

The burden of low back pain in adolescents and young adults

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Abstract.

BACKGROUND: Low back pain is highly prevalent and the main cause of years lived with disability, but data on the burden and trends of low back pain (LBP) in adolescents and young adults (AYAs) are sparse.

OBJECTIVE: To assess trends in the burden of LBP among AYAs aged 15–39 years at the global, regional and national levels from 1990 to 2019.

METHODS: Data from the Global Burden of Disease (GBD) 2019 were used to analyze incidence, prevalence and Disability-adjusted life year (DALY) due to LBP at global, regional, and national levels. Joinpoint regression analysis calculated the average annual percentage changes (AAPC). Then analyse the association between incidence, prevalence and DALYs and socioeconomic development using the GBD Socio-demographic Index (SDI). Finally, projections were made until 2030 and calculated in Nordpred.

RESULTS: The incidence, prevalence and DALYs rates (95%UI) were 2252.78 (1809.47–2784.79), 5473.43 (4488.62–6528.15) and 627.66 (419.71–866.97) in 2019, respectively. From 1990 to 2019, the incidence, prevalence, and DALYs rates AAPC (95%CI) were -0.49 (-0.56 to -0.42), -0.58 (-0.65 to -0.51) and -0.57 (-0.64 to -0.5), respectively. Incidence, prevalence, and DALYs rates in South Asia, East Asia, High-income North America, Western Europe, and Australasia decreased with SDI. Incidence, prevalence, and DALYs rates in Central Asia, Central Europe, and Eastern Europe decreased and then increased with SDI. At the national level, the incidence, prevalence, and DALYs rates are high in the United States and low in India and China. From the 2020 to 2030, most regions is predicted to decline.

CONCLUSION: LBP in AYAs is a major global public problem with a high burden. There are large differences in incidence, prevalence and DALYs across SDIs, regions and countries. there is still a need to focus on LBP in AYAs and tailor interventions to reduce the future burden of this condition.

Keywords: Low back pain, adolescent, young adult, global burden of disease

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1. Introduction

Low back pain (LBP) is characterized by discomfort in the lower back, lumbosacral portion, and buttocks, which may or may not radiate to the lower extremities [1,2]. In 2019, there were an estimated 223.5 million cases of LBP and 63.7 million disability-adjusted life years (DALYs) due to LBP [3]. Disability-adjusted life year (DALY) is the total number of years of healthy life lost from the onset of illness to death, taking into account a variety of factors such as the severity of the onset of illness, disease, death, disability (incapacity), the relative importance of age, etc., so that it can objectively reflect the degree of harm that illnesses can cause to society and to the population [4]. LBP is already a significant cause of health loss and disability around the globe, and in 2019 it was the ninth-largest disease burden worldwide [5]. The Global Burden of Disease (GBD) database was created with the support of the World Health Organization and the World Bank to research the global disease burden [6]. The database consists of 204 countries and 359 diseases in terms of incidence, prevalence, mortality, and DALYs by age, sex, and year; the GBD is extensively used in research on disease burden [7]. The GBD 2021 Low Back Pain Collaborators examined the global, regional, and national burdens of low back pain in the overall population and found that low back pain remains the leading cause of years lived with disability globally, and although age-standardised prevalence rates have declined slightly over the past three decades, it is projected that more than 800 million people globally will be living with low back pain by 2050 [8]. Wang et al. assess the global, regional, and national burdens of low back pain from 1990 to 2019 in the Global Burden of Disease 2019 study, found that global LBP age standardised prevalence and age-standardised DALY rates trended downwards, especially in East and South Asia [9]. Also some scholars have assessed the disease burden of low back pain in different regions or countries of the total population [10,11]. However, no study has been conducted on the disease burden of LBP in adolescents and young adults (AYAs). AYAs are individuals between the ages of 15 and 39, a phase of existence that bridges childhood and elderly age [12]. AYAs will experience profound physical, emotional, and psychosocial transformations, and significant life events; it is a characteristic period of life [13]. Current research on the global burden of low back pain focuses on the population as a whole, with insufficient research on the burden of disease in adolescents and young adults, LBP is a se-

rious problem not only among adults but also among adolescents and even children. Therefore, based on the fact that the years of life lost in AYAs will have a significant impact on society [14,15,16], the aim of this study was to fill this gap by performing trends in LBP in AYAs based on the GBD 2019 and assessing the diversity caused by the Socio-demographic Index (SDI) and geographic differences.

