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Magnitude, temporal trend and inequality in burden of neck pain: an analysis of the Global Burden of Disease Study 2019

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Abstract

Background This study aimed to comprehensively assess the magnitude, temporal trends, and inequalities associated with socioeconomic development in neck pain (NP) based on the Global Burden of Disease Study 2019.

Methods An assessment of incidence and years of life with disability (YLD) at the global, regional, and country levels by age, sex and year was conducted for NP. Joinpoint regression (JPR) was used to analyze trends between 1990 and 2019. Decomposition analysis was used to explore the extent to which population growth, aging, and epidemiological changes influenced the changes in incidence and YLD. A Bayesian Age-Period-Cohort (BAPC) model was constructed to predict trends over the next 25 years. Concentration curve and concentration index were used to examine the cross-country relative inequality of the burden of NP at the socio-demographic index (SDI) level.

Results In 2019, the global ASIR and ASDR of NP were 579.085 and 267.348 per 100,000 individuals, respectively. JPR analysis showed that the global ASIR and ASDR have decreased slightly over the past 30 years, although an increase was observed between 2011 and 2019. The BAPC model predicted that this upward trend would continue over the next 25 years. Decomposition analysis showed that the global increase in incidence and YLD in 2019 compared to 1990 was mainly driven by population growth. The burden of NP was higher in the middle-aged, old-age, and female groups, with differences in regional distribution. The analysis of cross-country inequality showed that the burden of NP was disproportionately concentrated in countries with a high SDI, and this phenomenon continued to increase over the 30-year study period.

Conclusions Globally, NP remains an important public health problem, and governments are urgently required to raise public awareness about NP and its risk factors, implement targeted prevention and control policies, and deliver the necessary health services.

Keywords Neck pain, Burden, Trend, Prediction, Inequality

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Introduction

Neck pain (NP) is the second most common type of musculoskeletal disorder after low back pain and is a major global public health problem affecting people of all ages [1]. As one of the leading causes of disability in adults, NP significantly affects years of life with disability (YLD). The Global Burden of Disease (GBD) study found that in 2010, NP was the fourth leading cause of YLD among

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291 diseases; in 2017, it ranked ninth out of 354 diseases causing YLD [2, 3].

NP causes physical and mental discomfort to patients and their families due to pain and disability and also seriously affects the quality of life, learning, and work efficiency. It also places a heavy burden on society, directly or indirectly, through costs related to healthcare, insurance, absenteeism, and lost productivity, affecting the health systems and economic fabric of countries [1, 4–10]. However, in the past, governments and funders have paid considerable attention to fatal chronic diseases such as cancer, cardiovascular disease, and respiratory disease, with little focus on chronic non-fatal diseases such as NP, which are highly prevalent [2].

In recent decades, changes in work and living habits as a result of rapid technological and economic development have resulted in more sedentary occupations, increased use of smartphones, and decreased time for physical exercise and outdoor activities [11]. Furthermore, factors such as the rapid growth of the global population, increase in average life expectancy, and improvements in the diagnosis and treatment of NP may impact the epidemiological characteristics and disease burden [12]. When making management recommendations, it is important that policymakers have accurate and up-to-date epidemiological information on the burden of NP and knowledge of the different categories of risk factors [13].

The GBD is a global collaborative research project established by the Institute for Health Metrics and Evaluation (IHME) at the University of Washington, United States. It is an internationally recognized system for assessing disease burden that provides comprehensive, reliable, and comparable data on population health globally [14]. This study aimed to use publicly available modeling data from the GBD 2019 study to systematically assess the incidence and YLD of NP at global, regional, and country levels by age, sex and year. It was expected to provide reference for clinicians, researchers and policymakers to understand the burden of NP across different regions at different stages of development, evaluate the effect of public health policies and interventions, carry out etiological studies, formulate targeted prevention and control strategies, and conduct health care planning and resource allocation.

Methods

Data sources

The GBD is the largest global observational epidemiological study conducted to date and is an important global tool for measuring preventable loss of life, with a dataset of more than 100,000 sources, including relevant population registration documents, autopsy data, mortality health test data, population survey data, and data provided by medical institutions in various regions of the world [15–17]. The GBD 2019 provides the world's most in-depth understanding of diseases, injuries, and risk factors [18]. Using the latest epidemiological data and standardized methods that have been improved by the IHME [14], it assesses age- and sex-specific mortality from 282 causes, prevalence and years of survival with disability for 369 diseases and injuries, and comparative risk for more than 80 risk factors in 204 countries and territories between January 1, 1990, and December 31, 2019 [18].

In the GBD 2019 study, NP is defined as NP (with or without pain referred into the upper limb[s]) that lasts for at least one day. (ICD-10 codes: M54.2, ICD-9 codes: 723.1) [1, 19] Detailed resource retrieval, inclusion and exclusion criteria, data processing procedures, and modeling methods for NP in the GBD 2019 are described on the IHME website (https://ghdx.healthdata.org/gbd-2019/code/nonfatal-8) and in previous GBD studies [19, 20].

The Global Health Data Exchange GBD Results Tool (https://vizhub.healthdata.org/gbd-results/) was used to extract estimates and 95% uncertainty intervals (UI) for the number, age-specific rates, age-standardized rates of incidence and YLD for NP by sex from 1990 to 2019 in different regions. GBD methodology does not attribute any increased mortality to NP in the current modeling, so the incidence and YLD of NP were only studied.

YLD is determined by multiplying the prevalence of a sequela by the disability weight (DW) for the corresponding health state. DWs represent the magnitude of health loss associated with NP and were obtained from surveys conducted in several countries from different regions [1, 21]. The methodology for calculating YLD has been described in previous studies. [1, 12, 19] Age standardization aims to eliminate the influence of the age composition of the population and ensure the comparability of the research indicators. The age standardization rate in the GBD database is estimated using the world population age standard [20]. The 95% UI is derived from 1000 extracts of the posterior distribution for each step in the estimate, considering the uncertainties in the estimate due to sampling, model estimates, and model specifications [12, 19].

