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Trends and future burden of other musculoskeletal diseases in China (1990–2041): a comparative analysis with G20 countries using GBD data

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Abstract

Background Other musculoskeletal diseases (OMSDs), as a critical component of the global public health challenge, remain understudied in China. This study aims to systematically analyze the epidemiological characteristics and future trends of OMSDs in China from 1990 to 2021.

Methods Based on data from the Global Burden of Disease Study(GBD) 2021, this research focused on prevalence and years lived with disability (YLDs), which were compared with G20 countries. Joinpoint regression was used to identify trend breakpoints, age-period-cohort analysis evaluated the independent effects of age, period, and cohort, and the Autoregressive Integrated Moving Average (ARIMA) model predicted the disease burden through 2041.

Results Between 1990 and 2021, both age-standardized prevalence rates (ASPR) and YLDs rates(ASYR) of OMSDs in China showed upward trends. Two critical turning points in ASPR occurred during 2000—2005 (APC = 1.5%, 95% CI: 1.4—1.6) and 2005—2009 (APC = 0.9%, 95% CI: 0.7—1.0). Age effects indicated that relative risk (RR) first increased and then decreased with age, peaking at 60—64 years (RR = 3.62, 95% CI: 3.62—3.63). Period effects showed a rising trend, while cohort effects revealed declining prevalence and YLDs rates. Projections suggest a gradual increase in burden indicators through 2041. Compared to other G20 countries, China ranked eighth from the bottom in disease burden, approaching the level of Germany.

Conclusion The burden of OMSDs in China continues to rise, particularly among women and the elderly. Although the current burden is at a mid-range level among G20 nations, population aging will exacerbate future challenges. To address this, advocating for healthy lifestyles, strengthening health education, and optimizing healthcare strategies are essential.

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†Shuilin Chen and Guicai Sun equal contributions to the study design, data analysis, and manuscript writing of this paper and serve as co-corresponding authors.

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Keywords Other musculoskeletal diseases, Disease burden, Joinpoint regression, Age—period—cohort model, Prediction

Introduction

Musculoskeletal diseases are a broad category of disorders that extensively involve the human locomotor system, encompassing over 150 diseases, such as those related to joints, bones, muscles, ligaments, the spine, tendons, as well as connective tissue diseases [1, 2]. These diseases not only seriously affect the quality of life of patients, but are also one of the most important factors leading to disability. They impose a heavy economic burden and medical pressure on families and society [3]. Research has shown that more than 1.63 billion people worldwide are affected by musculoskeletal diseases [4], and it has become the second-leading cause of non-fatal disability [5].

The Global Burden of Disease (GBD) database encompasses health loss data for hundreds of diseases, injuries, and risk factors [6]. It categorizes all musculoskeletal diseases into five specific types: rheumatoid arthritis, osteoarthritis, low back pain, neck pain, gout, and other musculoskeletal disorders (OMSDs) [7]. The OMSDs category is particularly complex, including inflammatory polyarthritis (excluding rheumatoid arthritis), psoriatic arthritis, infectious arthritis, muscle diseases, synovial and tendon disorders, and other conditions [4]. Despite significant differences in their etiologies and pathological mechanisms, these diseases collectively form an essential part of the musculoskeletal disease system and exert a profound influence on public health. In 2020, OMSDs ranked as the sixth leading cause of years lived with disability (YLDs) and the 19 th leading cause of disability-adjusted life years (DALYs) globally [4, 7]. Projections estimate that the number of people with OMSDs worldwide will increase from 494 million in 2020 to 1.06 billion in 2050 [4].

In China, the burden caused by musculoskeletal diseases is also extremely heavy. By 2017, musculoskeletal diseases had emerged as one of the three leading causes of disability in China [8]. From 1990 to 2017, the number of osteoarthritis cases surged from 26.1 million to 61.2 million, with an average annual percentage change (AAPC) of 0.24 (95% CI: 0.19—0.30). Concurrently, gout prevalence rate increased by 6.88% (AAPC 0.08, 95% CI: 0.08—0.09), while rheumatoid arthritis demonstrated an AAPC of 0.88 (95% CI: 0.83—0.93) and neck pain showed an AAPC of 0.25 (95% CI: 0.23—0.27) [9–11]. Occupational epidemiological studies reveal substantial variations in musculoskeletal diseases prevalence rate across professions (20.00%–90.00%), with particularly high rates observed among automotive assembly workers (64.10% neck pain prevalence rate) and obstetrics/gynecology medical staff (85.5% musculoskeletal diseases prevalence rate) [12–14].

On a global scale, due to their large population bases and diverse socioeconomic backgrounds, G20 countries exhibit significant differences in the burden of musculoskeletal diseases. In 2019, the global number of people affected by musculoskeletal diseases reached 354.57 million, among which India, China, the United States, Indonesia, and Brazil accounted for 51.03% of the global total. From 1990 to 2019, the prevalence rate of musculoskeletal diseases in regions with a low-middle Socio—demographic Index (SDI) showed a downward trend, while it increased in regions with a high—middle SDI [15]. Comparing the disease burden in China with that of other G20 countries can, on the one hand, vividly demonstrate the achievements and shortcomings of China in the prevention and control of musculoskeletal diseases. On the other hand, it can also provide important references for the rational allocation of domestic health resources.

Previous studies mainly focused on five specific musculoskeletal diseases from a global standpoint [2, 10, 15, 16], yet in—depth research on the disease burden of OMSDs in China is scarce. This study analyzes trends in the prevalence of OMSDs and YLDs in China from 1990 to 2021, aiming to characterize their prevalence across different populations. It also compares China's OMSDs burden with that of other G20 countries and projects the burden trend over the next 20 years. Findings of this study are expected to inform OMSDs prevention, control, and the formulation of relevant health policies in China.

Methods

Data sources

The data was obtained from the GBD 2021 database (https://ghdx.healthdata.org/), cited from Meifeng Lu (2024). The GBD 2021 employed a series of standardized analytical procedures, covering steps such as data screening, data adjustment, and DisMod-MR 2.1 estimation, to comprehensively estimate the incidence, prevalence, DALYs, deaths, YLDs, years of life lost due to premature death (YLLs), and maternal mortality rate of various diseases. It should be noted that there are certain limitations in the GBD disease burden estimates. Due to the complexity of data collection, there is a problem of sparse data, and the data in some regions or time periods may be incomplete, which may affect the accuracy of the estimates. At the same time, the GBD estimation process is highly dependent on models, with the DisMod—MR 2.1 model playing a crucial role. Although this model estimates the disease prevalence by integrating multi—source data and comprehensively considering complex factors such as the natural history of the disease and risk factors, there are certain differences between the assumptions of the model and the real world, which inevitably introduces estimation biases. In addition, there are differences in healthcare systems among different countries, and the under—reporting of medical records can also lead to inaccurate data, thus affecting the estimation results of the disease burden. In this study, data on OMSDs in China and G20 countries from 1990 to 2021 were obtained from the GBD 2021. Since this disease is one of the main causes of disability and are usually considered non—fatal diseases, we focused on its prevalence and YLDs.

Case definition

In the GBD, OMSDs are defined as musculoskeletal diseases excluding five specific diseases (gout, low back pain, neck pain, rheumatoid arthritis, and osteoarthritis). Fractures and dislocations related to musculoskeletal diseases are not included, as they are collected and calculated as part of the burden of non—fatal injuries [7]. The International Classification of Diseases, Ninth Revision (ICD—9) and ICD—10 codes are used to define infectious joint diseases (ICD—9: 711 or ICD—10: M00—M02), inflammatory polyarthritis (ICD—9: 712—713 or 446, ICD—10: M03, M06—M09 or M11—M13), other joint diseases (ICD—9: 716—719 or ICD—10: M20—M25), systemic lupus erythematosus (ICD—9: 710.0 or ICD—10: L93), generalized connective tissue diseases (ICD—9: 710.1—710.9 or ICD—10: M30—M36), dorsal deformities (ICD—9: 737 or 416.1, or ICD—10: M40—M43 or I27.1), spondylopathy (ICD—9: 720 or ICD—10: M45—M46), muscle diseases (ICD—9: 725 or ICD—10: M60—M63), synovial and tendon diseases (ICD—9: 726—728 or ICD—10: M65—M68), other soft—tissue diseases (ICD—9: 729, ICD—10: M70—M73 or M75—M79), diseases of bone density and structure (ICD—9: 733.0—733.2 or ICD—10: M80—M85), osteomyelitis (ICD—9: 730.1—730.3 or 730.7—730.9 or ICD—10: M86), arthritis (ICD—9: 733.3—733.9 or ICD—10: M87—M90), osteomalacia (ICD—9: 732 or ICD—10: M91—M94), and other diseases of the musculoskeletal system and connective tissue (ICD—9: 734—736 or 738—739, ICD—10: M95 or M99) [4]. The detailed codes for OMSDs are shown in Appendix 1.

Descriptive analysis

In this study, we described the trends of age-standardized prevalence rates (ASPR) and YLDs rates(ASYR) of OMSDs in G20 countries and regions with different SDI levels from 1990 to 2021, and quantified them using the Estimated Annual Percentage Change (EAPC). SDI is an indicator commonly used in the GBD database to reflect the socioeconomic development level of a country or region, taking into account aspects such as education, income, and fertility. The SDI ranges from 0 to 1. All countries or regions are divided into five levels according to the quintiles of SDI: high (0.805129—1), high—middle (0.689504—0.805129), middle (0.607679—0.689504), low—middle (0.454743—0.607679), and low (0—0.454743). EAPC is calculated based on a linear regression model, with the year as the independent variable x and the logarithm—transformed age—standardized rate (ASR) as the dependent variable y. The regression equation is $y = \alpha + \beta x \epsilon$. EAPC is calculated as $EAPC = 100 \times (\exp(\beta) - 1)$ from the slope β. When the value of EAPC is greater than 0, the ASR increases over time; when it is less than 0, the ASR decreases over time. In addition, we grouped by age and compared the trends of the prevalence and YLDs of OMSDs in China and G20 countries over time and by gender.

