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The incidence, prevalence, and health burden of hip fractures in China: Data from the global burden of disease study 2019

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ABSTRACT

Background: Hip fracture is commonly in the elderly as a consequence of osteoporsis. Currently, China is entering an aging society and there is a lack of studies about the epidemiology and health burden of hip fracturs there.
Methods: We used data from the Global Burden of Disease study 2019 (GBD 2019) to estimate the incidence, prevalence and disease burden of hip fractures in China and the temporal trends from 1990 to 2019. These estimates were produced by DisMod-MR 2.1, a Bayesian *meta*-regression tool. Estimated annual percentage change (EAPC) was used to represent the temporal trends.
Results: In 2019, there was estimated to be 2.0 million incident and 2.6 million prevalent hip fracture cases in China. The age standardized incidence and prevalence rate were estimated to be 117.8 (95 % UI, 83.8 to 161.6) per 100,000 and 139.8 (95 % UI, 125.7 to 154.7) per 100,000, respectively. From 1990 to 2019, the incidence (EAPC, 1.06; 95 % CI, 0.6 to 1.52) and prevalence (EAPC, 1.41; 95 % CI, 1.02 to 1.8) rates have increased, while the age standardized DALY decreased (95 %CI, −1.8; 95 % CI, −2.3 to −1.2). The incidence and DALY rates of hip fractures increased with age, and female people have higher incidence rate and disease burden. Falls were the leading cause for hip fractures, followed by road injuries.
Conclusion: Due to population growth and ageing, the challenges from hip fractures are expected to increase in the future, and related measures are in need to reduce the related health and economic burden.

1. Introduction

Hip fracture is a common injury among the elderly that causes substantial disabilities and is associated with great health loss. In 2019, the global incidence of hip fracture is estimated to be over 14 million, with the disease burden estimated to be 2.9 million years lived with disability (YLD) (Dong et al., 2022b). As the global population continues to increase and age, the health burden associated with hip fractures is expected to increase in the future, posing a major socioeconomic and healthcare challenge worldwide (Ferris et al., 2022; Hou et al., 2022; Kwak et al., 2022; Mafirakureva et al., 2023).

China has the largest population worldwide. After several decades of population growth, the population in China is entering into an aging era (Man et al., 2021). Despite the high incidence and heavy burden of hip fractures in the elderly, there are limited studies about the epidemiology and health burden of hip fracture in China (Yu and Xia, 2019). In this study, we used data from the Global Burden of Disease study 2019 (GBD 2019) to report the incidence and disease burden of hip fractures in 2019, as well as the temporal trends from 1990 to 2019 in China by age and sex, aiming to provide a comprehensive understanding of the epidemiology and burden of hip fracture for clinical practice and policy decisions.

2. Materials and methods

2.1. Data source

The data used in this study was pulled from the GBD 2019 database, which is funded by the Bill and Melinda Gates Foundation and managed by the WHO. GBD 2019 is a comprehensive epidemiological and disease burden study estimating the incidence, prevalence, and disabilities of 369 diseases and injuries in 204 countries and territories, by age, sex, year, and location (GBD2019DiseasesandInjuriesCollaborators, 2020). Hip fracture in this database is defined as a type of injury, and we

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focused on the incidence and disability of hip fracture in China. The relevant data were directly pulled from the official website of the GBD 2019 (https://vizhub.healthdata.org/gbd-results/). Like other fractures in the GBD study, the raw data used to generate the estimates of hip fractures were collected from vital registration records, insurance claims, health surveys, emergency department and other hospital records (Dong et al., 2022a; b). The final analyzed data were publicly available from GBD 2019, and no human subjects with safety and privacy concerns were included in this study. Ethical compliance is exempted for this study.

2.2. Definition and measurement

In GBD 2019, injuries are defined into two categories, namely the nature-of-injury and the cause-of-injury. Cause of injuries are those external forces that happen to the body, such as falls, road injuries, and conflicts. The nature-of-injuries are the consequences to the human body, including but not limited to hip fractures, vertebral fractures and injuries of many other anatomical sites of the body. In this study, we reported on the incidence of hip fractures and the associated health burden. The burden of hip fractures was measured by YLD. In GBD 2019, YLDs are defined as the sum of years that patients lived with any long-term or short-term health loss. More specifically, YLDs in this study indicate the years that lived with health loss due to hip fractures. In this study, we reported the absolute number of the incidence, prevalence and YLDs of hip fractures in 2019. We also reported the age standardized incidence rate (ASIR), age standardized prevalence rate (ASPR), and age standardized YLD rate (ASYR) in 2019. The age standardized rates were calculated based on the world standard population.