2. Methods

2.1. Overview

GBD 2019 provides global, regional, and national data on LBP. According to previous research [17,18], LBP is defined as a condition that lasts at least one day per year. The lower back comprises the lumbar spine, pars sacral, bilateral sacroiliac joints, and their adjacent tissues, including muscles, ligaments, fascia, posterior joints, lumbosacral joints, or sacral joints. The International Classification of Diseases (ICD) assigns the ICD-10 codes M54.3, M54.4, and M54.5 to LBP, while the ICD-9 code is 724. AYAs are defined as individuals aged 15 to 39. This study analyzed incidence cases, incidence rates, prevalence cases, prevalence rates, disability-adjusted life years (DALYs), and DALY rates to estimate the burden of LBP.

2.2. Data sources

Search for information using the Global Health Data Exchange's querying utility. The following parameters were set: the "GBD Estimata" parameter was set to "Cause of death or injury", the "Measure" parameter was set to "Incidence, Prevalence, and DALYs", the "Metric" parameter was set to "rates" and "Number", the "Cause" parameter was set to "low back pain", the "Location" parameter was set to "Global, High SDI, High-middle SDI, Low SDI, Low-middle SDI, Middle SDI, 21 regional and 204 country", the "Age" parameter was set to "15-39 years", and "Sex" parameter was set to "Both". The "Year" parameter is set to "All year".

2.3. Estimation framework

The GBD 2019 methodology has been described in detail in previous studies [19,20,21]. The prevalence rates (per 100,000) were calculated by dividing the total number of cases (including new and previously diagnosed cases) by the population size. The incidence

rates (per 100,000) were calculated by dividing the new cases by the total population. DALYs represent the total number of healthy life years lost from onset to death, calculated by aggregating the number of years lost to premature mortality and the number of years lost to disability. YLLs (Years of life lost due to premature mortality) are years lost due to disease-related premature death, whereas YLDs (Years lived with disability) are years lost due to disease-induced disability. $DALY = YLL + YLD$, $YLL = N \times L$ (N : number of deaths; L : standard life expectancy at age of death in years), $YLDI \times DW \times L$ (I : number of incident cases; DW : disability weight; L : average duration of disability years) [22].

2.4. Socio-demographic index

The SDI is a composite indicator of a country or region's development status based on a combination of data, including per capita income, average education level, and fertility rates. Each region (or country) is assigned an SDI value between 0 and 1, with greater values indicating a more developed region (or country). Worldwide, there are 204 regions or countries corresponding to 204 SDI values. Low SDI (41), low-middle SDI (41), middle SDI (40), high-middle SDI (41), and high SDI (41) are the five levels typically used by the academic community to stratify SDI from low to high.

2.5. Statistical analysis

From GBD 2019 datasets, incidence cases, incidence rates, prevalence cases, prevalence rates, DALYs, and DALY rates were extracted directly. GBD generates 95% uncertainty intervals (95% UI) for its metrics to characterize the metrics' confidence level and account for uncertainty in the initial data and subsequent calculations. The average annual percentage changes (AAPCs) and 95% confidence intervals (CIs) were calculated using the Joinpoint regression program, version 4.9.1.0 (Statistical Research and Applications Branch, National Cancer Institute, Bethesda, MD, USA). The AAPC is a summary measure of the trend over a predetermined fixed interval. It is calculated as a weighted average of the annual percentage change, allowing us to characterize the average APCs over multiple years with a single number. For 204 countries, incidence, prevalence, and DALYs rates were represented graphically. A smoothed spline model determined the relationship between global, 21 regions, and SDI from 1990 to 2019. The GBD datasets recom-

mended Nordpred age-period-cohort model was also used to predict the incidence, prevalence, and DALYs in 2030. The Nordpred model has been extensively used for 15 consecutive years to predict maladies, and its underlying principles have been described in detail (<http://www.kreftregisteret.no/en/Research/Projects/Nordpred/Nordpred-software/>) [23]. The Nordpred model a log-linear age-period-cohort model for predicting the number or rate of new cases. It can be fitted to trends by moderate exponential growth and constrained linear trend projection, showing effective prediction of future trends regarding burden [24,25].

3. Results

3.1. The incidence, prevalence, DALYs of low back pain at global level

In 2019, the number of cases was 67 million (95%UI: 54 to 83), the incidence rate was 2252.78 (95%UI:1809.47–2784.79) per 100,000 population; the number of diseases was 162 million (95%UI:133–193), the incidence rate was 5473.43 (95%UI:4488.62–6528.15) per 100,000 population; the number of DALYs was 19 million (95%UI:12–26), and the DALYs rate was 627.66 (95%UI:419.71–866.97) per 100,000 population. From 1990 to 2019, the incidence rate AAPC was -0.49 (-0.56 to -0.42); the prevalence rate AAPC was -0.58 (-0.65 to -0.51); and the DALYs rate AAPC was -0.57 (-0.64 to -0.5). The results of the number and rate of incidence, prevalence, DALYs for LBP in AYAs globally and regions in 1990 and 2019 are detailed in Table 1.