Joinpoint regression model

The Joinpoint regression model was employed to estimate the trends of the ASPR and ASYR of OMSDs in China and the G20 countries from 1990 to 2021. This model divides the longitudinal changes into different time periods through piece—wise regression and identifies the segment trends with statistical significance. Subsequently, natural logarithm regression fitting was performed on the prevalence and YLDs rates in different time periods, and the annual percentage change (APC) and the AAPC for each time period were calculated. Among them, APC represents the change within a specific time period, and AAPC represents the overall change over time. $APC < 0$ indicates a year—on—year decrease, and vice versa indicates a year—on—year increase; $APC = AAPC$ indicates that there are no obvious turning points in the trend [17].

Age—period—cohort analysis

The age-period-cohort model was used to explore the effects of age, period, and cohort on the prevalence rate of OMSDs and YLDs rates. The age effect takes into account factors such as population aging that influence the disease. People of different age groups may have different susceptibilities to diseases and present different disease manifestations due to differences in physiological functions, lifestyles, and disease exposures. Since children aged 1—4 years are generally in the early stage of growth and development, with relatively stable health conditions and less impact from chronic diseases, the age group of 1—4 years was selected as the reference in this study. The period effect reflects the changes in disease risks caused by objective factors (such as social and economic development, advancement of medical technology, environmental changes, and lifestyle changes) in different time periods. The cohort effect focuses on the influence of different birth cohorts on the disease. Due to the differences in social, economic, and environmental conditions that different birth cohorts are exposed to during their growth, there are also variations in the exposure levels of disease risk factors, which in turn affect their prevalence rate and YLDs rate. To avoid the collinearity problem among age, period, and cohort factors that cannot be eliminated by traditional statistical methods, this study used the intrinsic estimator (IE) method to evaluate the impacts of these three factors on the disease respectively [18]. The relative risk (RR) and its 95% confidence interval(CI) were calculated based on the estimated coefficients to quantify the impacts of age, period, and cohort on the prevalence rate and YLDs rate of different genders.

Prediction of prevalence and YLDs

The Autoregressive Integrated Moving Average (ARIMA) model is widely used in the fields of public health and epidemiology for short—term and long—term forecasting of disease burden, especially for handling non—stationary time—series data with trends and seasonality. The ARIMA model captures the main characteristics of time—series data through three components: autoregressive (AR), integration (I), and moving average (MA), and can effectively deal with non—stationary data. Additionally, by adjusting the parameters (p, d, q), the ARIMA model can flexibly adapt to time—series data with different characteristics [19]. The basic form of the ARIMA model can be expressed as: $Yt = \phi 1Yt - 1 + \phi 2Yt - 2 + \ldots + \phi pYt - p + \epsilon t - \theta 1\epsilon t - 1 - \ldots - \theta q\epsilon t - q$. Here, Yt is the observed value at time point t, and $\phi 1Yt - 1 + \phi 2Yt - 2 + \ldots + \phi pYt - p$ represents the AR part, which describes the relationship between the current value and the previous p historical values. ϵt is the random error term at time point t, which captures the prediction error of the model at this time point. $\theta 1\epsilon t - 1 + \ldots + \theta q\epsilon t - q\theta 1\epsilon t - 1 + \ldots + \theta q\epsilon t - q$ represents the MA part, which describes the relationship between the current prediction error and the previous q prediction errors [20]. We employed the differencing method to transform non—stationary data into stationary data. The autocorrelation function (ACF) and partial autocorrelation function (PACF) were utilized to test the stationarity of the differenced sequence. An optimal model was established using auto.arima() based on the Akaike Information Criterion (AIC) value. The QQ plot, PACF plot, and ACF plot were used to test whether the residuals were normally distributed, and the Ljung—Box test was employed to verify whether the residuals were white noise. Subsequently, the accuracy of the model prediction was evaluated using indicators such as the mean error (ME), root mean square error (RMSE), mean absolute error (MAE), mean percentage error (MPE), mean absolute percentage error (MAPE), and mean absolute scaled error (MASE) [18].

Statistical analysis

The Joinpoint regression model was constructed using Joinpoint software (version 5.2.0), and the APC, AAPC, and their 95% CI were calculated. First, the Kolmogorov—Smirnov (K—S) method was used to conduct a normality test on the dependent variable. If the data follows a normal distribution (or approximately normal distribution) and the data sample size is large (greater than 100), a linear model was used for analysis; otherwise, a log—linear model was adopted. According to the default settings of the software, the grid search method (GSM) was used for turning point analysis and parameter estimation, and the Monte Carlo permutation test was used for model optimization. The age-period-cohort model was constructed in the Stata 16.0 environment, and the RR was calculated to evaluate the relative risk of the disease among different ages, periods, and cohorts. The predictive analysis was carried out with the help of the"forecast"package in R software, and the auto.arima() function was used to automatically find the optimal ARIMA model parameters. To enhance the data visualization effect, the"ggplot2"package in R software was used for plotting. All statistical analyses were completed in the R (version 4.4.1) environment, and a *P*—value less than 0.05 was considered statistically significant.

Results

Trends in prevalence and YLDs of OMSDs in China and G20 countries from 1990 to 2021

As shown in Fig. 1 and Tables 1 and 2, in 2021, the number of patients with OMSDs in China was 85,026,742 cases (95% uncertainty interval (UI): 72,381,412—99,420,159). Among them, 36,674,776 cases (95% UI: 31,031,050—43,272,412) were male patients and 48,351,966 cases (95% UI: 41,477,010—56,286,140) were female patients. From 1990 to 2021, with the exception of Brazil (EAPC:—0.53 [95% CI:—0.37—- 0.69]), the ASPR (EAPC: 0.87[95% CI: 0.90—0.83]) and ASYR (EAPC: 0.87 [95% CI: 0.91—0.84]) of OMSDs in G20 showed an upward trend. Canada, Argentina, and the United States

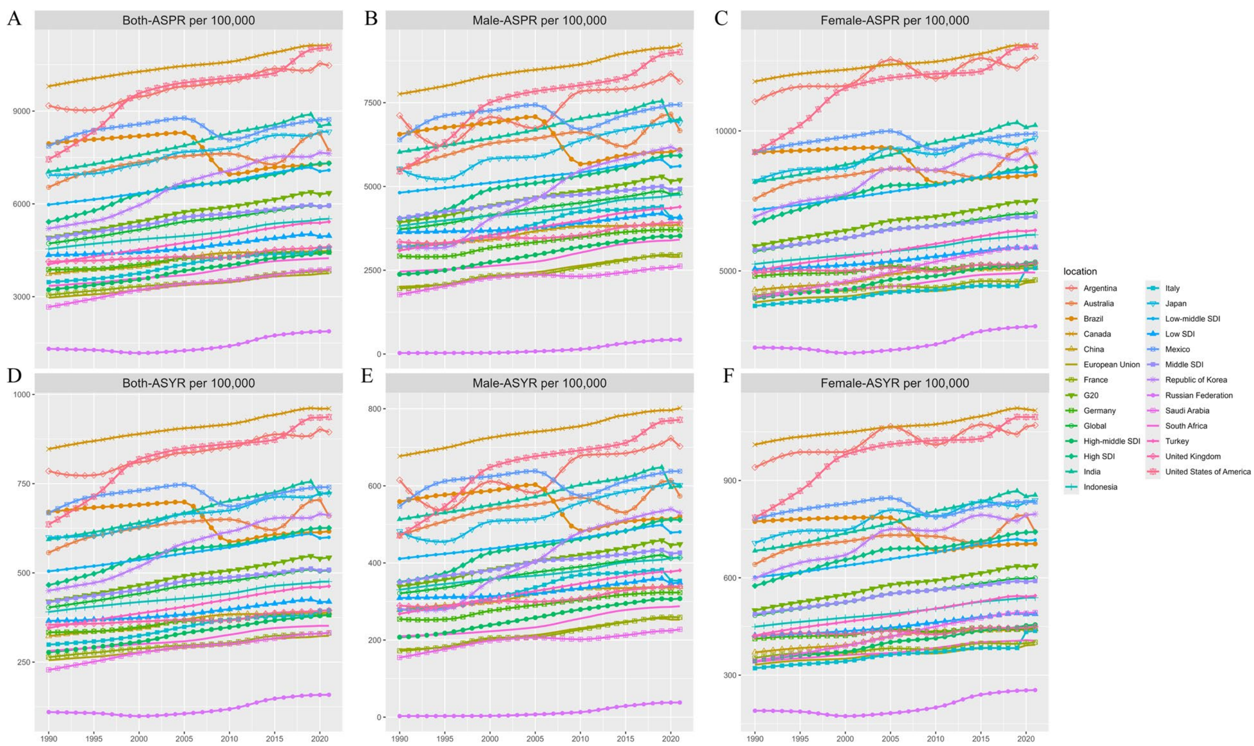

Fig. 1 Trends of the Age—Standardized Prevalence Rate (ASPR) and Age—Standardized Years Lived with Disability Rate (ASYR) of Other Musculoskeletal Diseases in the G20 and Different Socio—demographic Index (SDI) Regions from 1990 to 2021

ranked among the top three, while Russia consistently maintained the lowest level. 2021 China was in the bottom eight of the G20 countries for ASPR and ASYR for OMSDs (ASPR of 4,484.55 (95% UI: 5221.68—3,852.20) cases per 100,000 population; ASYR of 389.04 (95% UI: 544.88—264.24) cases per 100,000 population), higher than Russia, Saudi Arabia, France, the EU, South Africa, Italy and Germany. Among them, Germany's burden indicators for OMSDs were closest to China's (ASPR 4439.30 (95% UI: 5241.61—3700.28) cases per 100,000 population; ASYR 382.30 (95% UI: 541.01—256.85) cases per 100,000 population). Of the five SDI regions, the high SDI region had the highest burden of disease indicator (ASPR of 7310.34 (95% UI: 8058.08—6637.76) cases per 100,000 people; ASYR of 625.92 (95% UI: 855.73—436.01) cases per 100,000 people), and the high-medium SDI region had the lowest (ASPR of 4430.95 (95% UI: 5135.73—3815.65) cases; ASYR 381.97 (95% UI: 533.40—262.23) cases per 100,000 population), with China being closest to the high-middle SDI region in terms of disease burden status.