2.3. Statistical analysis

The standardized methods to estimate the incidence and YLD of hip fractures in China follow the general methods of the GBD 2019, which have been extensively described in previously published studies (Dong et al., 2022a; b; GBD2019DiseasesandInjuriesCollaborators, 2020; Hu et al., 2023a; Hu et al., 2023b). Briefly, the GBD fracture collaborators collected the raw fracture data from various sources, including emergency department records, hospital records, insurance claims, surveys, and vital registration systems in China and in many other countries. Then, the raw data were processed and modelled in DisMod-MR 2.1 to produce the incidence, prevalence, and YLD of hip fractures. DisMod-MR 2.1 is a Bayesian *meta*-regression tool used to generate the estimates and the associated 95 % uncertainty interval (95 % UI). In DisMod-MR 2.1, the estimates were produced according to the mean the 1000 draws of the input data, and the the 95 % UI was calculated as the 2.5th and 97.5th centiles of the ordered draws.

The temporal trends of the incidence and YLD of hip fractures were represented by estimated annual percentage change (EAPC). EAPC was calculated based on a linear regression model of the age standardized rates (ASRs) and the calendar year. The linear model was $\log_{10}(\text{ASR}) = a + \beta^*(\text{calendar year}) + e$, and EAPC was calculated as EPAC = 100*(10^β−1). For each EAPC, we also calculated the 95 % confidence interval (95 % CI). For an increasing trend, the EAPC value and its lower limit of 95 % CI are greater than zero, while for a decreasing tread, the EAPC value and its upper limit of 95 % CI are below zero. All data analyses, calculations and visualization were performed in the R software (version 4.3.1).

3. Results

3.1. The incidence and prevalence of hip fractures in China

In 2019, the incident and prevalent cases of hip fractures in China were estimated to be 2.0 million and 2.6 million, respectively, both accounting for about 1/9 of the global total cases. The ASIR in 2019 was estimated to be 117.8 (95 % UI, 83.8 to 161.6) per 100,000, and the ASPR was 139.8 (95 % UI, 125.7 to 154.7) per 100,000. Both the ASIR and ASPR were lower than the global level. Female people had a higher ASIR and ASPR than that of male people in China or globally. From 1990 to 2019, the EAPC was 1.06 (95 % CI, 0.6 to 1.52) for ASIR, and 1.41 (95 % CI, 1.02 to 1.8) for ASPR, indicating an increasing trend for both ASIR and ASPR of hip fractures in China during this period. Before 2005, the ASIR and ASPR remained relatively stable, but thereafter there was an apparent increase in both incidence and prevalence (Fig. 1).

3.2. The disability associated with hip fractures in China

The GBD 2019 study uses YLDs to measure the health loss due to different types of injury. For hip fractures in China, the total YLDs of hip fractures in China were estimated to be 0.23 million (95 % UI, 0.15 to 0.34 million). The ASYR of hip fractures in China in 2019 was estimated to be 12.7 (95 % UI, 8.4 to 18.5) per 100,000 for both sexes, which was lower than the global level (42.7 per 100,000; 95 % UI, 29.72 to 58.1 per 100,000). Female people had a higher ASYR of hip fractures than male people in China. From 1990 to 2019, the EAPC of hip fractures in China for male (-1.7; 95 % CI, −2.2 to −1.2), female (-1.8; 95 % CI, −2.33 to −1.2), or both sexes (-1.8; 95 % CI, −2.3 to −1.2) were all below zero, indicating a decreasing trend of ASYR during this period. However, a slight increase was observed after 2010 (Fig. 2).