3.2. The incidence, prevalence, DALYs of low back pain at regional level

Figure 2A illustrates the incidence rates smooth curve for 21 regions. The smoothed spline model showed a trend of increasing and then decreasing morbidity with increasing SDI, analysed as $R = 0.582$, $p = 0.000$. Five regions (South Asia, East Asia, High-income North America, Western Europe, and Australasia) exhibited a decreasing incidence trend. In comparison, three regions (Central Asia, Central Europe, and Eastern Europe) exhibited a decreasing incidence trend followed by an increasing incidence trend. Figure 2B shows the trend of prevalence rates in 21 regions. The smoothed spline model showed an increasing trend in prevalence with increasing SDI, analysed as $R = 0.718$, $p = 0.000$.

Table 1
Incidence case, incidence rate, prevalence case, prevalence rate, DALYs, and DALY rate by global and SDI in 1990 and 2019 and the change in the trends from 1990–2019

Year	Measure	Global	High SDI	High-middle SDI	Middle SDI	Low-middle SDI	Low SDI
1990	Incidence						
	Cases	57167274.66	1081923.29	13135922.44	18727245.68	10342884.49	4110487.49
	(95%UI)	(46060230.26–70393813.82)	(8675282.92–13497188.23)	(10561355.14–16106827.45)	(15043672.45–23004057.04)	(8304643.26–12771797.49)	(3307401.85–5027633.43)
	Rate	2606.22	3348.96	2716.76	2508.36	2322.48	2120.85
	(95%UI)	(2099.86–3209.21)	(2685.31–4177.86)	(2184.29–3331.2)	(2014.97–3081.2)	(1864.8–2867.89)	(1706.49–2594.06)
Prevalence	Cases	14255246.08	34897141.03	31218935.54	42946702.35	23961061.77	9456396.2
	(95%UI)	(118063591.78–170267006.11)	(29250999.77–41757188.1)	(25578276.87–37333446.3)	(35090691.42–51562021.74)	(19630886.25–28896584.84)	(7793973.78–11296585.34)
	Rate	6499	10801.9	6456.68	5752.35	5380.43	4879.13
	(95%UI)	(5382.44–7762.37)	(9054.22–12925.32)	(5290.08–7721.28)	(4700.1–6906.29)	(4408.1–6488.7)	(4021.38–5828.59)
	DALYs	16300876.85	3989564.96	3587003.05	4925791.33	2720390.02	1069554.98
2019	Incidence						
	Cases	(10975150.94–22412318.66)	(2691855.39–5469759.96)	(2380051.72–4986090.11)	(3292677.99–6823802.93)	(1824299.44–3756913.82)	(717028.37–1474148.98)
	Rate	743.15	1234.91	741.86	659.77	610.86	551.85
	(95%UI)	(500.35–1021.76)	(833.22–1693.08)	(492.24–1031.22)	(441.03–913.99)	(409.64–843.61)	(369.96–760.6)
	DALYs	66859444.59	10515778.04	12303466.39	21210595.87	14071604.88	8710828.79
Prevalence	Cases	(53702757.3–82648673.65)	(8445738.25–13211166.87)	(9768333.06–15277734.6)	(17006805.65–26188530.54)	(11239586.55–17361987.12)	(6979918.28–10658983.15)
	Rate	2252.78	3174.04	2381.07	2268.29	1913.74	1945.63
	(95%UI)	(1809.47–2784.79)	(2549.23–3987.61)	(1890.45–2986.68)	(1818.73–2800.64)	(1528.59–2361.23)	(1559.02–2380.77)
	Cases	162443872.41	31805322.79	29320580.9	49045189.18	32250289.04	19911979.96
	DALYs	5473.43	9600.00	5674.37	5244.96	4386.04	4447.5
1990–2019	Incidence						
	Cases	(448862–6528.15)	(8158.48–11304.74)	(4627.5–6806.6)	(4276.8–6260.85)	(3586.21–5286.66)	(3646.71–5335.97)
	Rate	18628061.25	3631381.99	3381828.52	5646844.63	3687201.99	2268133.82
	(95%UI)	(12456349.44–25730426.8)	(2456768.55–4949133.24)	(2225519.92–4721565.38)	(3752055.81–7819644.43)	(2442095.75–5101521.95)	(1520184.08–3124363.85)
	DALYs	627.66	1096.08	654.48	603.88	501.46	506.61
AAPC	Incidence	(419.71–866.97)	(741.54–1493.83)	(430.66–913.76)	(401.31–836.24)	(332.13–693.81)	(339.55–697.85)
	Rate	–0.49	–0.19	–0.45	–0.35	–0.71	–0.31
	(95%CI)	(–0.56 to –0.42)	(–0.25 to –0.13)	(–0.49 to –0.41)	(–0.46 to –0.24)	(–0.85 to –0.57)	(–0.35 to –0.27)
	Prevalence	–0.58	–0.38	–0.44	–0.32	–0.75	–0.34
	rate	(–0.65 to –0.51)	(–0.42 to –0.34)	(–0.47 to –0.41)	(–0.41 to –0.23)	(–0.9 to –0.6)	(–0.38 to –0.29)
DALYs	DALYs	–0.57	–0.39	–0.42	–0.31	–0.72	–0.31
	rate	(–0.64 to –0.5)	(–0.42 to –0.35)	(–0.45 to –0.4)	(–0.4 to –0.22)	(–0.87 to –0.58)	(–0.35 to –0.27)