Trends in the prevalence and YLDs of OMSDs in China and the G20, 1990–2021, are shown in Fig. 2, Appendices 2 and 3. Among them, the number of prevalent individuals and the prevalence rate of these diseases were higher in females than in males, and the YLDs were likewise higher in females than in males. Over time, the prevalence rates among both females and males demonstrated an upward tendency. In China, the male prevalence rate increased from 2,884.12 cases per 100,000 people (95% UI: 3,421.63—2,451.80) in 1990 to 5,037.03 cases per 100,000 people (95% UI: 5,943.17—4,261.90) in 2021, a 74.6% increase. For females, the prevalence rate rose from 3,956.31 cases per 100,000 people (95% UI: 4,617.78—3,412.83) to 6,960.70 cases per 100,000 people (95% UI: 8,102.89—5,970.99), a 75.9% increase. Regarding the G20, the female prevalence rate increased from 5,638.91 cases per 100,000 people (95% UI: 6,472.19—4,920.97) in 1990 to 9,053.64 cases per 100,000 people (95% UI: 10,251.56—8,034.64) in 2021, a 60.6% increase. The male prevalence rate in the G20 grew from 3,646.41 cases per 100,000 people (95% UI: 4,261.35—3,107.85) to 6,051.01 cases per 100,000 people (95% UI: 6,935.86—5,272.47), a 65.9% increase. In the past 31 years, the ASPR and ASYR of OMSDs in China also increased over time, EAPCs were 0.66 (95% CI: 0.73—0.59) and 0.68 (95% CI: 0.75—0.61) respectively. However, the growth rates were lower compared to those of the G20, where the EAPCs were 0.87 (95% CI: 0.90—0.83) and 0.87 (95% CI: 0.91—0.84) respectively.

As shown in Fig. 3A, B and Appendix 4, with the increase of age, the prevalence rate of OMSDs and the

Table 1 Changes in the prevalence of other musculoskeletal diseases in the G20 and different SDI regions from 1990 to 2021

Location	Number_1990 (95% UI)	ASR (95%UI)	Number_2021 (95% UI)	ASR (95%UI)	EAPC (95% CI)
Global	221036388.315(254855232.804 to 191778912.462)	4718.221(5436.665 to 4098.804)	504297455.038(574768515.114 to 443696176.566)	5942.826(6761.326 to 5237.367)	0.779 (0.808 to 0.75)
G20	170915360.826(197195962.682 to 147907213.357)	4909.081(5672.169 to 4250.35)	371315048.831(422365403.717 to 327091778.172)	6351.713(7197.994 to 5607.121)	0.866 (0.9 to 0.832)
High SDI	54048609.397(62951617.432 to 46447567.964)	5418.716(6308.657 to 4671.626)	102337316.548(114117752.551 to 92202037.419)	7310.338(8058.077 to 6637.757)	0.924 (0.997 to 0.851)
High-middle SDI	34856082.454(41155853.632 to 29499451.113)	3224.057(3798.676 to 2733.169)	74964278.244(87577227.648 to 64196644.764)	4430.947(5135.727 to 3815.647)	1.1 (1.131 to 1.068)
Middle SDI	68133492.147(78590790.993 to 58982022.835)	4885.239(5599.171 to 4251.51)	165089487.992(189796817.577 to 143543407.595)	5946.969(6804.537 to 5192.557)	0.664 (0.702 to 0.626)
Low-middle SDI	50030348.788(57277175.358 to 43705805.603)	5975.099(6822.295 to 5252.48)	124438338.548(141687292.608 to 108825250.403)	7089.791(8070.76 to 6227.191)	0.62 (0.642 to 0.597)
Low SDI	13836787.698(16030387.927 to 12009554.159)	4345.362(4998.471 to 3775.825)	37201915.604(43032045.584 to 32438648.705)	4966.308(5719.867 to 4329.05)	0.519 (0.557 to 0.481)
United States of America	20818055.602(23835747.634 to 18117978.921)	7438.91(8534.827 to 6515.426)	44853054.883(47795674.545 to 42208994.89)	11055.081(11723.939 to 10445.631)	1.111 (1.265 to 0.956)
United Kingdom	2850916.192(3406269.609 to 2371552.427)	4135.729(4904.29 to 3452.7)	3956071.821(4682984.521 to 3306058.489)	4609.801(5404.133 to 3885.704)	0.347 (0.39 to 0.303)
Canada	2997732.299(3433511.804 to 2605457.926)	9801.364(11218.208 to 8529.443)	5248145.668(5967706.492 to 4488099.061)	11135.168(12579.541 to 9721.207)	0.405 (0.419 to 0.391)
European Union	14573683.35(18009630.892 to 11705101.333)	2965.338(3617.934 to 2409.251)	21567134.018(25962278.79 to 17705723.036)	3753.992(4409.119 to 3148.647)	0.804 (0.825 to 0.783)
Australia	1225363.059(1375326.357 to 1069005.123)	6536.947(7325.007 to 5715.225)	2546058.242(2976022.937 to 2156383.342)	7721.393(8932.097 to 6577.439)	0.475 (0.585 to 0.364)
Germany	3810054.118(4660163.15 to 3073557.385)	3874.007(4662.893 to 3152.208)	4858535.288(5878125.417 to 3945320.516)	4439.297(5241.607 to 3700.275)	0.521 (0.56 to 0.483)
France	1951819.127(2505817.728 to 1502807.431)	3052.612(3807.74 to 2369.781)	2949577.09(3668054.417 to 2335081.082)	3833.806(4603.268 to 3132.434)	0.737 (0.763 to 0.711)
Italy	2376345.68(2959983.874 to 1847102.167)	3469.495(4282.114 to 2750.36)	3748621.186(4523263.505 to 3042380.238)	4584.782(5451.21 to 3831.842)	0.964 (1.021 to 0.907)
China	40037827.711(46891356.359 to 34374241.59)	3736.826(4370.002 to 3201.296)	85026741.992(99420158.849 to 72381412.106)	4484.551(5221.675 to 3852.199)	0.659 (0.728 to 0.591)
Japan	10686484.133(12446456.755 to 9109717.855)	6931.601(8062.162 to 5928.051)	16032586.797(18,442,947.847 to 13914981.345)	8332.532(9518.437 to 7296.084)	0.686 (0.723 to 0.65)
Republic of Korea	2265866.674(2719716.175 to 1875353.642)	5202.943(6250.893 to 4274.325)	5458012.572(6425661.167 to 4648678.735)	7625.751(8809.611 to 6577.351)	1.428 (1.533 to 1.324)
India	46576940.557(53479389.993 to 40449822.848)	7045.424(8050.628 to 6134.823)	121312923.071(138244514.646 to 105958433.129)	8576.032(9747.606 to 7493.54)	0.767 (0.811 to 0.722)
Russian Federation	2338869.684(2934726.577 to 1849313.893)	1314.367(1634.638 to 1048.178)	3736402.698(4693367.803 to 2993945.838)	1880.418(2307.414 to 1530.974)	1.473 (1.816 to 1.13)
Indonesia	6425689.032(7508274.962 to 5505059.086)	4542.415(5276.059 to 3919.534)	16476315.668(19018102.972 to 14239972.99)	5517.045(6332.613 to 4794.282)	0.629 (0.648 to 0.61)
Mexico	4685765.13(5443103.085 to 4011003.609)	7866.822(8944.217 to 6795.621)	11883135.743(13439600.002 to 10414619.649)	8730.795(9839.455 to 7673.197)	0.124 (0.229 to 0.02)
Brazil	9446752.208(10885487.394 to 8238105.9)	7944.537(9028.702 to 6952.655)	18541815.09(21344227.983 to 15964034.563)	7320.187(8396.965 to 6328.003)	−0.531 (−0.374 to −0.687)
Argentina	2952042.243(3373137.18 to 2552371.011)	9173.286(10,504.382 to 7926.239)	5360964.857(6102803.632 to 4678362.395)	10475.239(11899.54 to 9132.908)	0.541 (0.579 to 0.504)
Turkey	1824952.36(2124211.455 to 1542629.958)	4047.139(4714.676 to 3440.85)	5206365.622(5990779.1 to 4490091.336)	5422.211(6231.827 to 4683.09)	0.967 (0.989 to 0.945)
Saudi Arabia	306942.231(389618.905 to 240786.335)	2666.034(3335.05 to 2064.138)	1755853.434(2177334.966 to 1394390.6)	3893.525(4695.808 to 3126.092)	1.166 (1.248 to 1.083)
South Africa	901478.362(1086661.484 to 748337.493)	3346.29(3994.316 to 2787.715)	2353466.654(2738275.155 to 2011570.621)	4243.178(4918.342 to 3666.838)	0.848 (0.884 to 0.812)

Table 2 Changes in the YLDs of other musculoskeletal diseases in the G20 and different SDI regions from 1990 to 2021