3.3. Leading causes of hip fractures in China

The four leading causes of hip fractures in China are presented in Table 3 and Fig. 3. Their contribution to hip fractures was measured by the ASIR and ASYR due to these causes. In 2019, the leading cause of hip fractures in China was falls, which resulted in about 1.66 million hip fractures in that year. The ASIR and ASYR of hip fractures due to falls were estimated to be 97.2 per 100,000 (95 % UI, 64.15 to 139.6 per 100,000) and 7.7 per 100,000 (95 % UI, 4.65 to 12.3 per 100,000), respectively, which were much higher than those due to other causes (Fig. 3A and B). The second leading cause was road injuries, with an ASIR and ASYR of 13.1 (95 % UI, 8.03 to 20.2) and 4 (95 % UI, 2.74 to 5.5) per 100,000, respectively. From 1990 to 2019, the ASIR of hip fractures due to falls has increased, especially during the period after 2005, while the ASIR due to road injuries has slightly increased (Fig. 3C). The incidence of hip fractures due to interpersonal violence and mechanical trauma has remained relatively stable in the past thirty years (Fig. 3C). In contrast to the ASIR, the ASYR of hip fractures due to falls decreased from 1990 to 2010, and then increased since 2010. Road injury related ASYR decreased from 1990 to 2005, and has remained relatively stable since then (Fig. 3D).

3.4. Hip fracture incidence and YLD in China by age and sex

Fig. 4 shows the trends of ASIR and ASYR of hip fractures in China for male and female people from 1990 to 2019. During this period, both ASIR and ASYR were higher in female people than that in female people every year. A gradual increase of ASIR with year was seen for both female and male people (Fig. 4A). The EAPC of the ASIR for female and male people were 1.33 (95 % UI, 0.89 to 1.76) and 1.01 (95 % UI, 0.55 to 1.47), respectively (Table 1), indicating that the incidence of hip fractures in China has increased with time. In contrast to the incidence, the EAPCs of ASYR of male and female people were all below zero (Table 2), indicating that the disease burden associated with hip fractures has decreased from 1990 to 2019. However, a slight increase for both male and female people were seen after 2010 (Fig. 4B).

Fig. 5 shows the incidence and YLD of hip fractures by age in China. The incidence and YLD rate remained relatively stable before 60 years of age for both female and male people (Fig. 5A, B), and then increased after the age of 70 years. The increase of the incidence and YLD rate with age was more pronounced in female people. Considering the causes, the