In the majority of regions, the prevalence rates remained stable; five regions (South Asia, East Asia, High-income North America, Western Europe, and Australasia) exhibited a decreasing trend, and three regions (Central Asia, Central Europe, and Eastern Europe) exhibited a decreasing and then increasing trend. Figure 2B shows the rates smooth curve of DALYs across 21 regions. Using a smoothed spline model, $R = 0.725$ and $p = 0.000$ determined that the DALYs rates have a rising, steady, and increasing trend with increasing SDI. In the majority of regions, the prevalence rates remained stable; five regions (South Asia, East Asia, High-income North America, Western Europe, and Australasia) showed a decreasing trend; and three regions (Central Asia, Central Europe, and Eastern Europe) showed a decreasing trend followed by an increasing trend.

3.3. The incidence, prevalence, DALYs of LBP at country level

Figures 3A and 4A show the incidence rates for 204 countries. With increasing SDI, the smoothed spline model demonstrates an increasing and decreasing trend in prevalence. China, India, and South Africa had prevalence rates significantly below the smooth curve. Eleven nations (Poland, Bulgaria, Hungary, Slovakia, Slovenia, Croatia, Romania, Serbia, Montenegro, the United States, and Albania) had a significantly higher prevalence than the smooth curve. Figures 3A and 4A show the prevalence rates across 204 countries. The prevalence of the smoothed spline model increases with increasing SDI. One country's (India) prevalence rate is significantly below the smooth curve. The prevalence in one country (the United States) was significantly higher than the smooth curve. Figures 3A and 4A display the DALYs rates for 204 countries. As SDI rises, refined spline models indicate an increasing DALYs rate trend. However, in one country (India), the DALYs rates are significantly below the smooth curve. The rates of DALYs in one country (the United States) are well above the smooth curve.

3.4. Predictions of LBPn from 2020 to 2030 at global and regional level

By 2030, it was anticipated that the incidence, prevalence, and DALYs rates would be 2158.822782, 5218.415942, and 587.871504. From 2020 to 2030, the incidence, prevalence, and DALYs rates decreased in most regions, with Central Latin America showing a tremendous increase among regions with an increasing trend. Table 2 and Fig. 4 show the predicted incidence rates, prevalence rates, and DALYs rates for 21 regions.

4. Discussion

To the best of our knowledge, this study is the first to analyze the burden comprehensively and changing trends of LBP in AYAs at the global, regional, and national levels. Over the past 30 years, the incidence, prevalence, and rates of DALYs at global and regional levels were analyzed, as were the incidence, prevalence, and rates of DALYs in various regions and countries as SDI levels changed. Our study adds detailed information on global, regional and national levels to the limited epidemiological data on low back pain in adolescents and young adults.

In terms of global disease burden, the number of incidence, prevalence, and DALYs increased in 2019 compared to 1990. However, the rates of incidence, prevalence, and DALYs decreased in 2019 compared to 1990, with AAPCs of -0.49 (-0.56 to -0.42), -0.58 (-0.65 to -0.51), and -0.57 (-0.64 to -0.5), respectively. In Fig. 1, incidence, prevalence, and DALYs showed a decreasing trend with SDI. The increase in incidence, prevalence, and DALYs may be related to the growth of the global population and does not directly reflect the disease burden. Combined with the global burden of disease, it demonstrates that the burden of LBP among AYAs is gradually decreasing at the global level, which may be attributable to the increased emphasis on health conditions among AYAs today [20], as well as the gradual emphasis on prevention of LBP with economic development, such as the rise in popularity of ergonomic tools and the reduction in monotonous work and awkward postures [26,27]. Although the burden of disease for low back pain in adolescents and young adults has decreased, the global prevalence and incidence of the disease is very high, and low back pain in adolescents and young adults is a major global public problem, and the reduction of low back pain incidence, prevalence, and rates of DALYs is a global problem.