Location	Number_1990 (95% UI)	ASR (95%UI)	Number_2021 (95% UI)	ASR (95%UI)	EAPC (95% CI)
Global	18979064.074(26393681.851 to 13024021.083)	403.132(558.092 to 278.312)	42988181.629(59205437.922 to 29647810.878)	507.207(698.138 to 349.557)	0.783 (0.815 to 0.752)
G20	14670970.648(20345292.715 to 10075589.748)	419.831(581.25 to 289.759)	31603075.742(43362747.021 to 21815175.108)	543.037(746.603 to 374.932)	0.873 (0.909 to 0.837)
High SDI	4634684.843(6451723.193 to 3198276.257)	466.088(646.108 to 321.881)	8652511.992(11754750.019 to 6008056.58)	625.924(855.734 to 436.01)	0.916 (0.99 to 0.842)
High-middle SDI	3006157.049(4242082.283 to 2036072.891)	277.433(390.334 to 188.478)	6419265.149(8982969.526 to 4360968.005)	381.965(533.397 to 262.227)	1.111 (1.144 to 1.078)
Middle SDI	5881079.76(8224956.77 to 4060772.292)	417.822(578.24 to 289.227)	14118802.247(19577432.973 to 9728486.956)	508.775(703.489 to 349.919)	0.672 (0.711 to 0.633)
Low-middle SDI	4268838.709(5933014.826 to 2973818.249)	504.656(691.594 to 350.381)	10592031.711(14548325.201 to 7302034.385)	599.646(821.876 to 413.603)	0.635 (0.66 to 0.61)
Low SDI	1177035.496(1652796.241 to 812044.632)	365.432(503.269 to 251.038)	3182811.329(4443064.392 to 2182566.263)	419.333(579.396 to 287.625)	0.543 (0.583 to 0.503)
United States of America	1772885.798(2420387.823 to 1231921.162)	635.817(872.501 to 443.699)	3749406.804(5023705.379 to 2670484.757)	936.545(1251.219 to 666.623)	1.091 (1.249 to 0.934)
United Kingdom	242852.172(343769.734 to 164268.787)	354.506(497.776 to 238.104)	335899.825(474954.919 to 225,159.527)	394.899(554.708 to 267.401)	0.352 (0.394 to 0.309)
Canada	258451.767(354894.529 to 178138.051)	846.988(1159.049 to 582.149)	447384.688(613364.723 to 308174.579)	960.517(1313.961 to 666.075)	0.404 (0.418 to 0.391)
European Union	1249605.07(1795565.423 to 835393.077)	255.441(366.006 to 169.482)	1837738.405(2634503.652 to 1239842.82)	323.568(455.034 to 218.068)	0.811 (0.834 to 0.789)
Australia	104109.084(141603.797 to 70620.051)	556.59(752.842 to 377.739)	215497.688(301,168.167 to 149628.399)	659.217(914.143 to 457.711)	0.477 (0.587 to 0.367)
Germany	326283.743(469010.225 to 214392.423)	333.565(473.434 to 220.71)	413862.984(592373.274 to 271225.402)	382.304(541.008 to 256.846)	0.525 (0.564 to 0.486)
France	168290.142(248394.842 to 109590.763)	263.909(388.776 to 172.815)	252,725.676(373201.724 to 163812.061)	331.329(477.382 to 222.852)	0.738 (0.765 to 0.71)
Italy	203725.816(293184.239 to 134724.611)	299.008(428.789 to 196.269)	319102.637(456320.41 to 212047.858)	395.018(561.502 to 266.6)	0.974 (1.032 to 0.916)
China	3485723.261(4916031.311 to 2375212.486)	322.83(454.751 to 218.905)	7328080.495(10305035.1 to 4930443.948)	389.042(544.881 to 264.238)	0.676 (0.746 to 0.607)
Japan	920778.571(1276423.014 to 622018.011)	599.665(835.394 to 411.665)	1357567.884(1862682.573 to 933657.795)	721.631(995.792 to 497.38)	0.693 (0.729 to 0.657)
Republic of Korea	197949.702(282931.386 to 133481.135)	450.097(634.945 to 301.35)	468738.771(653517.714 to 321693.964)	661.753(924.885 to 458.652)	1.438 (1.544 to 1.331)
India	3965477.169(5469127.983 to 2765659.193)	593.813(815.097 to 413.709)	10304235.187(14126271.717 to 7123541.85)	725.169(994.033 to 500.897)	0.79 (0.838 to 0.741)
Russian Federation	195247.318(286502.596 to 127046.148)	110.012(159.295 to 72.512)	311121.361(449992.417 to 206495.146)	158.403(229.528 to 105.513)	1.508 (1.855 to 1.162)
Indonesia	558631.147(792023.485 to 381350.454)	390.598(544.802 to 269.661)	1428481.793(1983229.933 to 982586.749)	475.684(659.232 to 329.131)	0.645 (0.663 to 0.626)
Mexico	402360.946(561017.049 to 279836.301)	667.98(925.189 to 461.978)	1009498.245(1383227.934 to 695729.405)	740.243(1012.591 to 510.882)	0.115 (0.222 to 0.008)
Brazil	804026.647(1112932.405 to 565736.951)	670.264(922.279 to 470.065)	1561126.681(2157882.877 to 1075183.359)	616.59(854.998 to 424.516)	−0.528 (−0.374 to −0.681)
Argentina	252712.372(350319.789 to 174938.04)	785.267(1089.023 to 545.035)	456327.185(626091.94 to 320180.756)	894.497(1227.599 to 630.589)	0.542 (0.579 to 0.504)
Turkey	156907.005(218657.442 to 106370.212)	345.245(480.781 to 232.765)	443969.76(618908.503 to 308518.298)	462.72(643.543 to 322.54)	0.968 (0.991 to 0.944)
Saudi Arabia	26604.476(39002.536 to 17158.554)	228.282(336.678 to 148.952)	151468.856(224923.3 to 100407.476)	332.425(476.558 to 223.673)	1.158 (1.243 to 1.073)
South Africa	76648.145(108689.673 to 52926.056)	281.252(397.193 to 192.967)	196532.112(275371.194 to 135852.917)	351.728(488.416 to 244.877)	0.804 (0.843 to 0.766)

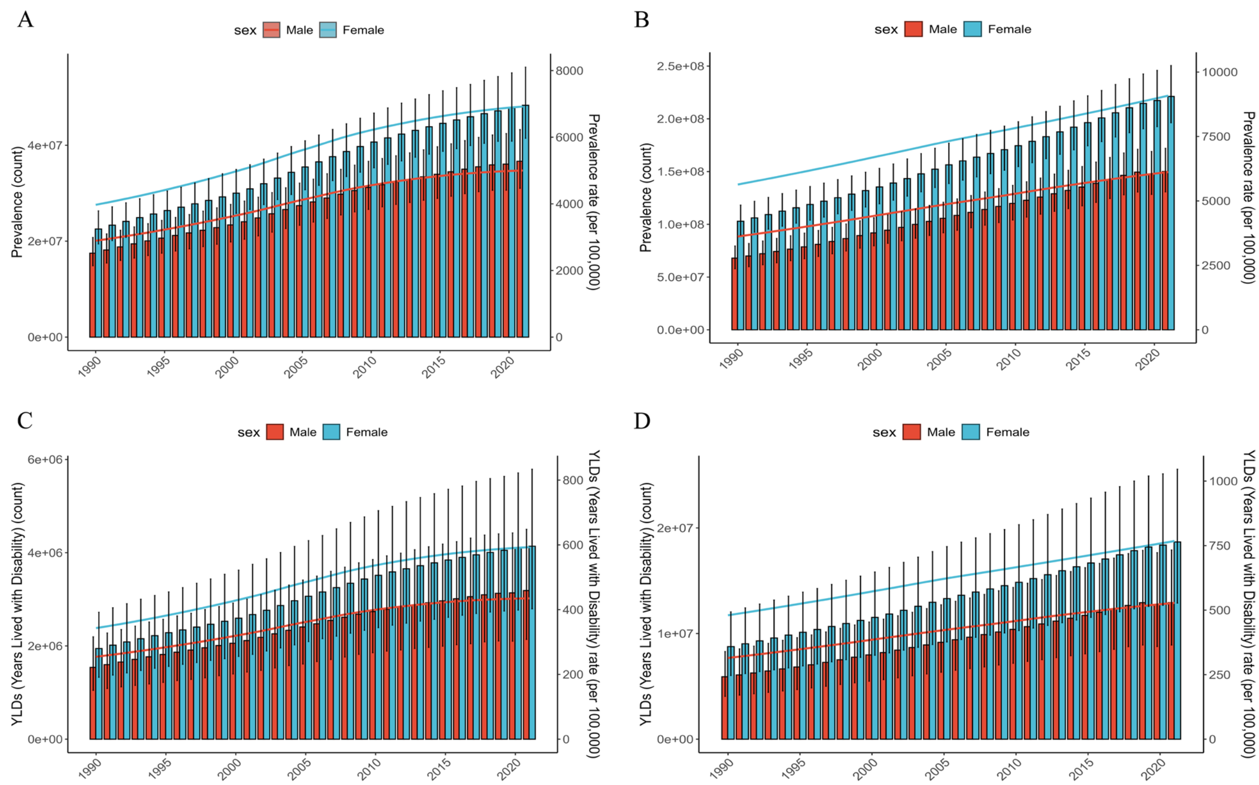

Fig. 2 The number of prevalence cases, prevalence rate, number of YLDs(Years Lived with Disability) cases, and YLDs rate of other musculoskeletal diseases in China and the G20 from 1990 to 2021. **A** and **C** represent the disease burden trends in China; **B** and **D** represent the burden trends in the G20

YLDs rate first increased and then decreased. Taking 2021 as an example, the prevalence rate in the population under 20 years old was only 177.92 cases per 100,000 people (95% UI: 108.37—260.35). After the age of 20, the prevalence rate increased significantly. The prevalence rate in the 20—24 age group rose to 1,991.34 cases per 100,000 people (95% UI: 1,472.95—2,543.98), and reached the highest in the 65—69 age group (10,853.85 cases per 100,000 people, 95% UI: 7,321.82—15,608.15). Thereafter, the prevalence rate gradually decreased with the increase of age. In addition, compared with 1990, the prevalence rate of OMSDs in the population over 80 years old in China decreased in 2021, while under 80 years old increased.

As shown in Fig. 3C, D and Appendix 5, in all age groups of both China and the G20 countries, the number of female patients is higher than that of male patients. In China, the largest number of female patients was in the 55—59 age group, with 6,298,653cases (95% UI: 8,216,363—4,609,363). The largest number of male patients was in the 50—54 age group, with 4,685,909 cases (95% UI: 6,492,662—3,198,962). Among the G20 countries, the largest number of male and female patients was in the 50—54 age group, with 15,686,095 cases (95% UI: 21,027,106—11,082,134) and 23,569,887 cases (95% UI: 30,449,014—17,472,202) respectively. In both China and the G20, the prevalence rate of male patients was lower than that of female patients in the population under 85 years old. However, in the population over 85 years old, the prevalence rate of male patients was higher than that of female patients.