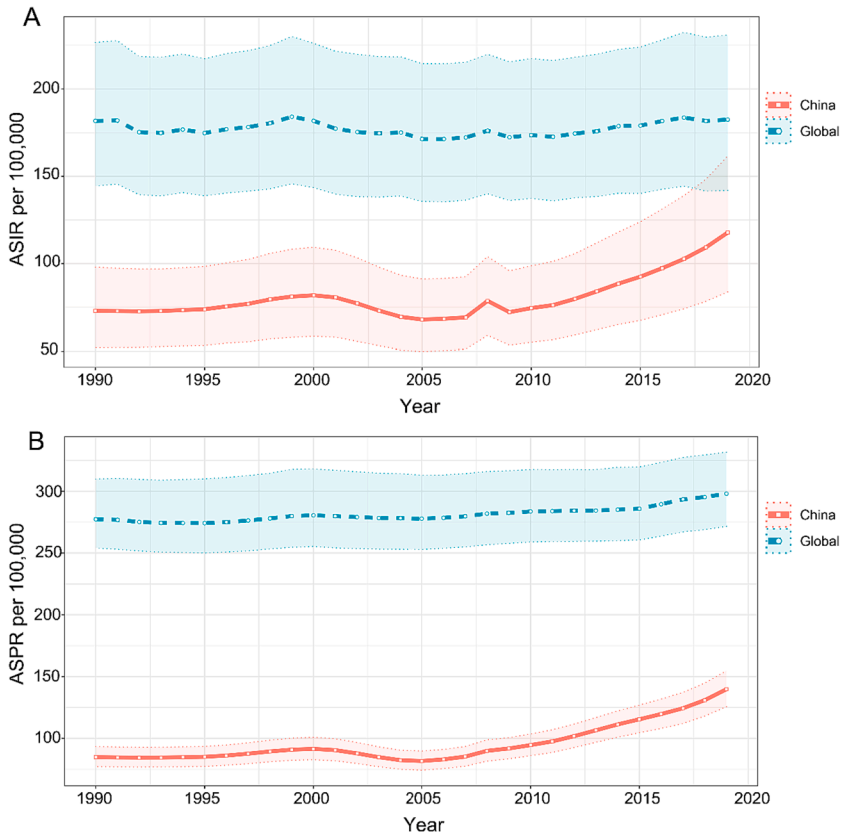

Fig. 1. The incidence and prevalence of hip fractures in China in 2019 (A) The age standardized incidence rate (ASIR) per 100,000 of hip fractures at the global level and in China; (B) The age standardized prevalence rate (ASPR) per 100,000 of hip fractures at the global level and in China.

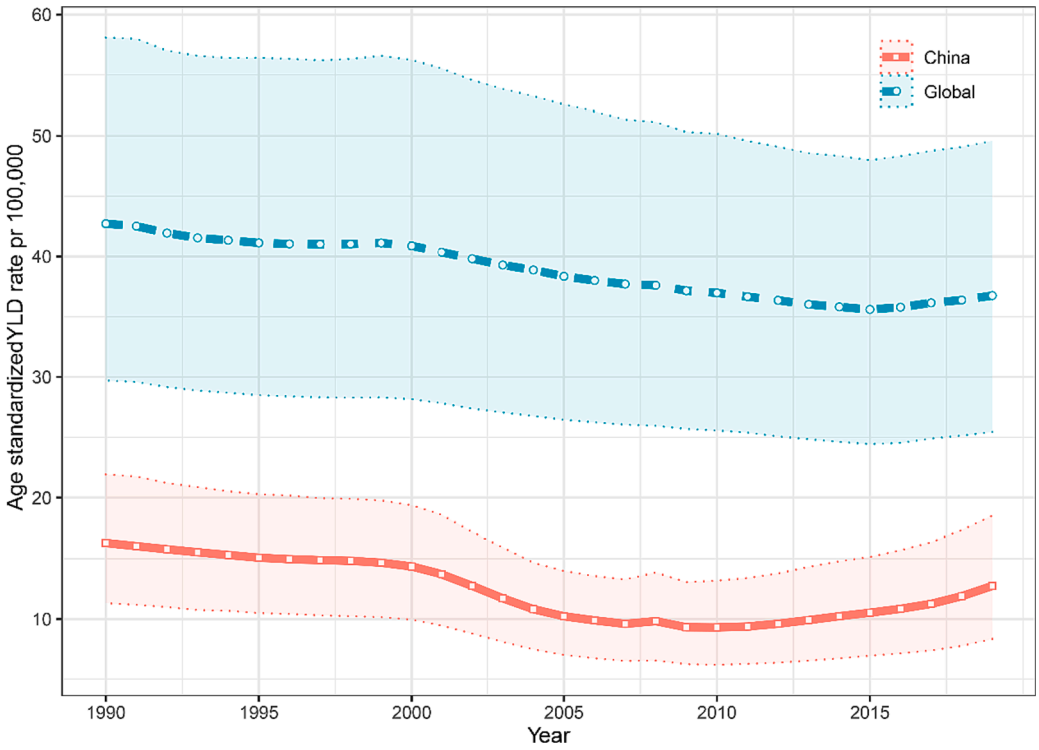

Fig. 2. The disability of hip fractures in China in 2019. The disability of hip fractures is represented by age standardized YLD rate (ASYR) per 100,000. The ASYR of hip fractures in China and in the globe is presented. YLD, years lived with disability.