Population estimates in this study were obtained from the United Nations official website of World Population Prospects 2022 (https://population.un.org/wpp/Download/Standard/CSV/). The standard population was derived from a study published in the Lancet [22]. The socio-demographic index (SDI) is a comprehensive index calculated using three indicators: per capita income, total fertility rate of women aged <25 years, and average years of schooling of adults aged ≥ 15 years, reflecting the socio-demographic development level of a region or country. The SDI ranges from 0 to 1, with higher values indicating higher socioeconomic levels [18, 23]. The SDI quintile divides the 204 countries and territories into five categories: low (0–0.454743), low–middle (0.454743–0.607679), middle (0.607679–0.689504), middle–high (0.689504–0.805129), and high (0.805129–1) SDI regions. Furthermore, the world is geographically divided into 21 GBD regions, including Oceania, Central Asia, Central Europe, Australasia, and others.

Descriptive analysis

Descriptive analyses of the incidence, YLD, age-standardized incidence rate (ASIR), and age-standardized YLD rate (ASDR) of NP were conducted by age, sex, year, and region. Maps were generated to visualize the geographical differences. The ranking of NP-caused YLD among all disabling diseases in the GBD and the percentage of all-cause YLD were also analyzed.

Joinpoint regression analysis

A joinpoint regression (JPR) analysis was performed to explore the overall and stage trends of the ASIR and ASDR of NP over the past three decades. The JPR model used the Monte Carlo substitution test to determine the number and location of connection points and divide the long-term trend of the rate into several heterogeneous time segments. The main outcome indicators of the JPR analysis were the annual percentage change (APC) and average annual percentage change (AAPC). The APC reflects the annual change in incidence in each time segment, whereas the AAPC reflects the annual change in incidence over the entire time segment. If the 95% confidence interval (CI) of the APC or AAPC did not include 0, the changing trend of the rate in the corresponding time period was considered significant. At this point, if the APC/AAPC were less than or greater than 0, it was considered to indicate a downward or upward trend [17]. The maximum number of joinpoints calculated in this study was 5, and the rates were logarithmically transformed.

Decomposition analysis

The extent to which population growth, aging, and epidemiological changes (ASIR or ASDR) contribute to the change in incidence and YLD of NP in 2019 compared to 1990 was assessed by decomposition analysis. The principles of decomposition analysis have been described in detail in previous studies [24].

Predictive analysis

A Bayesian Age-Period-Cohort (BAPC) model was constructed using data from 1990 to 2019 and population estimates for the next 25 years to predict the incidence, YLD, ASIR, and ASDR from 2020 to 2044. A detailed explanation of the BAPC model has been provided in previous studies [16, 25–27].

Cross-country inequality

The concentration curve and index were used to estimate the relative cross-country health inequality of the burden for NP, and ASDR was selected as the assessment measure. The curve was located above or below the equality line (diagonal), indicating that the burden was more concentrated in countries with lower or higher socioeconomic status, respectively. The concentration index was derived from the concentration curve, defined as twice the area between the concentration curve and the equality line, and was used to quantify the degree of burden inequality. The concentration index ranges from −1 to 1, with a positive or negative value indicating that countries with higher or lower socioeconomic status bear more of the burden, respectively [23, 28–30]. Furthermore, the changing trend of the concentration index over the past 30 years was explored using the JPR model. The maximum number of joinpoints was calculated as 5, and the concentration indices were logarithmically transformed.

All statistical analyses were performed using R software (version 4.3.1) and the Joinpoint regression program (version 4.9.0.0). Statistical significance was set at $P < 0.05$.

Results

Descriptive analysis

Global level

Globally, the incidence and YLD of NP increased by 71.894% and 78.169%, respectively, from 27,650,151 (95% UI: 21,839,123 to 35,190,239) and 12,393,477.8 (95% UI: 8,128,865.8 to 17,740,323.8) in 1990 to 47,528,965 (95% UI: 37,448,844 to 59,936,490) and 22,081,323.1 (95% UI: 14,508,244.2 to 31,726,932.9) in 2019. (Tables 1 and S1) ASIR and ASDR decreased slightly from 581.736 (95% UI: 460.941 to 737.678) and 268.259 (95% UI: 176.712 to 382.671) in 1990 to 579.085 (95% UI: 457.903 to 729.638) and 267.348 (95% UI: 175.526 to 383.537) in 2019, respectively. The AAPCs for ASIR and ASDR over these 30 years were −0.060 (95% CI: −0.084 to −0.036) % and −0.095 (95%CI: −0.132 to −0.058) %, respectively.

Age-sex pattern

In both 1990 and 2019, the incidence, YLD, ASIR, and ASDR in females were higher than those in males, as were the AAPCs of ASIR and ASDR. (Tables 1 and S1).

The highest incidence was observed in the "35–39 years" group in 1990 and in the "40–44 years" group in 2019. The age-specific incidence rate was at a high level in the "40–74 years" group. The AAPC for age-specific incidence rate in the “45–74 years” group was greater than 0. The highest YLD in 1990 and 2019 was observed in the "35–39 years" group and "45–49 years" group, respectively. The age-specific YLD rate was high in the "45–79 years" group, and the AAPC for the age-specific YLD rate was greater than 0 in the "50–74 years" group.

The incidence and YLD in each age group were higher in females than in males. (Figures S1 and S2) In age groups below 85 years, the age-specific incidence rate was higher in females than in males. Additionally, the age-specific YLD rate was higher in females than in males across all age groups except the "95 + years" group.