Results of joinpoint regression analysis

The joinpoint regression analysis indicates that from 1990 to 2021, the overall trends of the ASPR and ASYR of OMSDs in both China and the G20 countries showed an upward trend (see Fig. 4 and Appendix 6). From 2000 to 2005 and from 2005 to 2009, the ASPR in China increased relatively rapidly, with the APC being 1.5% (95% CI: 1.4—1.6) and 0.9% (95% CI: 0.7—1.0) respectively. From 2009 to 2021, it tended to be stable (APC = 0.1%, 95% CI: 0.1—0.1). The changing trend of the ASYR was also similar to that of the ASPR (Fig. 4A, B). In China, the AAPC of both the ASPR and the ASYR was 0.6. In the G20 countries, the AAPC was 0.8, indicating that the growth of the disease burden in China was lower than the average level of the G20. From 1990 to 2005 and from 2011 to 2019, the ASPR in the G20 countries maintained a relatively rapid

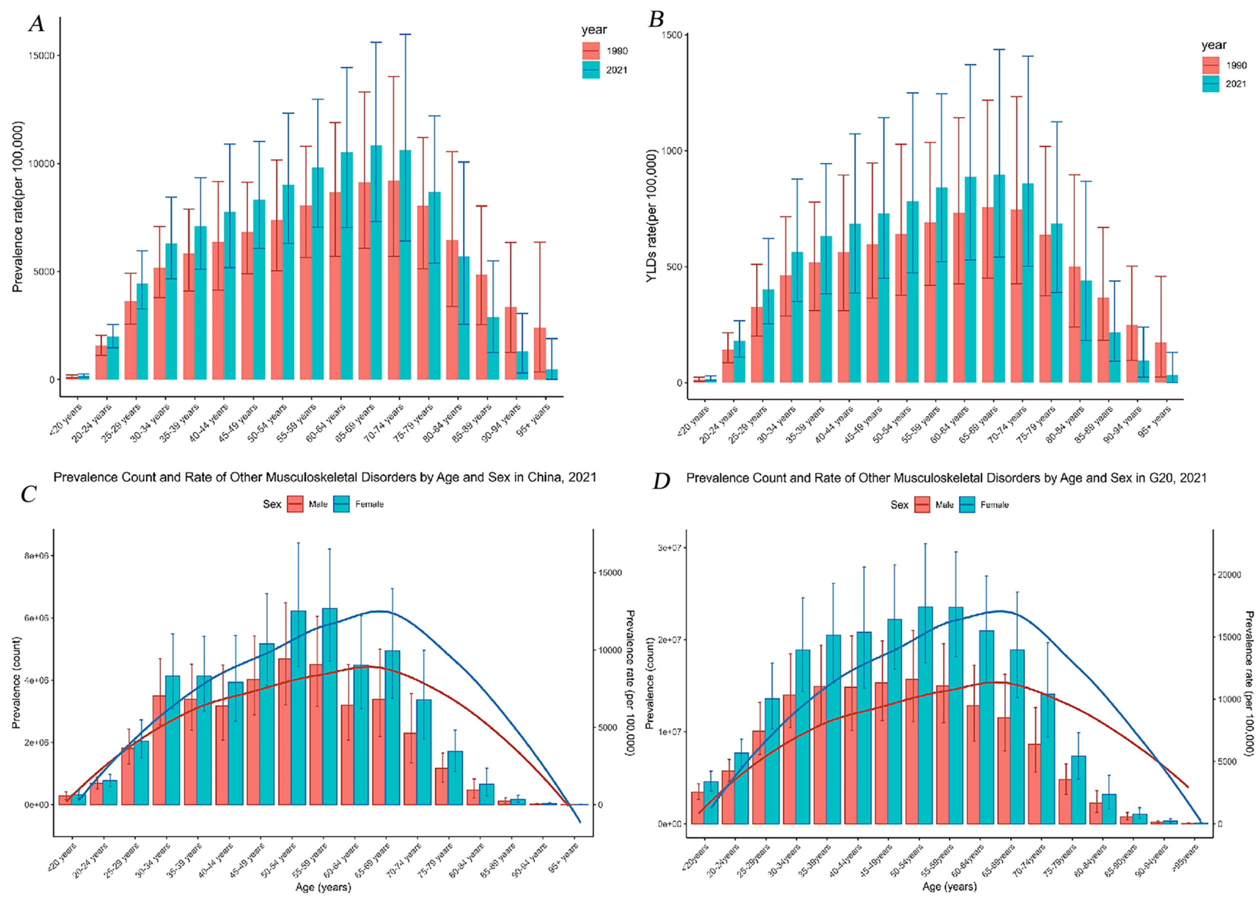

Fig. 3 **A** and **B** Age distribution of the prevalence and YLDs(Years Lived with Disability) rates of other musculoskeletal disorders in China in 1990 and 2021; (**C**) and (**D**) Age and sex distribution of the number of people affected and prevalence rates of other musculoskeletal disorders in China and the G20 countries group in 2021

growth trend, with the APC being 1.1% (95% CI: 1.0—1.1) and 0.9% (95% CI: 0.8—0.9) respectively. After that, from 2019 to 2021, it showed a downward trend (APC = −0.3%, 95% CI: −0.7—0.1). It is worth noting that from 2019 to 2021, the ASPR and ASYR of females in the G20 countries showed a slight upward trend, while those of males showed a significant downward trend (Fig. 4C, D).

Age—period—cohort analysis

As age increases, the prevalence and YLDs rate generally show a trend of first increasing and then decreasing (Fig. 5A, B). Before the age of 20, the upward trend of prevalence and YLDs rate is relatively gentle; there is a rapid increase from 20 to 35 years old; thereafter, it gradually increases with age and reaches its peak in the 65—69 age group. The periodical changes in the prevalence and YLDs rate of OMSDs show a trend of first increasing and then decreasing in people over 80 years old, and the trends of patients in other age groups are relatively stable (Fig. 5C, D). The results of the birth cohorts in each age group show that for patients in the age group of over 80 years old, both the prevalence rate and the YLDs rate first increase and then decrease with the changes in the birth cohort. However, starting from the age group of 75–79 years old, this trend tends to be balanced (Fig. 5E, F).

Influence of age, period, and cohort on prevalence and YLDs rate

After controlling for period and cohort factors, age is associated with prevalence rate. The risk shows a trend of first increasing and then decreasing with age (see Fig. 6 and Appendix 7). Taking the 1—4 age group as a reference, the RR values of both males and females reach their peaks at 60—64 years old, which are (RR age(60—64) = 3.41, 95% CI: 3.41—3.42) and (RR age(60—64) = 3.82, 95%CI: 3.82—3.83), respectively. During 1990—2021, the period effects in different gender groups showed an upward trend. The cohort effects of prevalence rate in different gender groups all showed a downward trend. In

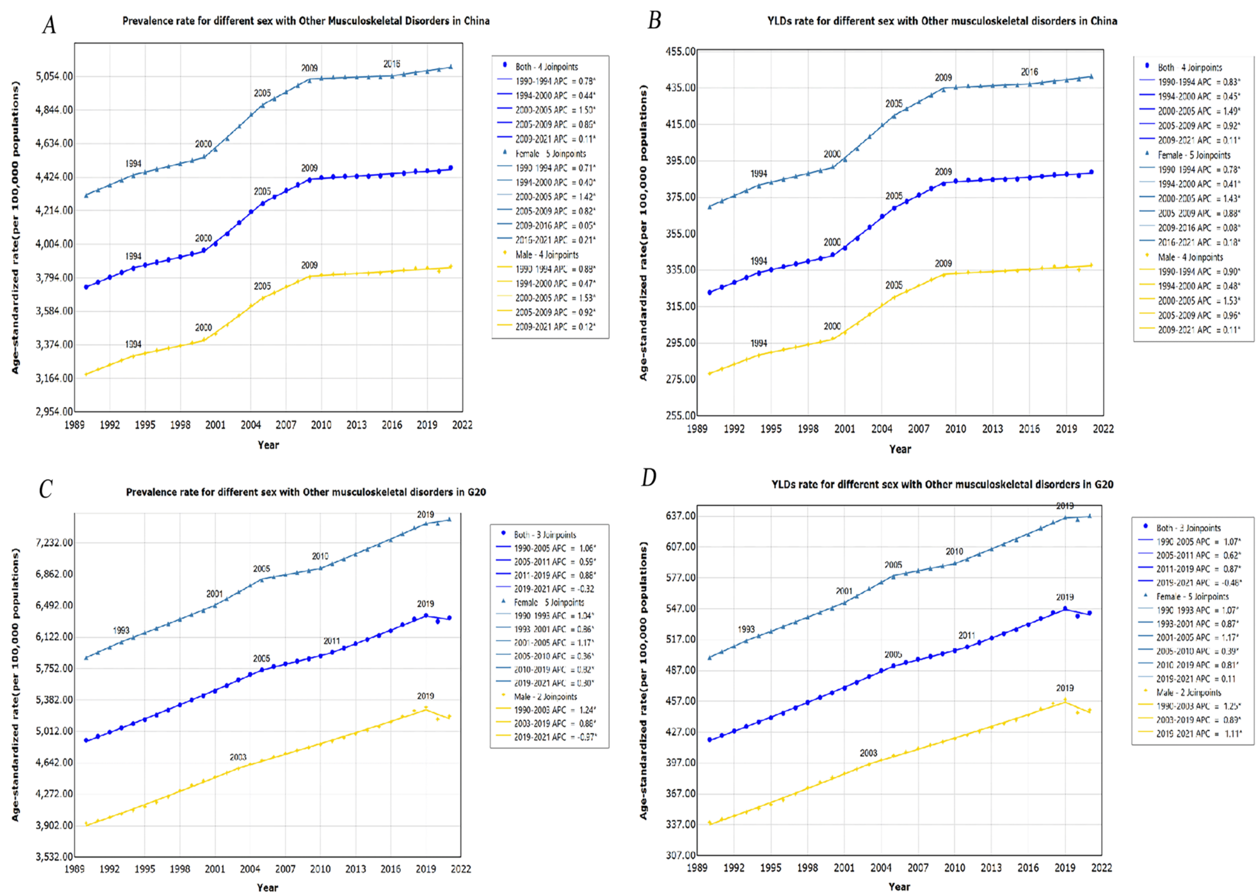

Fig. 4 Joinpoint regression analysis of trends in age—standardized prevalence rate (ASPR) and age—standardized years lived with disability rate (ASYR) of other musculoskeletal diseases in China and the G20 from 1990 to 2021. **A** and **B** Joinpoint analysis of ASPR and ASYR for males and females in China; (**C**) and (**D**) Joinpoint analysis of ASPR and ASYR for males and females in the G20

the whole population, the RR of premature birth cohorts is relatively large (RR cohort(1895—1899) =4.21, 95%CI: 4.00—4.43), and the risk of recent birth cohorts continues to decline (RR cohort(2020—2024) =0.11, 95%CI: 0.10—0.11). The changing trends of age, period, and cohort effects of YLDs rate are similar to those of prevalence rate (see Fig. 7 and Appendix 8). In the whole population, the risk first gradually increases with age to the highest in the 30—34 age group (RR age(30—34) =39.13, 95%CI: 4.38E—07—3493325553.09), and then gradually decreases with age. The period effect risk of YLDs rate is relatively stable overall, and the cohort effect shows a significant downward trend.