Regarding regional disease burden, the incidence, prevalence, and DALYs rates were stable in most regions, indicating that most countries have attained stability in preventing and treating LBP in adolescents and young adults. The incidence rates, prevalence rates, and DALYs rates all decreased in South Asia, East Asia, High-income North America, Western Europe, and Australasia, indicating that these regions have achieved tremendous success in controlling the risk factors of LBP and have also achieved some effect in the treatment of LBP, which should serve as an example for other regions. The incidence, prevalence, and DALYs rates in Central Asia, Central Europe, and Eastern Eu-

Table 2
Prediction of incidence rate, prevalence rate and DALYs rate of low back pain from 2020–2030

Location	2020			2030		
	Incidence	Prevalence	DALYs	Incidence	Prevalence	DALYs
	Rate per 100,000 people (95%UI)			Rate per 100,000 people (95%UI)		
Global	2226.001747	5409.507171	620.389416	2158.822782	5218.415942	597.871504
Andean Latin America	2283.396025	5210.570754	599.709787	2270.651466	5185.482509	596.779717
Australasia	2800.819001	8195.226346	931.803026	2709.995618	7559.829997	857.075478
Caribbean	2475.890585	5706.062365	653.306484	2468.21939	5694.958011	651.686736
Central Asia	2505.959036	5634.012418	650.345925	2458.042452	5530.737425	637.275235
Central Europe	3852.25996	9034.217406	1044.517196	3745.655283	8792.216993	1014.36572
Central Latin America	2754.307124	6489.811382	745.293067	2817.238035	6650.595195	764.359177
Central Sub-Saharan Africa	2089.522189	4778.787194	542.225007	2071.62133	4739.7498	539.02311
East Asia	1673.169061	3847.005702	447.569508	1698.104844	3936.682168	456.707372
Eastern Europe	3183.507913	7387.034923	851.077629	3036.655359	7101.893598	815.422968
Eastern Sub-Saharan Africa	1893.128636	4241.795183	484.599956	1909.96299	4296.0681	491.616085
High-income Asia Pacific	3176.801533	9489.998975	1097.470608	3173.963676	9220.476813	1065.215571
High-income North America	3525.782229	11701.8552	1325.270183	3553.698771	11728.48298	1324.504503
North Africa and Middle East	2939.827012	6802.528196	781.208941	2851.398486	6549.144145	751.074663
Oceania	3086.722186	7040.22849	804.511197	3034.34008	6934.487681	792.364261
South Asia	1535.611344	3471.73123	395.738122	1442.828306	3242.310234	370.025716
Southeast Asia	2808.656684	6380.343966	736.248252	2726.737935	6235.071505	719.493338
Southern Latin America	2340.321439	6355.718999	729.294989	2382.523587	6324.33593	725.510111
Southern Sub-Saharan Africa	1793.346739	4054.157898	461.510057	1781.638987	4030.620444	458.48576
Tropical Latin America	3049.965297	7289.277629	830.105719	3040.241121	7265.881413	824.595541
Western Europe	2888.373807	8669.772477	990.722244	2829.255415	8265.667356	943.627288
Western Sub-Saharan Africa	2145.947461	5113.890864	583.036729	2123.788885	5062.688611	577.251742