SDI region level

There were differences in the ASIR and ASDR among the different SDI regions. (Tables 1 and S1) In 1990 and 2019, the lowest ASIR and ASDR values were observed in low-SDI region. The highest ASIR was observed in the middle-SDI region in 1990 and the high-SDI region in 2019. The highest ASDR was observed in the high-SDI region in both 1990 and 2019. The lowest AAPCs for ASIR and ASDR were in the high-SDI region, and the highest were in the high-middle SDI region. There was no significant change in ASDR in the low-SDI region and ASIR in the high-SDI region.

GBD region level

Regional and temporal differences were observed in the distributions of ASIR and ASDR. (Tables 1 and S1) The highest ASIR and ASDR in 1990 were in Southeast Asia, and these rates in 2019 were in high-income North America. The lowest ASIR and ASDR in both 1990 and 2019 were in Australasia. The highest AAPCs for ASIR and ASDR were found in Tropical Latin America. The lowest values were found in the high-income North Pacific. There was no significant change in ASIR in the Caribbean, North Africa and Middle East, and Eastern Sub-Saharan Africa. Additionally, there was no significant change in ASDR in the four regions: high-income Asia Pacific, Central Latin America, Southern Latin America, and North Africa and Middle East.

Country level

At the national level, the Philippines had the highest ASIR and ASDR in both 1990 and 2019. In contrast, Australia had the lowest rates in 1990, while New Zealand had the lowest in 2019. (Tables S2 and S3) Among the 204 countries and territories, ASIR showed no significant change in 32 countries, decreased in 102 countries, and increased in 70 countries. Additionally, there were 31 non-significant changes in ASDR, with decreases observed in 77 countries and increases in 96 countries. The distribution of ASIR and ASDR for each country in 1990 and 2019, as well as AAPCs, can be seen in the maps. (Figs. 1 and S3).

YLD ranking analysis

In both 1990 and 2019, NP-caused YLD ranked 9th among all diseases in the GBD 2019, with the percentage of all-cause YLD increasing from 2.305% in 1990 to 2.565% in 2019. (Tables S4 and S5) NP-caused YLD in the female subgroup ranked 10th in both 1990 and 2019, while in the male subgroup, it rose from 11th in 1990 to 10th in 2019.

In the "40–49 years", NP-caused YLD had the highest ranking. NP-caused YLD ranked lower in the "0–19 years" but had increased the most. In "0–14 years" and "45–79 years", NP-caused YLD as a percentage of all-cause YLD increased.

NP-caused YLD ranked lower in the low-SDI region but had also increased the most. Except for Western Europe and Australasia, the percentage of NP-caused YLD in all-cause YLD increased in all regions. Of the 204 countries, only 23 experienced a decrease in NP-caused YLD as a percentage of all-cause YLD, whereas all others experienced an increase.

JPR analysis

The JPR trends of global ASIR and ASDR for NP in both sexes and in male and female groups were similar, with the exception of ASIR in females from 2013 to 2019 and the rest from 2011 to 2019, showing a significant upward trend. (Tables S6 and S7, Figs. 2 and S4) In the hierarchical analysis across different SDI regions, ASIR and ASDR exhibited similar trends. Except for the high-SDI region in the last stage of the rise, there was a decrease in ASIR and ASDR in the other four areas.

Decomposition analysis

To explore the impact of population growth, aging, and epidemiological changes on NP, we conducted a decomposition analysis of incidence and YLD for NP in 1990 and 2019. (Table S8, Fig. 3) Globally, the incidence in 2019 increased by 198,878,813.080 (71.894%) compared with that in 1990. The contributions of population growth, aging, and ASIR were 48.768%, 23.761%, and −0.635% respectively. The YLD increased by 9,687,845.308 (78.169%). The contributions of population growth, aging, and ASDR were 49.748%, 28.922%, and −0.501%, respectively. Changes in incidence and YLD of NP were primarily driven by population growth.

Predicted Trend

According to the BAPC forecasting, the global incidence, YLD, ASIR, and ASDR of NP from 2020 to 2044 will exhibit a continuous upward trend, and these variables