Predicted trends in prevalence of OMSDs in China from 2022 to 2041

In the prevalence prediction, for both, males, and females, the ARIMA(0, 2, 1), ARIMA(0, 2, 0), and ARIMA(2, 2, 0) models were selected respectively, with the corresponding AIC values being 215.66, 237.96, and 185.39. The Q—Q plot, ACF and PACF plots indicated that the residuals were normally distributed (Appendix 9). The Ljung—Box test confirmed that the residuals of the ARIMA model had no autocorrelation and were white noise (chi—square values were 0.20/0.003/1.07 respectively, and *P*—values were 0.653/0.954/0.302 respectively). According to the prediction, the number of patients with other musculoskeletal diseases and the ASPR in China will show a slow growth trend. The number of male patients is estimated to increase from 36,674,776 cases (95% UI: 43,272,412—31,031,050) in 2021 to 49,047,493 cases (95% UI: 50,916,577—47,178,409) in 2041, an increase of 33.7%. The number of female patients is expected to reach 63,871,994 cases (95% UI: 66,399,995—61,343,994) in 2041 (see Fig. 8A, B, C and Appendix 10). When predicting the YLDs, for both, males, and females, the ARIMA(0, 2, 1), ARIMA(0, 2, 0), and ARIMA(3, 2, 0) models were

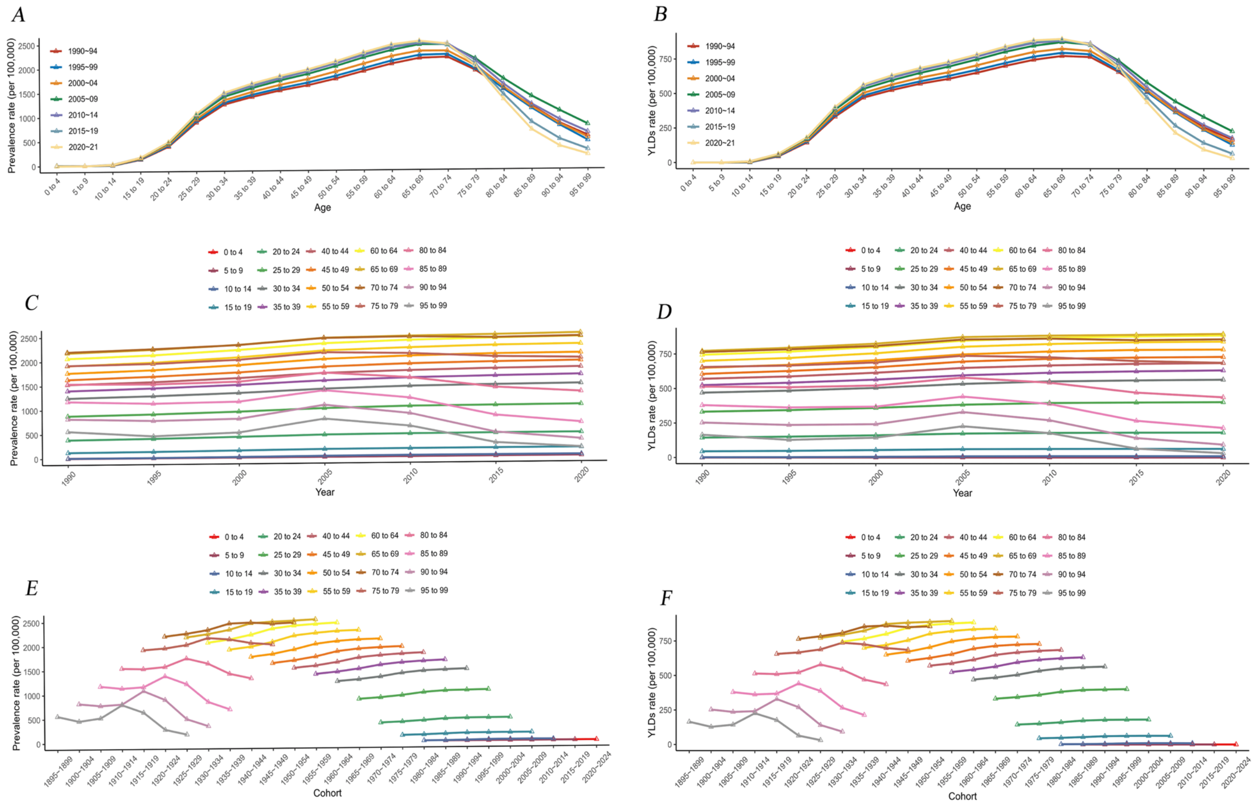

Fig. 5 Long–term trends of age–specific, period–based, and cohort–based variation of other musculoskeletal diseases prevalence rate and YLDs rate in China during 1990–2021. **A**, **B** Age–specific prevalence rate and YLDs rate. **C**, **D** Period–based prevalence rate and YLDs rate. **E**, **F** Cohort–based prevalence rate and YLDs rate

selected respectively, with AIC values of 69.80, 91.37, and 39.43. The Ljung—Box test confirmed that the residuals were white noise (chi—square values were 1.05e—05/0.011/0.014 respectively, and P values were 0.997/0.915/0.907 respectively). According to the prediction, the YLDs and ASYR of OMSDs in China will also experience a slow growth in the next 20 years. The number of YLDs for males will increase from 3,188,423 (95% UI: 4,500,750—2,139,570) in 2021 to 4,175,882 (95% UI: 4,819,619—3,532,145) in 2041, an increase of 31.0%. By 2041, the female YLDs will increase from 4,139,658 (95% UI: 5,789,940—2,796,605) in 2021 to 5,430,590 (95% UI: 5,692,094—5,169,087), an increase of 31.2% (see Fig. 8D, E, F and Appendix 10).

Discussion

This study thoroughly analyzed the temporal trends of the prevalence and YLDs rate of OMSDs in China from 1990 to 2021. It was found that over the past 31 years, both the prevalence and YLDs rate generally showed an upward trend. In 2021, the number of patients in China reached 85,026,742 cases (95% UI: 99,420,159—72,381,412), and the number of cases with YLDs was 7,328,080 cases (95% UI: 10,305,035—4,930,444). The ASPR for males was 3,866.9 cases per 100,000 people (95% UI: 4,525.55—3,298.38), and for females it was 5,118.9 cases per 100,000 people (95% UI: 5,907.47—4,419.79).

Overall, both ASPR and ASYR of OMSDs in China are lower than those of the G20 countries. When compared with other G20 countries, China ranks eighth from the bottom in terms of the ASPR and ASYR of OMSDs, being higher than Russia, Saudi Arabia, France, the European Union, South Africa, Italy and Germany. Among them, Germany has the smallest gap with China (ASPR is 4,439.3 cases per 100,000 people (95% UI: 5,241.61—3,700.28); ASYR is 382.3 cases per 100,000 people (95% UI: 541.01—256.85)). There are differences in the disease burden among regions with different SDI levels. The high SDI region has the heaviest disease burden (ASPR is 7,310.3 cases per 100,000 people (95% UI: 8,058.08—6,637.76); ASYR is 625.9 cases per 100,000 people (95% UI: 855.73—436.01)), followed by the low—middle SDI region, the middle SDI region, and the low SDI region. The high—middle SDI region has the lowest disease burden (ASPR is 4,430.9 cases per 100,000 people (95% UI: 5,135.73—3,815.65); ASYR is 382 cases per 100,000

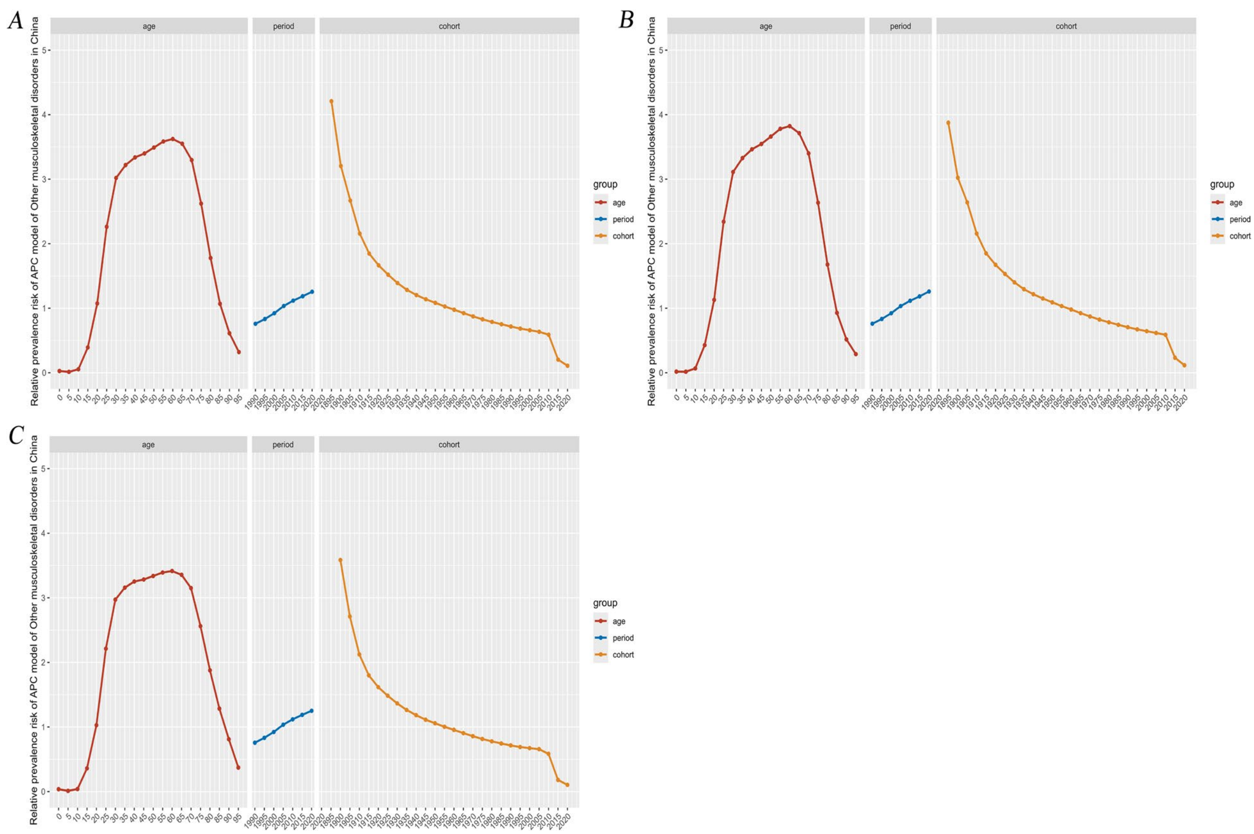

Fig. 6 Relative prevalence risk of age—period—cohort model of Other musculoskeletal diseases in China. **A** Both sex; **B** Female; **C** Male

people (95% UI: 533.40—262.23)), and China's disease burden situation is the closest to that of the high—middle SDI region.