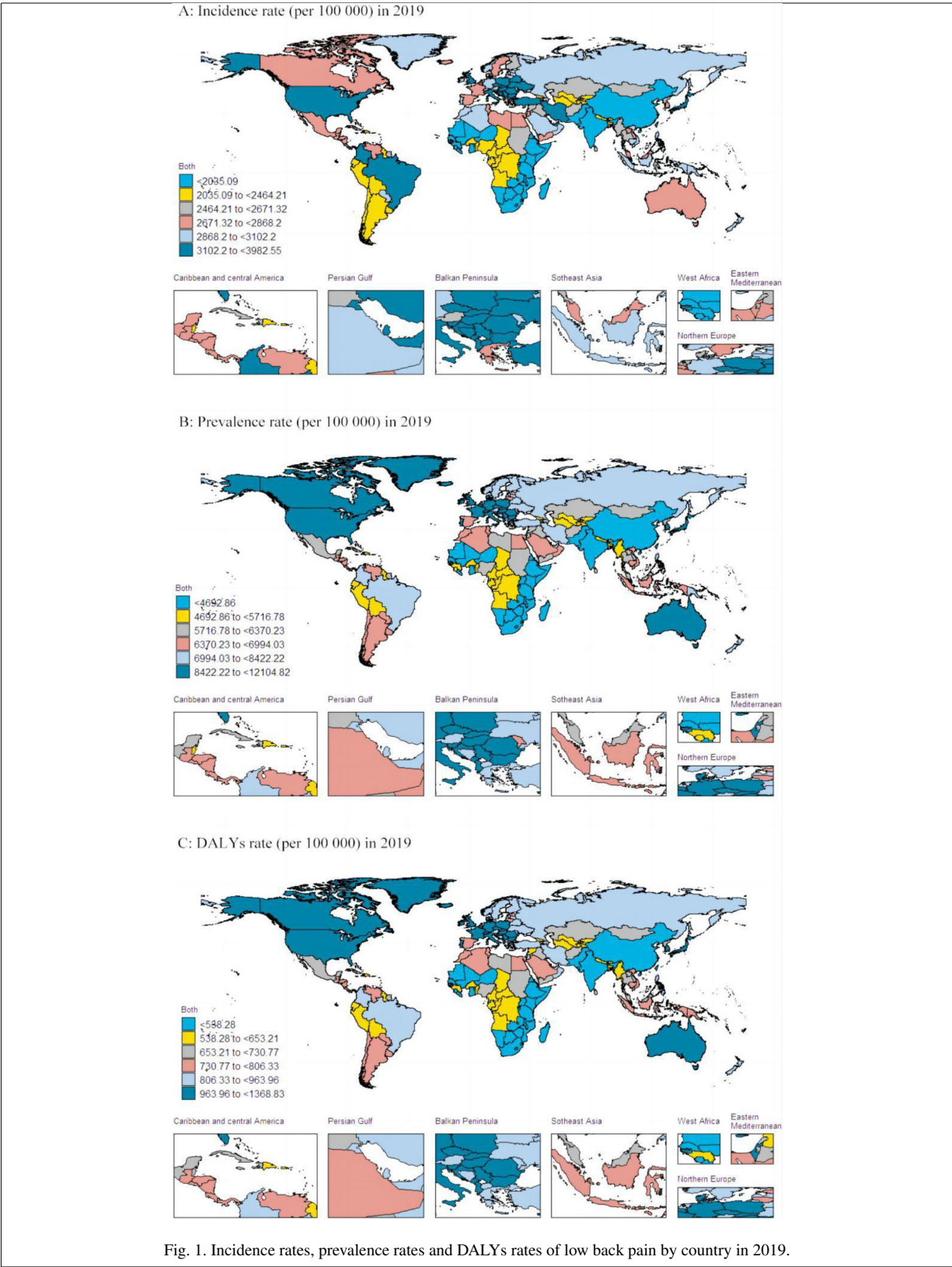
rope showed a decreasing and then increasing trend, and there have been problems in the prevention and treatment of LBP in these three regions in recent years; therefore, the work in this area should be intensified. Most of these countries are low- and middle-income countries that are experiencing the effects of rising obesity rates, rapid industrial growth and the accompanying decline in physical activity. At the same time, health and social systems in these countries are only able to respond to priorities such as infectious diseases and are not yet equipped to deal with the growing burden of low back pain, which in turn leads to an increasing number of DALYs [28,29].

In terms of the national disease burden, the incidence rates, prevalence, and DALYs situation is average in most countries. However, eleven countries are above the average incidence rates, whereas the United States is above the average prevalence and DALYs rates. Previous research has demonstrated that LBP is closely associated with obesity, overweight [30], and a sedentary lifestyle, and the rising prevalence of overweight and obesity in the United States may contribute to the high incidence, prevalence, and DALYs rates of LBP [31]. The causes of the high incidence of LBP are complex and may involve differences in economics, culture, history, geographical factors, health systems and policies. However, risk factors such as lifestyle, social factors, place of residence, type of workload, environmental

factors and high-risk activities should be controlled [4, 32,33]. To reduce the disease burden caused by LBP, the United States should strengthen the prevention and treatment of LBP in adolescents and young adults. Meanwhile, the incidence, prevalence, and DALYs rates in India and China are significantly lower than the global average, which may be attributable to the gradual improvement of health awareness among AYAs as a result of India's and China's rapid socioeconomic development and the propensity of young people to engage in some light physical labour [7].

Incidence, prevalence, and DALYs rates at the global level all show a decreasing trend from 2020 to 2030, indicating that the disease burden of LBP has been reduced to some extent globally but that the overall disease burden remains high. In terms of incidence, prevalence, and DALYs, most regions exhibited a stable and decreasing trend, with Central Latin America showing a tremendous increase among regions with an increasing trend. In previous studies, the risk factors for LBP in Central Latin America, such as melancholy, obesity and overweight, and smoking, have also increased [34,35, 36]. Therefore, the burden of LBP could be alleviated over the next ten years, but Central Latin America must still be fortified.