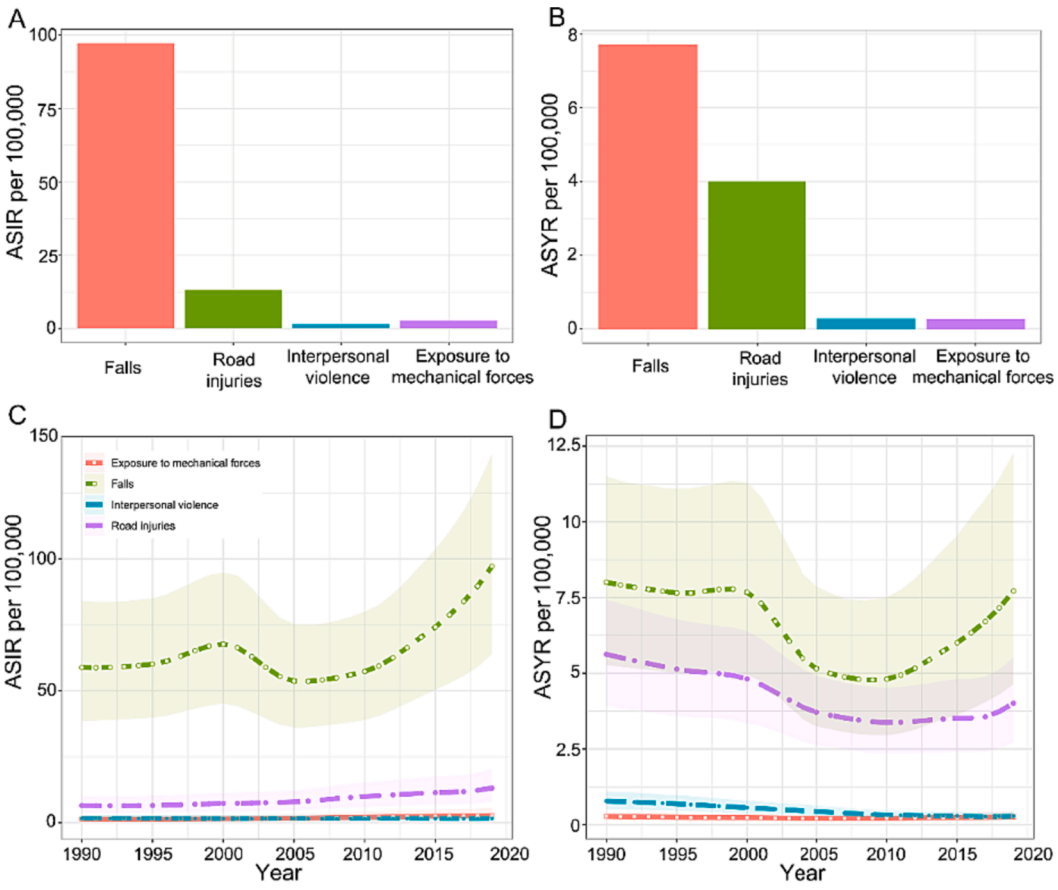

Fig. 3. The causes for hip fractures in China in 2019. (A) The age standardized incidence rate (ASIR) of hip fractures due to different causes in China in 2019. (B) The age standardized YLD rate (ASYR) of hip fractures due to different causes in China in 2019. (C) The trends of age standardized incidence rate (ASIR) of hip fractures due to the leading four causes in China from 1990 to 2019. (D) The trends of age standardized YLD rate (ASYR) of hip fractures due to the leading four causes in China from 1990 to 2019.

increase of incidence and YLD rates of hip fractures were mainly due to those caused by falls (Fig. 5C, D). Falls were the leading cause for the incidence and YLD in all age groups. These results indicate that fall prevention will be an essential measure to reduce the incidence and health burden of hip fractures.

4. Discussion

In this study, we comprehensively analyzed the incidence, prevalence and disease burden of hip fractures in China in 2019, and the temporal trends from 1990 to 2019, using data from GBD 2019. The ASIR and ASPR of hip fracturs in China were below the global level. However, both ASIR and ASPR have increased over time. The ASYR of hip fracturs has decreased in China, indicating the disability associated with hip fractures has decreased. However, as the population in China continued to grow from 1990 to 2019, the absolute number of hip fractures remains huge. Falls were the leading cause for hip fractures. Female people showed higher incidence and disability rate of hip fractures than that in male people. The incidence and YLD rates increased with age, and as the population in China continues to age in the coming years, there is no doubt that China will face more and more challenges from hip fractures.