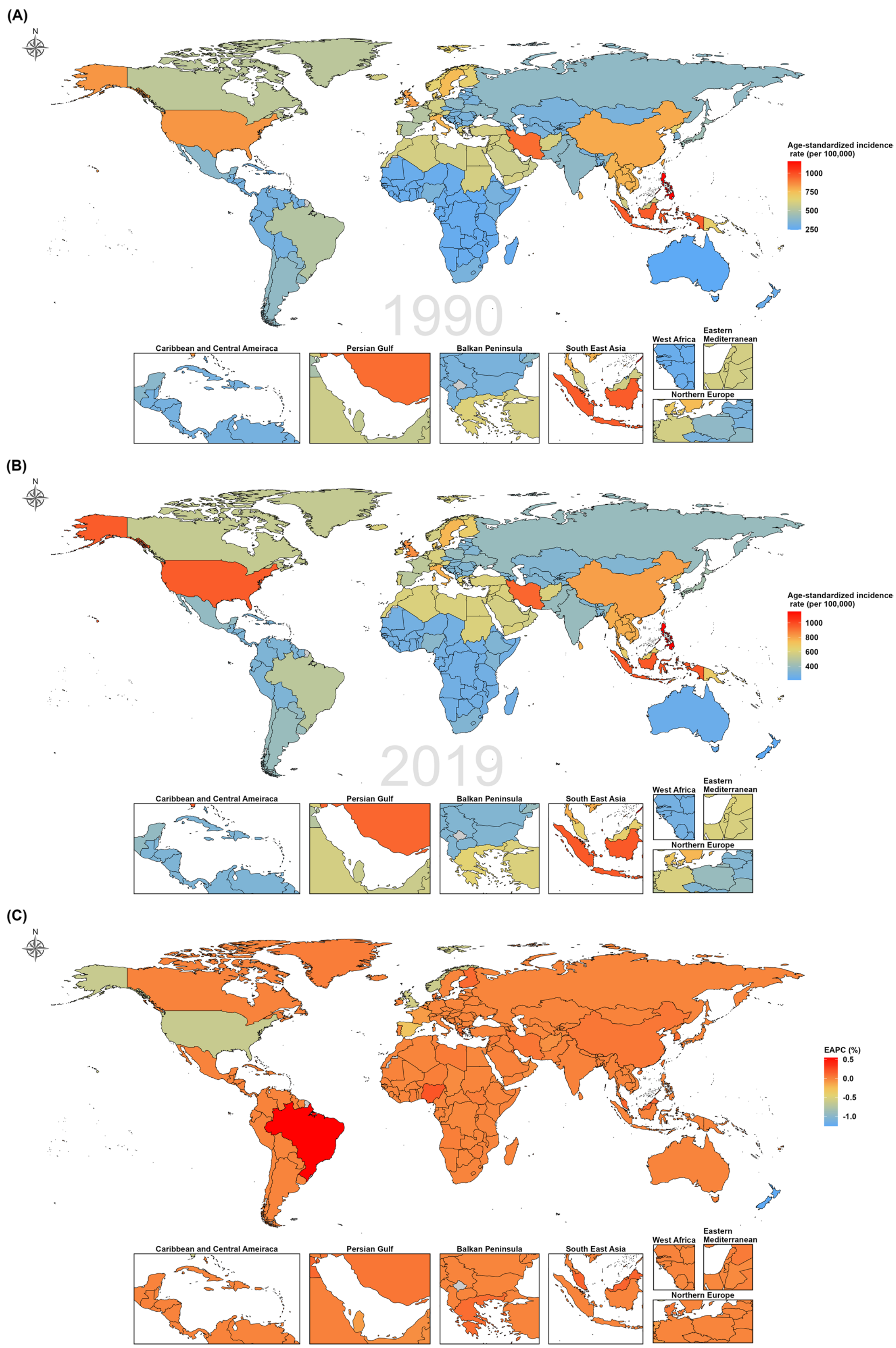

Fig. 1 Geographical distribution of (A) age-standardized incidence rate in 1990, (B) age-standardized incidence rate in 2019, and (C) AAPC of age-standardized incidence rate from 1990 to 2019 for neck pain among 204 countries and territories. Abbreviations: AAPC, average annual percentage change

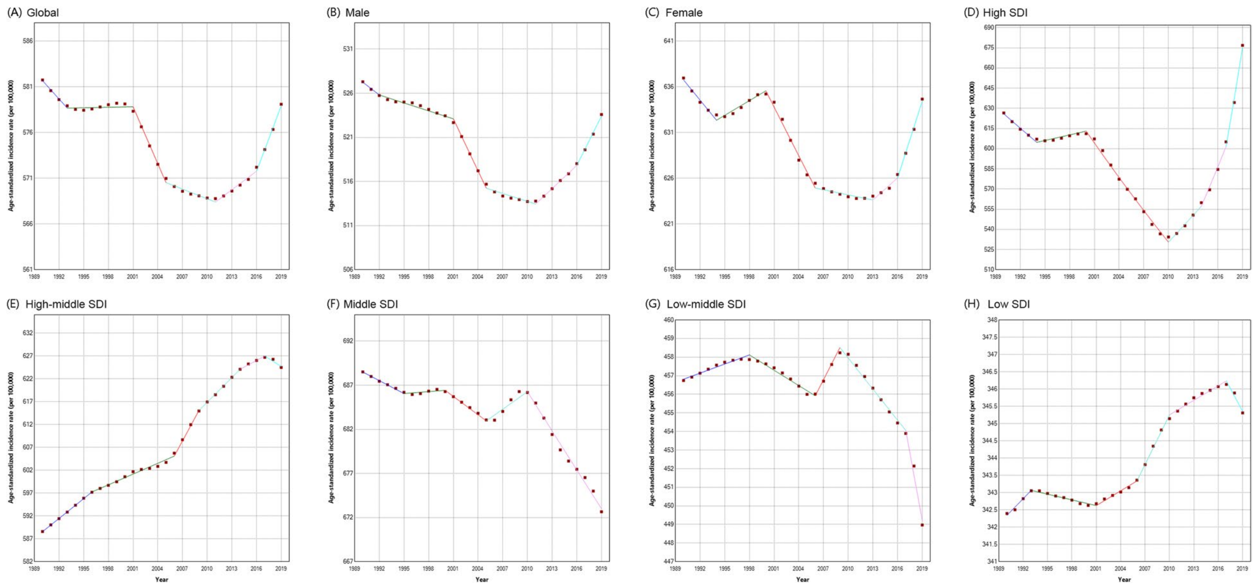

Fig. 2 Joinpoint regression analysis of age-standardize incidence rate for neck pain from 1990 to 2019. Abbreviations: SDI, sociodemographic index