Previous studies have identified that the risk factors for musculoskeletal diseases mainly include physical factors (such as high body mass index, repetitive movements, awkward postures, heavy physical labor, and lack of physical activity), psychosocial factors (such as high work pressure, low work control, and low social support), and individual factors (such as age, gender, and smoking) [21–24]. High—SDI countries like Canada, the United Kingdom, the United States, Japan, and South Korea have the heaviest disease burden, which may be related to their aging population, high obesity rates, and psychosocial factors [25]. It has been reported that more than a quarter of Canadian adults suffer from obesity [26], the adult obesity prevalence in the United States is 42.8% [27], 59% of women and 67% of men in the United Kingdom are overweight or obese [28]. Moreover, Japan and South Korea have entered a super—aging society. On the other hand, countries such as Russia, Saudi Arabia, France, the European Union, South Africa, Italy, and Germany have a relatively lower disease burden, which may benefit from a relatively sound healthcare and labor management system, a relatively young population structure, a relatively low occupational exposure risk, less intense physical labor, and a healthier lifestyle.

The prevalence rate of OMSDs among females is higher than that among males. This phenomenon may be related to gender—specific physiological and social factors. Furthermore, as age increases, the prevalence rate shows a trend of first increasing and then decreasing, peaking in the 60—69 age group. This result is similar to the conclusion of a global study on OMSDs in 2023 [4]. It may be associated with physiological degeneration, cumulative injuries, as well as occupational and lifestyle factors in this age group. Compared with 1990, the prevalence rate of OMSDs among the elderly over 80 years old in China decreased in 2021. This may reflect the positive impacts brought about by the improvement of healthcare levels and the enhancement of health awareness. On the other hand, the life expectancy of the Chinese population has increased significantly in the past 30 years, which may also contribute to the relatively lower prevalence rate in the elderly [29]. However, in other age groups, the prevalence rate generally increased, which may be related to population aging, changes in lifestyle, and reduced physical activity. This finding emphasizes the importance of

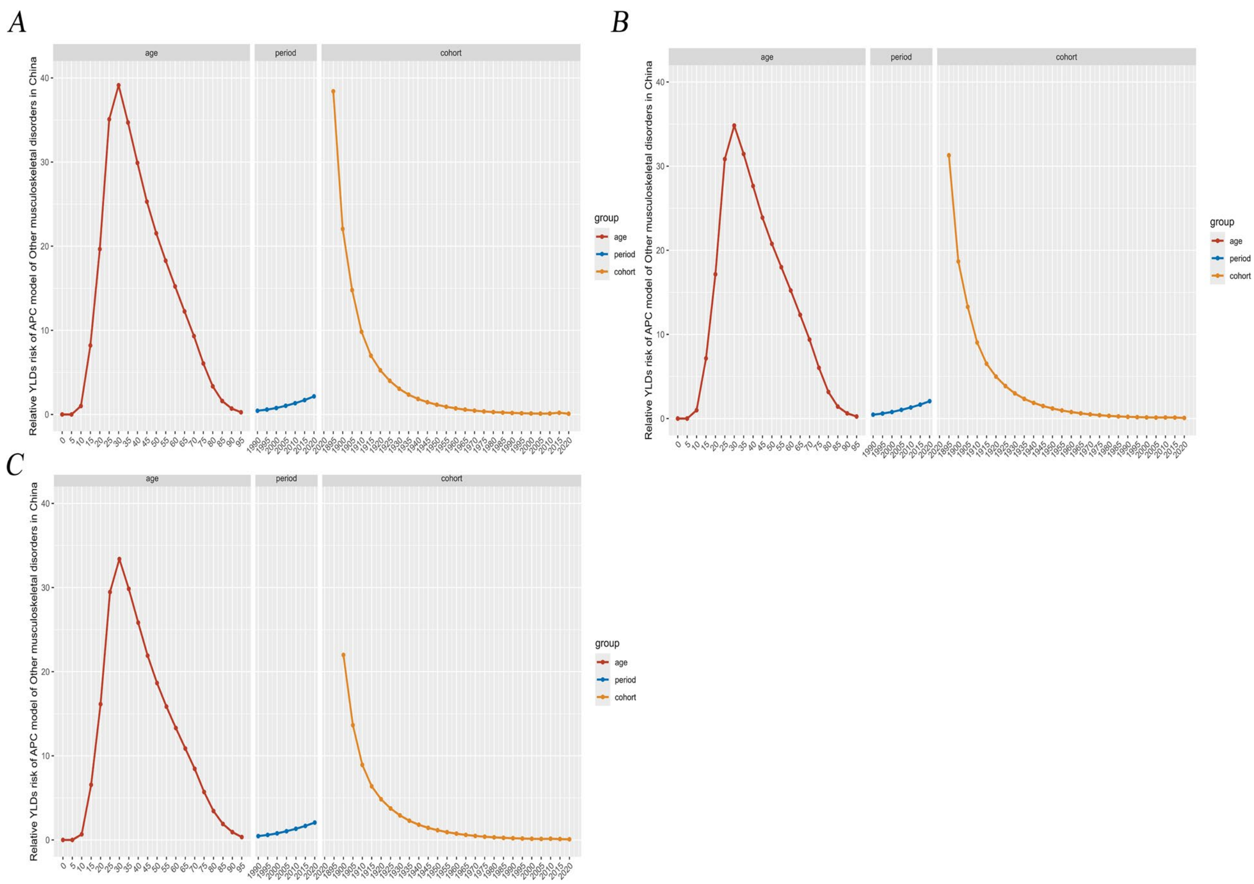

Fig. 7 Relative YLDs risk of age—period—cohort model of Other musculoskeletal diseases in China. **A** Both sex; **B** Female; **C** Male

adopting specific health—promotion and disease—prevention strategies for different age groups and genders. In particular, for the high—risk age group of 60—69 years old, more attention and intervention measures are needed to alleviate the burden of OMSDs. In addition, for the elderly over 80 years old, although the prevalence rate is relatively low, continuous monitoring and the provision of appropriate medical services are still necessary to maintain and improve their quality of life.

The joinpoint regression analysis shows that from 1990 to 2021, the ASPR and ASYR in China generally showed an upward trend, but the growth rates varied in different periods. There was a significant increase from 2000 to 2005, and the growth rate tended to level off from 2009 to 2021. This may be caused by multiple factors. On the one hand, with the rapid development of China's economy, people's lifestyles have undergone tremendous changes. Reduced physical activity, increased sedentary time, and poor dietary habits may increase the risk of getting sick. A number of studies have shown that behaviors such as prolonged sitting and long-term computer use are closely related to musculoskeletal diseases [30–32]. On the other hand, the process of population aging has accelerated, and the number of elderly people has increased. Elderly people are more prone to such diseases. The significant increase from 2000 to 2005 may be related to the rapid socio-economic changes, the acceleration of the urbanization process, and the drastic changes in people's lifestyles during this period. The growth rate tended to be flat from 2009 to 2021, which may be due to the improvement of people's health awareness, the progress of medical technology, and the government's attention to public health, and some prevention and control measures have been taken, thereby slowing down the disease growth rate.

Compared with China, the ASPR and ASYR of G20 grow faster, and the annual average change rate is also greater. It is worth noting that in the G20, there was a significant downward trend in males from 2019 to 2021, while females still maintained growth. The higher prevalence rate in the G20 may be due to the higher economic development level of these countries, more diversified lifestyles, and also facing problems such as population aging. Sebbag [33] found that there is a strong correlation