Over 90 % of hip fractures are caused by low-trauma forces, particularly in the elderly with decreased BMD or with osteoporosis. Both hip and vertebral fractures are common types of fragile fractures associated with osteoporosis (Khan et al., 2018). Unlike vertebral fractures, hip fractures are associated with the highest morbidity and mortality. It has been reported that only 50 % of patients are able to return to the pre-fracture status in terms of the walking ability and the need for domestic help (Sernbo and Johnell, 1993). Besides, the one-year excess mortality rate of hip fractures reaches 20–30 % after the onset of hip fractures (Kanis et al., 2003), leading to substantial health burden. Hip fractures are also associated with enormous economic burden, particularly in developing countries. Because of the its impact on health and physical function, most hip fracture cases are hospitalized for active treatment. In China, the average cost of treating a hip fracture reached ¥53 440, which is almost the total annual income of many Chinese families. In Iran, another developing country in Asia, the cost for treating each hip fracture was approximately €11,700, and the total hospitalization cost has been increasing with year (Ferris et al., 2022), placing a huge burden on both the patient's family and the society.

A major finding of the current study is that both the ASIR and ASPR rates have increased from 1990 to 2019. This finding is consistent with previous studies about the epidemiology of hip fractures in many large cities in China, such as Beijing (Xia et al., 2012), Shenyang (Yan et al., 1999), Tangshan (Tian et al., 2014), and Hefei (Wang et al., 2014), which have reported increased prevalence of hip fractures. The increased incidence or prevalence of fractures may be a result of the population growth in China in recent decades. China has the largest population in the world, with an increasing trend in the recent decades. Besides, with the development of economic and medical levels, the life expectancy has been prolonged and China has entered an ageing era. Meanwhile, the high prevalence of osteoporosis in China may also play a role. A large cross-sectional study showed that the prevalence of osteoporosis was 5 % in men and 20.6 % in women in people aged over 40 years or older (Wang et al., 2021). Another study has showed that the

