RA disease burden in China from 1990–2021 were extracted from GBD 2021 (<http://ghdx.healthdata.org/gbd-results-tool>). The study utilized publicly available incidence (crude rates), case numbers, prevalence (crude rates), and prevalent cases to characterize RA epidemiology. Disease burden was quantified using DALYs rates (crude), where DALYs represent total healthy life years lost from disease onset to death, comprising YLLs from premature mortality and YLDs from disability. Based on GBD age groupings, we categorized ages into 16 five-year intervals: 5–9, 10–14, 15–19, 20–24, 25–29, 30–34, 35–39, 40–44, 45–49, 50–54, 55–59, 60–64, 65–69, 70–74, 75–79, and ≥80 years. Temporal trends were analyzed using change rates and estimated annual percentage change (EAPC).

Calculations: (1) Change rate (%) = $(2021 \text{ value} - 1990 \text{ value}) / 1990 \text{ value} \times 100\%$; (2) EAPC (%) quantifies variable change over time and was calculated as $100 \times (e^{\hat{\alpha}} - 1)$, where $\hat{\alpha}$ is the regression coefficient from the equation $y = \alpha x + \dots$, with y representing the natural logarithm of RA incidence or prevalence and x representing year. EAPC significance was tested using t-tests.

ARIMA Model

The ARIMA (autoregressive integrated moving average) model, also known as the Box-Jenkins model, combines autoregressive (AR), moving average (MA), and differencing (I) components, expressed as ARIMA(p,d,q), where p is the AR order, d is the differencing order, and q is the MA order. This time series forecasting model leverages historical data patterns to predict future trends. The AR component describes relationships between current and historical values, while the MA component uses past forecast errors to predict future values. Differencing addresses non-stationary sequences; d=0 for stationary series.

Modeling procedures: (1) Test time series stationarity; apply differencing if needed. (2) Analyze autocorrelation function (ACF) and partial autocorrelation function (PACF) for the stationary series to determine p, d, and q parameters. (3) Visually assess fit and test parameter significance. (4) Use SPSS software for model fitting and select the final model based on comparative results. (5) Perform white noise testing on residuals. (6) Generate forecasts.

Statistical Analysis

SPSS 27.0 was used for data compilation and analysis of RA disease burden (incidence, prevalence, DALYs rates) and trends (change rates, EAPC) from 1990–2021. ARIMA models were constructed using SPSS 27.0 to forecast RA incidence, prevalence, and DALYs rates in China for 2022–2042. The significance level was set at $\alpha=0.05$.

Results

Overall Disease Burden of RA in China, 1990–2021

In 2021, China reported 127,826 incident RA cases, a 93.47% increase from 1990. The incidence rate rose from 10.87/100,000 in 1990 to 17.38/100,000 in 2021 (change rate: 59.89%; EAPC: 1.61%; $P<0.05$). Prevalent cases totaled 4,755,487 in 2021, up 132.92% from 1990, with prevalence increasing from 173.54/100,000 to 334.25/100,000 (change rate: 92.61%; EAPC: 2.33%; $P<0.05$). DALYs reached 833,818 years in 2021, a 106.87% increase from 1990, with the DALYs rate rising from 34.26/100,000 to 58.61/100,000 (change rate: 71.07%; EAPC: 2.02%; $P<0.05$).

Gender-Specific Disease Burden

In 2021, men accounted for 90,637 incident cases (incidence: 12.45/100,000; 78.62% increase from 1990; EAPC: 2.02%; $P<0.05$) and 1,558,790 prevalent cases (prevalence: 214.09/100,000; 106.67% increase; EAPC: 2.49%; $P<0.05$). Male DALYs totaled 290,285 years (rate: 39.87/100,000; 130.67% increase; EAPC: 2.43%; $P<0.05$).

Women experienced 156,670 incident cases in 2021 (incidence: 22.55/100,000; 50.23% increase; EAPC: 1.51%; $P<0.05$) and 3,196,697 prevalent cases (prevalence: 460.19/100,000; 85.51% increase; EAPC: 2.22%; $P<0.05$). Female DALYs reached 543,533 years (rate: 78.25/100,000; 96.07% increase; EAPC: 1.82%; $P<0.05$). All burden metrics were significantly higher in women than men in 2021 ($P<0.05$).

Age-Specific Disease Burden

In 2021, RA incidence peaked at ages 75–79 years (34.37/100,000), representing a 36.71% increase from 1990 (EAPC: 0.90%; $P < 0.05$). Prevalence and DALYs rates both peaked at age 80 years, reaching 836.13/100,000 (23.13% increase; EAPC: 0.70%; $P < 0.05$) and 223.81/100,000 (10.85% increase; EAPC: 0.60%; $P < 0.05$), respectively .

Age and Gender Patterns

Incidence: In 2021, male incidence peaked at ages 75–79 years (39.15/100,000; 53.29% increase; EAPC: 1.31%; $P < 0.05$), while female incidence peaked at ages 60–64 years (35.10/100,000; 26.67% increase; EAPC: 0.80%; $P < 0.05$).

Prevalence: Male prevalence peaked at age 80 years (738.08/100,000; 38.62% increase; EAPC: 1.01%; $P < 0.05$). Female prevalence peaked at ages 70–74 years (980.96/100,000; 15.34% increase; EAPC: 0.57%; $P < 0.05$).

DALYs: Male DALYs rate peaked at age 80 years (216.14/100,000; 28.47% increase; EAPC: 1.21%; $P < 0.05$). Female DALYs rate also peaked at age 80 years (228.89/100,000; 3.43% increase; EAPC: 0.30%; $P < 0.05$) .