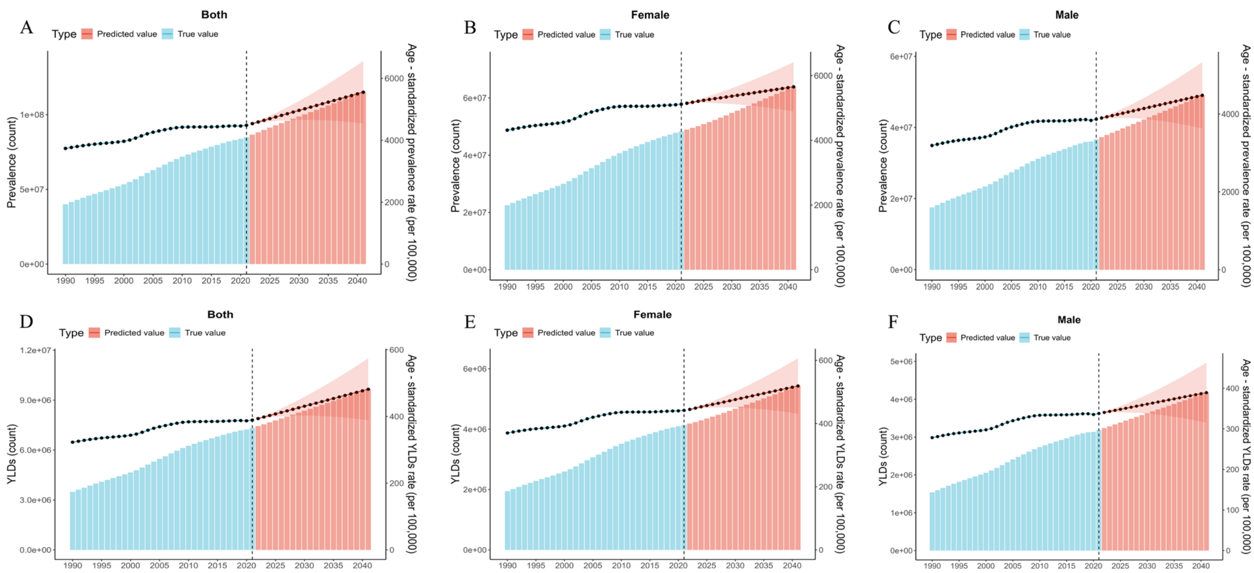

Fig. 8 Trends and predictions of the burden of other musculoskeletal diseases in China from 1990—2041. The blue part represents the actual values, the red part represents the predicted values, and the light red part represents the confidence interval. The black vertical dotted line divides the data into actual values (1990—2021) and predicted values (2022—2041). **A**, **B**, **C** represent the predicted trends of the number of prevalence and age—standardized prevalence rate(ASPR) for all genders, males, and females respectively; **D**, **E**, **F** represent the predicted trends of the number of YLDs cases and age—standardized YLDs rate (ASYR) for all genders, males, and females respectively

between the burden of musculoskeletal diseases and per capita GDP, and the burden of diseases in high—income countries is heavier. Safiri [34] also found some significant differences between countries. The burden of diseases is higher in elderly female populations in developed countries. The change in prevalence rate of the G20 from 2019 to 2021 may be affected by the COVID—19 pandemic. The remote office model has been widely used during the pandemic. Studies have found that inappropriate ergonomics, sedentary behavior, and psychosocial and organizational factors during remote office work will increase the risk of musculoskeletal diseases [35–37].

The age-period-cohort analysis revealed that, with increasing age, the ASPR and ASYR generally follow a pattern of initial increase followed by a subsequent decline. It is relatively flat before the age of 20, grows rapidly from 20 to 35 years old, and gradually decreases with age after reaching the peak in the 65—69 age group. Unhealthy lifestyles in youth, such as lack of exercise and overwork, may lead to a cumulative effect, resulting in a rapid increase in prevalence rate after the age of 20—35. As people age, the musculoskeletal system of the human body will gradually degenerate, and problems such as joint cartilage wear and bone loss will increase, leading to an increased risk of disease. Reaching the peak at the age of 65—69 may be because at this time, the body's various functions decline more obviously, and multiple musculoskeletal diseases accumulate and attack. The decrease after the age of 80 may be because some high—risk people have passed away, and the proportion of people with relatively mild conditions in the surviving population increases. This study also found that the disease risk of the whole population gradually increases with time, while the cohort effect gradually decreases. The increase in disease risk with the period effect may be related to social and economic development. As time goes by, the social economy continues to develop, and people's lifestyles and working environments change. For example, sedentary office work and reduced physical labor may increase the risk of musculoskeletal diseases [30–32]. In addition, the progress of medical technology and people's increasing attention to health also make more mild symptoms diagnosed, resulting in an upward trend in prevalence rate statistically. A series of factors such as improved living conditions, improved healthcare levels, and enhanced health awareness make the prevalence rate of later—born cohorts lower.

The prediction results indicate that in the next 20 years, the ASPR and ASYR of OMSDs in China will continue to increase, and the number of patients and those with YLDs will also rise further. The ASPR for males is expected to increase from 3,867 cases per 100,000 people (95% UI: 4,525.55—3,298.38) in 2021 to 4,480 cases per 100,000 people (95% UI: 5,329.79—3,630.18) in 2041, representing an increase of 15.9%. For females, it will rise from 5,119 cases per 100,000 people (95% UI: 5,907.47—4,419.79) to 5,654 cases per 100,000 people (95% UI: 6,414.36—4,894.23), showing an increase of 10.5%. Moreover, it is estimated that the number of patients in China will reach as high as 115,058,278 cases (95% UI: 119,463,455—110,653,100) by 2041.

The continuous growth trend of ASPR and ASYR suggests that China will face greater public—health challenges regarding OMSDs in the future. This will exert more pressure on the healthcare system, including increasing the demand for medical resources and improving the quality and accessibility of medical services. With the advancement of population aging and the decline in the neonatal birth rate, this situation may become even more severe. The government and society should draw on the experience of other G20 countries. Firstly, the healthcare system should be further improved. On one hand, disease screening and diagnosis, especially for the middle—aged and elderly population, should be strengthened. On the other hand, the accessibility and quality of medical and rehabilitation services need to be enhanced. Secondly, as the prevalence among people over 20 years old has increased significantly, health education and lifestyle interventions for this group are necessary to reduce risk factors such as obesity and lack of exercise. Occupational risks are also important causes of musculoskeletal diseases. Therefore, it is crucial to improve the labor management system, enhance the working environment, promote ergonomic intervention measures, and reduce the risk of occupational exposure. With the acceleration of population aging, it is particularly important to strengthen the development of geriatrics and rehabilitation medicine and improve the level of elderly health management.

Limitations

This study may have the following limitations. Firstly, the data of this study are derived from the GBD 2021. Given its diverse data sources, there may be biases in the data collection methods and definition criteria, which in turn affect the reliability of the research results. Secondly, the data may be mainly concentrated in specific regions or populations, lacking representativeness for some remote areas or specific subgroups, and thus failing to comprehensively reflect the overall prevalence of OMSDs in China. Thirdly, due to the unavailability of provincial-level data, this study was unable to describe the disease burden from a geographical perspective [38]. Fourthly, in the age-period-cohort analysis, due to limitations in data collection, it was impossible to adjust for potential confounding factors such as occupational exposure, accessibility of medical services, and changes in lifestyle. These factors may introduce biases in the period and cohort effects, thereby affecting the accuracy of the research results. In addition, the use of the indirect estimation method has limitations such as high data requirements, strict assumptions, and possible confounding of residuals, which may also affect the interpretability of the results. Fifthly, this study used the ARIMA model for prediction. Although this model performs well in short-term time series forecasting, it has certain limitations in long-term prediction. As the prediction time span lengthens, the uncertainty increases significantly, and it may not be able to adapt to sudden changes or new influencing factors in a timely manner. Sixthly, this study mainly focused on the impacts of factors such as age, gender, time, and period on the disease, but failed to fully consider potential unmeasured confounding factors, such as genetic susceptibility, environmental factors, psychological factors, and dietary factors, which may introduce certain biases in the research results. Seventhly, OMSDs are a broad category of diseases with high heterogeneity. Therefore, the overall disease burden may mask the severity of certain specific diseases. In addition, different diseases have diverse treatment methods, which may lead to a lack of pertinence in intervention measures. Moreover, heterogeneity may also introduce biases in the interpretation of research results.

Future research should focus on optimizing the comprehensiveness and standardization of data collection, integrating multi-dimensional variables (such as occupational exposure, medical accessibility, etc.) to control confounding biases; strengthening the coverage of remote areas and special groups, and deepening the refined analysis of disease subtypes; exploring interdisciplinary research methods, combining multiple factors such as genetics, environment, psychology, and diet to construct complex prediction models, and improving the accuracy of prevention and control strategies.

Conclusion

The prevalence and YLDs of OMSDs in China have been on a continuous upward trend, especially among women and the middle—aged and elderly population. Compared with other G20 countries, the burden of OMSDs in China is at a medium level. However, it is expected that the burden will further increase in the future. To address this challenge, it is necessary to advocate a healthy lifestyle, strengthen health education, and optimize healthcare strategies.

Abbreviations

OMSDs	Other musculoskeletal diseases
GBD	Global Burden of Disease
YLDs	Years lived with disability
AAPC	Average annual percentage change
APC	Annual percentage change
ARIMA	Autoregressive Integrated Moving Average
ASPR	Age—standardized prevalence rate
RR	Relative risk
ASYR	Age—standardized YLDs rate
DALYs	Disability—adjusted life years
SDI	Socio—demographic Index
YLLs	Years of Life Lost
EAPC	Estimated Annual Percentage Change
MASE	Mean absolute scaled error
K—S	Kolmogorov—Smirnov
ASR	Age—standardized rate
IE	Intrinsic estimator
CI	Confidence interval
AR	Autoregressive
MA	Moving average
ACF	Autocorrelation function
PACF	Partial autocorrelation function
AIC	Akaike Information Criterion
ME	Mean error
RMSE	Root mean square error
MAE	Mean absolute error
MPE	Mean percentage error
MAPE	Mean absolute percentage error
GSM	Grid search method

Supplementary Information

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Supplementary Material 1.

Supplementary Material 2.

Supplementary Material 3.

Supplementary Material 4.

Supplementary Material 5.

Supplementary Material 6.

Supplementary Material 7.

Supplementary Material 8.

Supplementary Material 9.

Supplementary Material 10.

Supplementary Material 11.

Supplementary Material 12.

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Authors' contributions
Meifeng Lu：Provided research ideas and methods, conducted detailed data analysis, and wrote the main part of the research draft. Guihao Zheng: collected and organized data and participated in writing the research draft. Xin Shen：Provided statistical support and participated in writing the research draft. Yulong Ouyang：Organized and analyzed data and participated in writing the research draft. Bei Hu：Translation of research draft and participated in writing the research draft. Shuilin Chen: Responsible for software related work, demonstrating data visualization and participating in the writing of research drafts. Guicai Sun：Managed the project and thoroughly reviewed and edited the research draft. All authors reviewed the manuscript.

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Data availability
Data is provided within the manuscript or supplementary information files.

Declarations

Ethics approval and consent to participate
The data from the GBD study used in this research is publicly available, hence no ethical approval was needed for this study. Data access and usage are in accordance with the guidelines and terms of use of the GBD study.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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