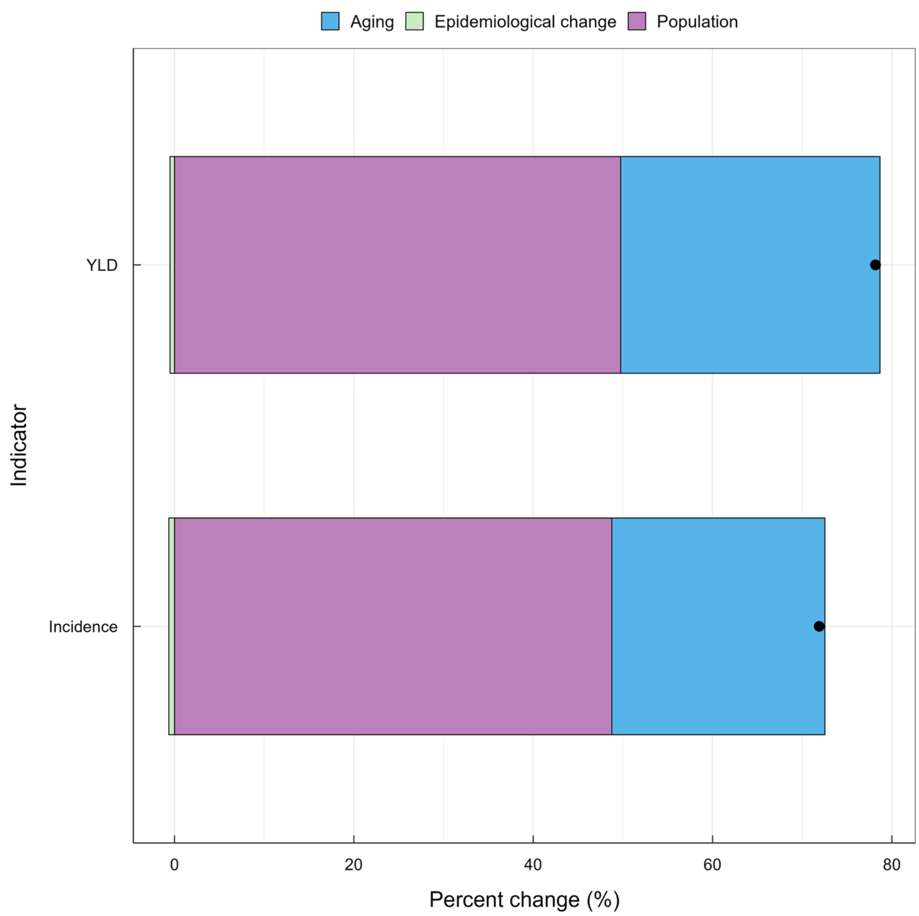

Fig. 3 The results of decomposition analysis. Abbreviations: YLD, years lived with disability

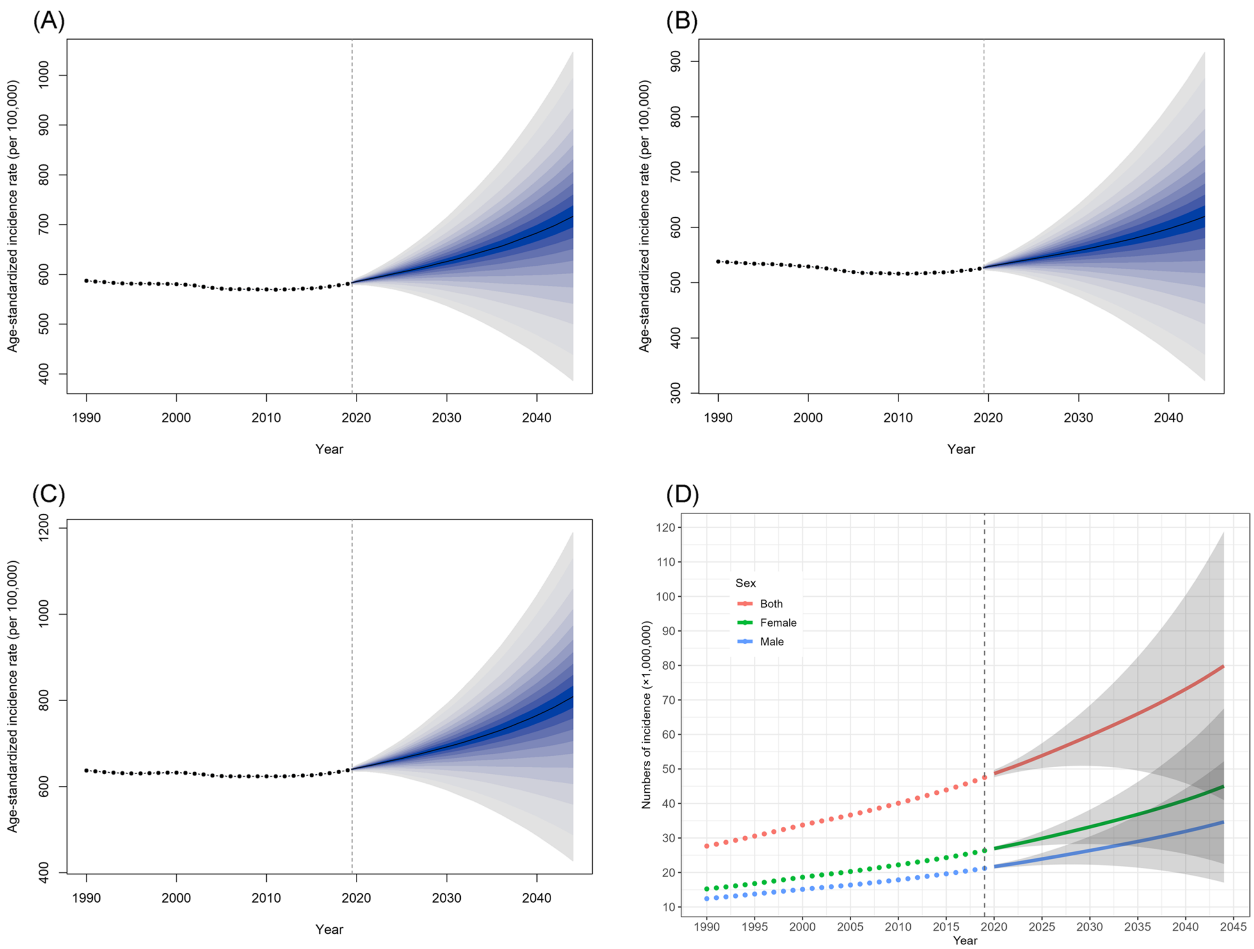

Fig. 4 The global change trends of age-standardized incidence rate and incidence number for neck pain from 1990 to 2019, and the predicted trends between 2020 and 2044 by BAPC model. **A**-**C** respectively show the age-standardized incidence rates for both sexes, males and females; (**D**) shows the incidence number by sex. The dotted line shows the true trend from 1990 to 2019, while the solid line and shadow show the predicted trend between 2020 and 2044 and its 95% confidence interval (95% CI). Abbreviations: BAPC, Bayesian age-period-cohort

were expected to reach 79,870,508 (95% CI: 41,017,850–118,723,166), 41,651,974 (95% CI: 21,032,142–62,271,806), 716.536 (95% CI: 386.997–1,046.075) and 360.034 (95% CI: 190.209–529.859) per 100,000 people, respectively. (Tables S9 and S10; Figs. 4 and S5) The same trend was observed for both males and females over the next 25 years.