This study is not without limitations. The GBD database data on LBP were derived from participants' self-reports and largely depended on participants' per-



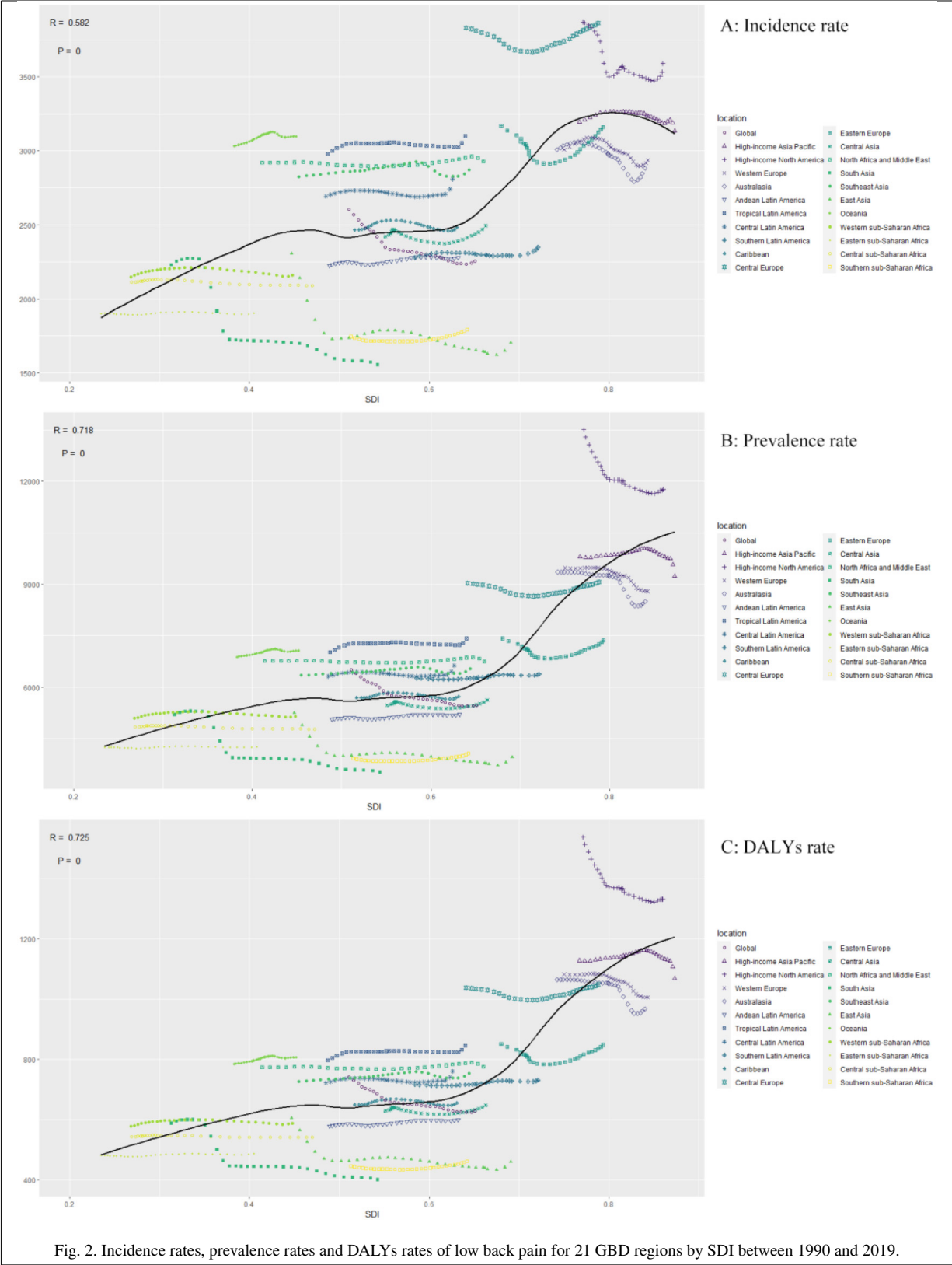
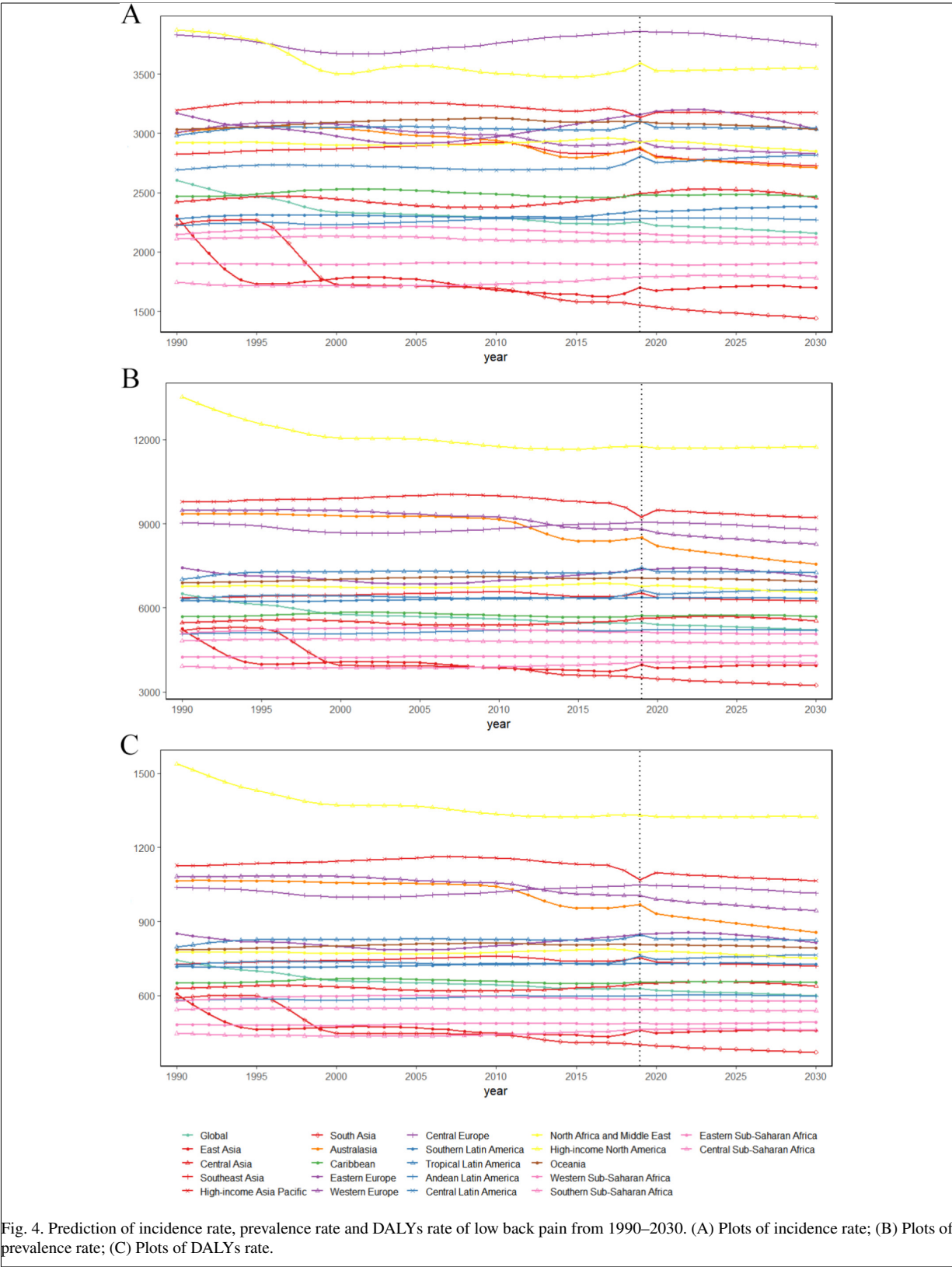