Future Projections (2022–2042)

ARIMA forecasts indicate continued upward trends in RA incidence, prevalence, and DALYs rates through 2042. Projected 2042 rates are: - **Incidence:** 20.26/100,000 overall (15.57% increase from 2022); 17.07/100,000 in men (34.73% increase); 24.84/100,000 in women (9.62% increase) - **Prevalence:** 468.60/100,000 overall (37.94% increase); 292.52/100,000 in men (34.29% increase); 626.50/100,000 in women (34.08% increase) - **DALYs:** 82.09/100,000 overall (37.90% increase); 53.17/100,000 in men (31.28% increase); 103.55/100,000 in women (30.33% increase)

All 2042 projections show significantly higher burden in women ($P < 0.05$) [Figure 1: see original paper].

Discussion

RA is a chronic joint disease that imposes heavy burdens on families and society, representing a critical public health challenge worldwide. Rapid economic development has transformed lifestyles and dietary patterns, substantially altering RA disease patterns. Understanding current RA epidemiology and disease burden in China is essential for formulating effective prevention and control measures.

Previous research on RA disease burden has been limited. This study describes RA prevalence, disease burden, and trends in China from 1990–2021 using pub-

licly available GBD 2021 data, with ARIMA modeling for future predictions. Our findings show that RA incidence, prevalence, and DALYs rates increased from 1990 to 2021 across the total population and both sexes, consistent with global trends reported in the literature. While China's 2021 RA prevalence was lower than in developed countries such as Canada, it substantially exceeded the global prevalence reported in GBD 2021 (227.14/100,000), underscoring that RA disease burden in China cannot be ignored.

Significant gender differences emerged, with 2021 RA incidence, prevalence, and DALYs rates in women (22.55/100,000, 460.19/100,000, and 78.25/100,000) approximately double those in men (12.45/100,000, 214.09/100,000, and 39.87/100,000) ($P < 0.05$), aligning with numerous studies. This disparity may relate to female hormones (estrogen and progesterone), physiological structure, pregnancy, and menopause. Hormonal fluctuations during menstrual cycles, pregnancy, childbirth, and lactation can cause endocrine imbalances that may trigger immune dysfunction and increase RA risk. Estrogen not only maintains secondary sexual characteristics but also regulates various pathophysiological processes in both sexes. Research indicates that imbalances in 17β -estradiol (E2) contribute to health issues in perimenopausal women, potentially addressable through estrogen therapy. Traditional Chinese medicine suggests that women are more susceptible to external pathogenic factors (wind, cold, dampness, heat) during special physiological periods when blood and qi become disharmonious, increasing RA risk. Additionally, clothing habits and occupational exposures may increase women's environmental risk, particularly cold exposure to joints.

Age-specific patterns showed RA incidence peaking at 75–79 years overall, prevalence and DALYs rates peaking at \$ 80 years, concentrating among middle-aged and elderly populations. This likely reflects age-related immune decline and immunosenescence, which increase susceptibility to autoimmune diseases including RA. The concentration of DALYs among those \$ 80 years also reflects China's large population base and rapid population aging: the proportion of elderly individuals rose from approximately 4.9% in 1990 to 18.7% by 2020. Therefore, RA disease burden warrants serious attention, requiring health education on modifiable risk factors alongside secondary and tertiary prevention and rational resource allocation.

ARIMA projections indicate that by 2042, RA incidence, prevalence, and DALYs rates will continue rising, with persistent gender disparities. The upward incidence trend may relate to unhealthy dietary patterns and lifestyle changes, highlighting the need for primary prevention and health awareness initiatives. Improved medical care and diagnostic capabilities, coupled with increased life expectancy, will likely improve RA survival rates, driving up prevalence and DALYs. Changing risk factor profiles also influence prevalence trends. Established RA risk factors include genetic factors (family history, HLA-shared epitope alleles, epigenetic modifications, ethnicity), dietary factors (low vitamin D and antioxidant intake; high sugar, sodium, red meat, protein, and iron in-

take; protective effects of fruits, vegetables, and whole grains), and lifestyle factors (appropriate exercise and lower BMI reduce risk; smoking and alcohol consumption increase risk). Swedish research demonstrates that smoking duration matters more than intensity: smoking <10 years shows no significant RA association, while >20 years of smoking nearly triples RA risk regardless of intensity. Therefore, early smoking cessation and avoidance of secondhand smoke, balanced nutrition, and regular physical activity are essential preventive measures.

In conclusion, RA incidence, prevalence, and DALYs rates in China increased significantly from 1990–2021 with clear age and gender patterns. Women exhibited substantially higher burden than men in 2021, with male incidence peaking at 75–79 years and female incidence at 60–64 years, highlighting the need for targeted attention to men and postmenopausal women. Forecasts through 2042 predict continued increases with persistent gender disparities, necessitating strengthened prevention strategies for women. Women should monitor endocrine health, maintain healthy lifestyles during key physiological periods, protect joints from cold exposure, and consider traditional Chinese medicine approaches for harmonizing blood and qi to enhance resistance. Limitations include reliance on GBD database estimates, which may differ from actual conditions, and lack of provincial/regional analysis. Further research is needed to address these gaps.

Author Contributions

Ling Yao conceptualized the study, retrieved GBD 2021 data, performed data analysis, and drafted the manuscript. Zhang Wenbin retrieved GBD 2021 data, created figures, and conducted data analysis. Wang Shihong participated in data collection and study design. Chen Yongze and Dong Wenjiao compiled and verified data. Deng Xingyu contributed to manuscript writing. Ding Yuanlin supervised quality control and revised the final manuscript. All authors approved the final version.

Conflict of Interest

The authors declare no conflict of interest.

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

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