Cross-country inequality analysis

A significant SDI-related relative inequality was found in the NP burden, with the concentration curve located below the equality line, indicating that higher ASDRs were disproportionately concentrated in countries with higher SDI. (Fig. 5) The concentration index was 0.099 (95% CI: 0.035–0.162) in 1990 and increased to 0.158 (95% CI: 0.143–0.174) in 2019. The dynamic changes in the concentration index from 1990 to 2019 are shown in Table S11.

According to the results of the JPR analysis (Table S12, Fig. 6), the concentration index showed a significant upward trend from 1990 to 2019, with an average increase of 0.216 (95% CI: 0.178–0.254) %. This result indicated that the gap between the NP burdens borne by countries with different SDI levels has increased over time. During 1990–2019, the concentration index changes occurred in three stages, all of which were significantly increased: in 1990–2012, the APC was 0.079 (95% CI: 0.065–0.092) %; in 2012–2017, the APC was 0.392 (95% CI: 0.245–0.539) %; in 2017–2019, the APC was 1.104 (95% CI: 0.872–1.336) %.

Discussion

NP is a common problem affecting many populations worldwide, placing a heavy burden on global health and the economy [1]. Studies of the global epidemiological characteristics of NP are essential for identifying

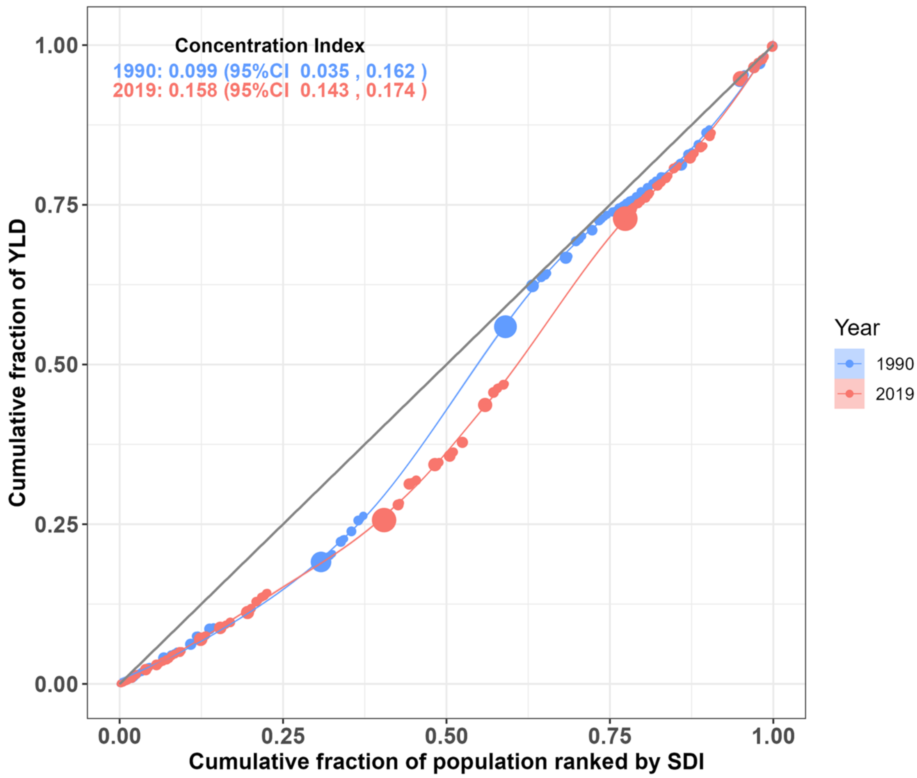

Fig. 5 Concentration curve of age-standardized YLD rate for neck pain in 1990 and 2019 across 204 countries and territories. The size of the points represents the relative size of population. Abbreviations: SDI, sociodemographic index; YLD, years lived with disability