Fig. 2. Incidence rates, prevalence rates and DALYs rates of low back pain for 21 GBD regions by SDI between 1990 and 2019.



Fig. 3. Incidence rate, prevalence rate and DALYs rate of low back pain by 204 countries and terri-ries and SDI in 2019.



ceptions of signs and symptoms. GBD datasets from the GBD database primarily utilise estimated data derived from mathematical-statistical models that are susceptible to distortion. The absence of data typically indicates a deficiency in healthcare resources, so the LBP burden among AYAs was likely underestimated and underreported globally. The absence of data sources may have also introduced bias into our findings. Consequently, national estimates must be interpreted with prudence.

5. Conclusions

The incidence, prevalence and DALYs of LBP in AYAs decreased slightly from 1990-2019, but in 2019, there are still 66859444.59 cases of incidence, 162443872.41 cases of prevalence, and 18628061.25 number of DALYs in the globe. LBP in AYAs is a major global public problem with a high burden. There are large differences in incidence, prevalence and DALYs across SDIs, regions and countries, with Central Asia, Central Europe, Eastern Europe at the regional level and the United States at the national level represented as showing an increasing trend. Therefore, there is still a need to focus on LBP in AYAs and tailor interventions to reduce the future burden of this condition.

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Author contributions

Bin Pei and Ying Liu designed the study. Guoxin Huang and Zhiming Wu analyzed and interpreted the data. The manuscript was drafted by Zhiming Wu with contributions from Ying Liu. Jinwei Ai revised the manuscript. Bin Pei is the guarantor of this work. All authors read and approved the final version of the manuscript. All authors agree to be accountable for the work and to ensure that any questions relating to the accuracy and integrity of the paper are investigated and properly resolved.

Conflict of interest

The authors declare no conflict of interest.

Data availability statement

The data used are publicly available online on the website of the Institute for Health Metrics and Evaluation (IHME) (<http://ghdx.healthdata.org/gbd-resultstool>).

Ethical approval

Not applicable.

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Informed consent

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