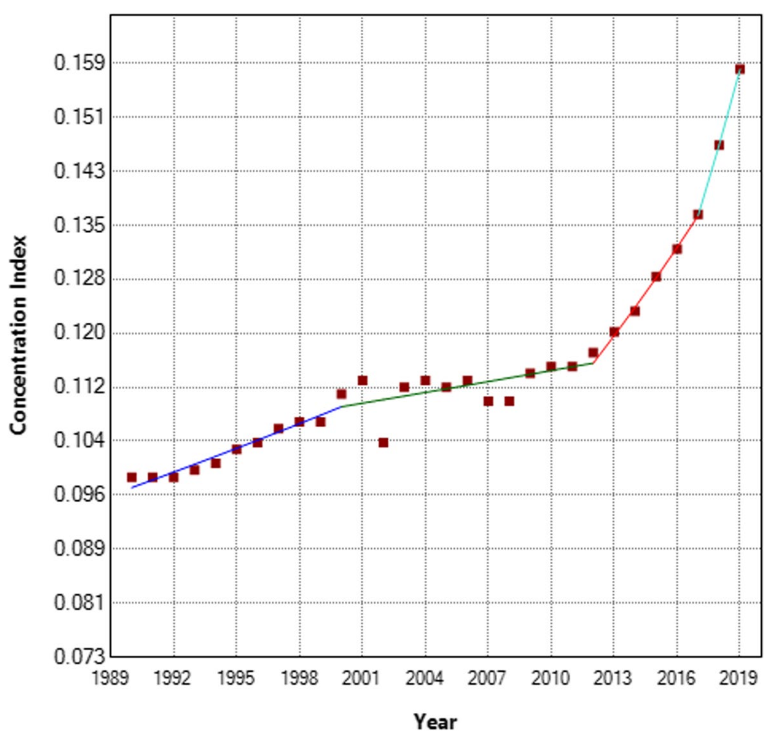

Fig. 6 Trends in concentration index of age-standardized YLD rate for neck pain from 1990 to 2019 analyzed by Joinpoint regression analysis. Abbreviations: YLD, years lived with disability

high-risk groups, allocating resources rationally, and developing public health policies and interventions. In this study, a comprehensive analysis of the burden of NP was conducted based on GBD 2019, which filled in the gaps of previous studies in many ways [8, 11, 13]. It included: 1) More in-depth analysis of the phased trends of ASIR and ASDR for NP; 2) Assessment of the contribution of population growth, aging, and epidemiological changes to the incidence and YLD of NP; 3) Prediction of the incidence, YLD, ASIR and ASDR for NP over the next 25 years; 4) Quantification of the cross-country inequality in the NP burden at the SDI level.

This study revealed an overall downward trend in the ASIR and ASDR of NP worldwide from 1990 to 2019, likely due to increased health awareness, improved treatment, and prevention strategies [12]. However, the incidence and YLD for NP increased in 2019 compared to 1990. A study based on GBD 2017 also showed an increase in 2017 compared to 1990 [13]. We further determined using decomposition analysis that the increase was mainly attributable to the rapid growth of the population and the gradual intensification of aging.

The decrease in the ASIR and ASDR shown by the AAPC only reflects the average level of the entire time period, and the recent trend is more relevant for the formulation of prevention and control policies. The JPR analysis suggested that the ASIR and ASDR showed a continuous upward trend from 2011 to 2019. This may be due to advances in social welfare and technology, which have changed the way people live and work. In recent years, the proportion of white-collar workers working in front of computers and the excessive use of smartphones has increased, while the time spent engaging in physical exercise and outdoor activities has considerably decreased [8, 31]. When watching TV, computers, and handheld devices such as smartphones, the head leans forward, which increases the weight load on the cervical spine and may lead to early wear, tear, and disintegration. [5, 9, 10, 32–38] Moreover, it is generally believed that participation in physical activity is an effective measure to prevent the development of NP, and adequate physical activity can reduce spinal pain by reducing muscle tension, reducing disc pressure, and increasing blood circulation [4, 9, 35, 37, 39]. It is also important to note that with medical advances, the level of NP diagnosis and reporting has gradually improved, which may also affect the data [21].

The results of the BAPC analysis showed that the incidence, YLD, ASIR and ASDR of NP were expected to continue to increase in the future. It reflected the significant gaps that remain between the burden of NP and policy, research, and health service responses. There is an urgent need to develop more effective prevention and control strategies. Owing to the diversity of etiologies for NP, a biopsychosocial framework can be used to guide management, including education, self-management, resumption of daily activities and exercise, and psychological interventions for patients with persistent symptoms [8, 21].

A stratified analysis of the burden of NP in different age groups revealed several issues. Firstly, the age-specific incidence and YLD rates were highest in the middle-aged and elderly groups, which was also consistent with the conclusions of previous studies [3, 5, 10, 31–33, 36, 40, 41]. The high burden of NP in middle-aged may be due to the fact that they tend to be very active and overworked, and many job-related factors can increase the occurrence of NP. [9, 42] Intervertebral disc degeneration is considered an important cause of NP, and the degree of intervertebral disc degeneration increases with age, which may explain, to some extent, the age-related pattern observed [4]. Secondly, the peak incidence and YLD of NP shifted from the "35–39 years" group in 1990 to the "40–44 years" group and the "45–49 years" group in 2019, respectively. This shift can be attributed to several factors: longer life expectancy combined with the effects of aging, longer education leading to delayed commencement of work, and more effective treatments for NP. [8] Thirdly, an increase in the YLD ranking in the "0–19 years" group was observed. This could result from the increased exposure to mobile phones and other electronic devices, leading to "text neck syndrome". [35] Childhood and adolescence are critical periods of learning and growth, and studies have shown that NP is a major cause of decreased concentration and skipping class, which affects the future career prospects of students [32]. Also, individuals who develop pain and disability in adolescence are more likely to report these health problems in adulthood [43]. Therefore, it is important to focus on the burden of NP in children and adolescents [37].

Females had a higher burden of NP than males, whether measured by incidence or YLD. This was observed in almost all age groups. Gender differences in the burden of NP are controversial, but most studies support this conclusion [32, 33, 44]. The causes of gender inequality are complex, and it is widely accepted that both biological and social factors play important roles. There are innate differences in visceral and somatic perception between males and females, with females exhibiting lower pain thresholds, higher pain sensitivity, and lower pain tolerance [43]. Female hormones, particularly post-menopausal hormones, play important roles in the etiology and pathobiology of various musculoskeletal degenerative diseases. [11] Females are less likely than males to be physically active and spend more time engaged in sedentary activities [8]. Females are more likely than men to experience negative emotions and mental health issues such as depression and anxiety [36]. Furthermore, females have a higher awareness of the signs and symptoms of NP and are more likely to report pain symptoms [45, 46].

The burden of NP varied between regions and countries, as did inequality at the SDI level. It is widely recognized that wealth or income is a core social determinant of health [14, 28, 29]. In general, countries with a high level of socio-economic development have good access to the health care system, a population with a higher level of health awareness, and are better able to manage disease [29] In other words, disease burden is generally negatively correlated with the SDI level. However, our study on the burden of NP came to the opposite conclusion, which is consistent with many studies on musculoskeletal disorders [4, 21, 31, 46]. The high burden levels of NP in high SDI regions or countries may be due to the fact that people are more likely to engage in sedentary repetitive precision work characterized by a lack of physical activity and prolonged periods of cervical flexion [11]. Simultaneously, a competitive work environment, high-pressure work, and long working hours may lead to a higher risk of mental illness, indirectly promoting the occurrence of NP. [42] Moreover, regions or countries with low SDI are more likely to invest limited resources in the prevention and treatment of high-profile fatal diseases, which may prevent non-fatal chronic degenerative diseases such as NP from being diagnosed and underestimating the disease burden [8, 11]. Moreover, relative inequality at the SDI level continued to expand. The reasons behind this phenomenon deserve further investigation.

It should be noted that the analysis of cross-country inequality cannot infer causality. Since the burden of NP is affected by multiple factors, the potential factors behind the inequality need to be explored through deeper multi-factor analysis [9]. However, what is certain is that cross-country inequality analysis is useful for data exploration and the extraction of inequality patterns, helping to identify countries that need to strengthen disease prevention and control, which may inform policy-making [14]. Notably, countries with a similar SDI level can have very different burdens of NP. Countries with high or rising burdens should compare the determinants of the differences between themselves and more successful countries, particularly those with similar SDI levels, as this is critical for improving their own situation [28, 29]. Additionally, in countries with lower SDI levels, health systems are likely to be relatively underdeveloped and face greater challenges in managing the increasing burden of NP. Given that NP shares many of the same risk factors as other chronic non-infectious diseases, there is a need to establish and strengthen integrated collaborative approaches to reduce the NP burden in an affordable and cost-effective manner [21].

This study is subject to all the limitations of the GBD database. First, it relies on a variety of data sources, the quality and availability of which may vary across regions and countries. Second, for some regions or diseases, reliable raw data may be insufficient, and GBD studies use statistical models and assumptions to fill these gaps, which can lead to increased uncertainty. Third, the lack of NP-related risk factor data in the GBD prevented an attribution analysis. Fourth, the use of DW to estimate YLD is controversial because it is based on a selected survey of a small number of countries, and no new data have been collected since 2013. Fifth, the GBD datasets are not updated in real-time and typically publish estimates for the past year, meaning that the latest health trends may not be reflected immediately [21, 45].

Conclusions

Globally, NP remains an important public health problem, and its burden will continue to increase over the next 25 years. Middle-aged, elderly, and female groups, identified as high-risk groups, need to be focused. Due to regional differences, governments need to implement targeted prevention and control policies in accordance with their own circumstances. In the future, addressing differences in diagnostic tools for NP across countries and standardizing the collection of NP-related health data will be critical to better understanding NP and reducing its burden.

Abbreviations

NP	Neck pain
YLD	Years of life with disability
JPR	Joinpoint regression
BAPC	Bayesian Age-Period-Cohort
SDI	Sociodemographic index
GBD	Global Burden of Disease
IHME	Institute for Health Metrics and Evaluation
UI	Uncertainty intervals
DW	Disability weight
ASIR	Age-standardized incidence rate
ASDR	Age-standardized YLD rate
APC	Annual percentage change
AAPC	Average annual percentage change
CI	Confidence interval

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12891-025-08342-3.

Supplementary Material 1. **Figure S1.** The incidence number and age-standardized incidence rate of neck pain in 1990 and 2019 by age and sex. Shading indicates the 95% uncertainty interval (95% UI). **Figure S2.** The YLD number and age-standardized YLD rate of neck pain in 1990 and 2019 by age and sex. Shading indicates the 95% uncertainty interval (95% UI). Abbreviations: YLD, years lived with disability. **Figure S3.** Geographical distribution of (A) age-standardized YLD rate in 1990, (B) age-standardized YLD rate in 2019, and (C) AAPC of age-standardized YLD rate from 1990 to 2019 for neck pain among 204 countries and territories. Abbreviations: YLD, years lived with disability; AAPC, average annual percentage change. **Figure S4.** Joinpoint regression analysis of age-standardize YLD rate for neck pain from 1990 to 2019. Abbreviations: YLD, years lived with disability; SDI, sociodemographic index. **Figure S5.** The global change trends of age -standardized YLD rate and YLD number for neck pain from 1990 to 2019, and the predicted trends between 2020 and 2044 by BAPC model. (A)-(C) respectively show the age-standardized YLD rates of both sexes, males and females; (D) shows the YLD number by sex. The dotted line shows the true trend from 1990 to 2019, while the solid line and shadow show the predicted trend between 2020 and 2044 and its 95% confidence interval (95% CI). Abbreviations: BAPC, Bayesian age-period-cohort; YLD, years lived with disability.

Supplementary Material 2.

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Authors' contributions
FX created the study protocol, performed the statistical analyses, and wrote the first manuscript draft. XZ and MY wrote the first manuscript draft. QZ, QW and JL performed the statistical analyses. RZ, TC and ZK assisted in the study design and extracted the data. MZ confirmed the study design and revised the manuscript. All authors read and approved the final manuscript.

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Data availability
The data used in this study can be obtained from the Global Health Data Exchange GBD Results Tool (https://vizhub.healthdata.org/gbd-results/).

Declarations

Ethics approval and consent to participate
The GBD Study 2019, conducted by the Institute of Health Metrics and Evaluation (IHME), adheres to the Guidelines for Accurate and Transparent Health Estimates Reporting (GATHER) statement. The study was reviewed and approved by the Institutional Review Board of the University of Washington with a waiver of informed consent.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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