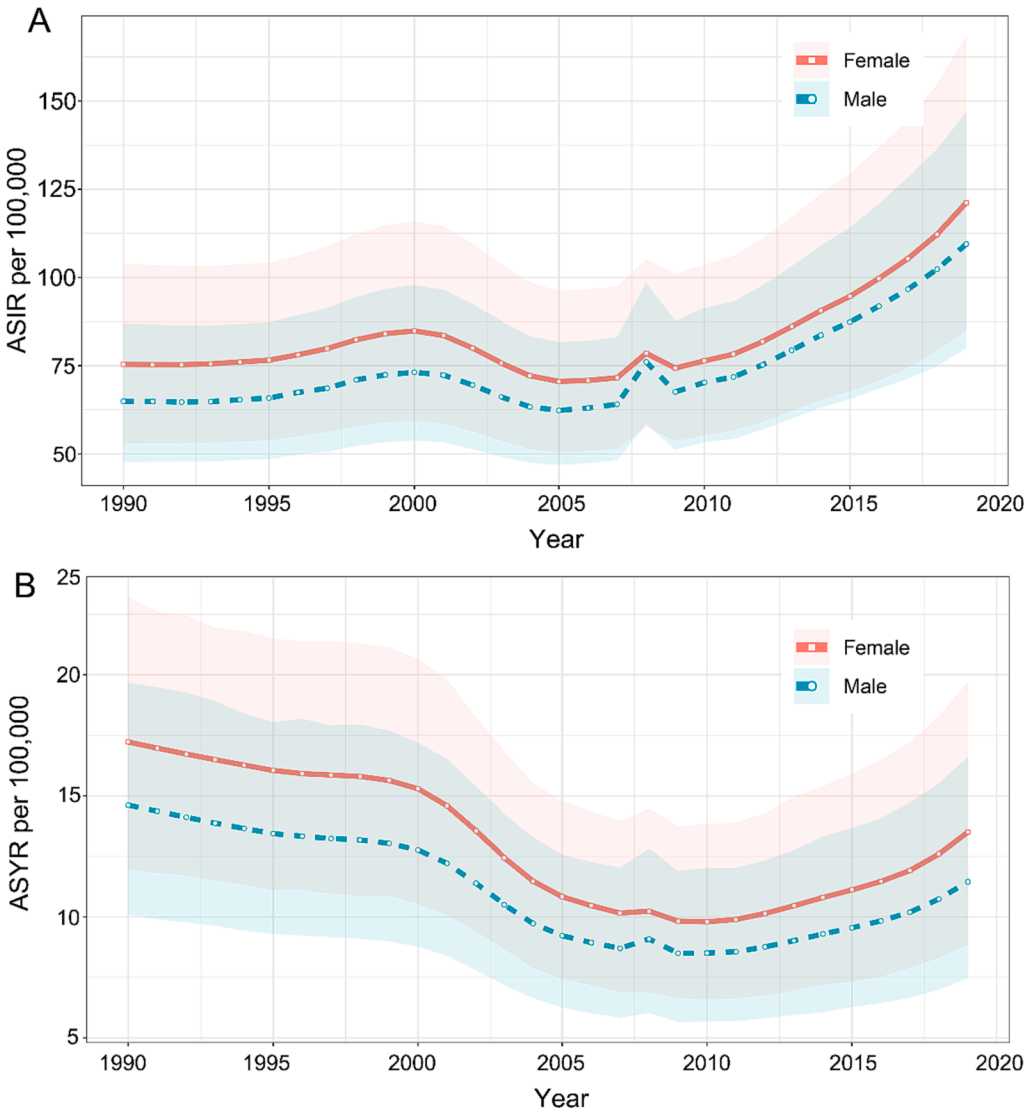

Fig. 4. The trends of incidence and burden of hip fractures in China by sex. The trends of incidence and burden of hip fractures in China by sex from 1990 to 2019. (A) The trends of age standardized incidence rate (ASIR) per 100,000 of hip fractures for male and female people in China from 1990 to 2019. (B) The trends of age standardized YLD rate (ASYR) per 100,000 of hip fractures for male and female people in China from 1990 to 2019.

age standardized summary exposure value to osteoporosis in China has decreased, but the absolute number of disabilities associated with low bone mineral density has increased substantially due to population growth and ageing (Chen et al., 2022). W As the population ages, hip fractures are expected to continue to increase in the future. Finally, we found that road injuries ranked as the second cause of hip fracture incidence and disability. Since the reform and opening up policy, the use of motor vehicles in China has increased rapidly year by year, accompanied by increased road accidents, which leaded to increased incidence of traumatic injuries, including hip fractures.

Despite the increase in hip fracture incidence and prevalence, our results showed that the ASYR rate has decreased over the past thirty decades. This may be due to the gradual improvement of the health care system, the increase in family income and the popularization of high-quality medical services. With the development of social economy and the increase of individual income in recent years, patients with hip fractures are more likely to seek medical care and can afford the cost, which will greatly contribute to reducing the burden associated with the injury. However, considering the huge population, high incidence and high cost for inpatient care (Wang et al., 2018; Williamson et al., 2017) of hip fractures, the absolute number of hip fractures remains high each year. To further reduce the health burden, it is more cost-effective to prevent hip fractures than to treat them. As most hip fractures occur in the elderly after low trauma forces, the screening and treatment of osteoporosis play an essential role in preventing hip fractures. In China, many efforts have been made to meet the challenges of an increasing osteoporotic population, such as, such as improved training of doctors, increased public education and coverage of the most effective anti-osteoporotic drugs by the national health insurance (NationalHealthcareSecurityAdministration, 2020). These measures have made great strides in reducing the burden of osteoporosis. However, gaps still exist. It has been reported that only 6.5 % of patients received anti-osteoporotic treatment within 6 months after a fracture (Kung et al., 2013). Besides, China has a large rural population, and screening and treatment for osteoporosis may be less adequate in rural areas. Finally, a recent study suggests that men have lower prevalence of low bone mineral density than women, but the burden due to this disease is much higher in men (Zhu et al., 2023). Osteoporosis may have been overlooked in men for too long (The Lancet Diabetes, 2021), and more attention should be paid to the screening and treatment of this disease in men.

In addition to osteoporosis screening and treatment, the prevention

Table 1
The incidence and prevalence of hip fractures in China and the temporal trends from 1990 to 2019.

	Location	Number in 2019 (×1000) (95 % UI)	Age standardized rate per 100,000 in 2019 (95 % UI)	EAPC of age standardized rate from 1990 to 2019 (95 % CI)
Incidence	**China**			
	Male	894 (649 to 1,191)	109.4 (80.0 to 146.7)	1.33 (0.89 to 1.76)
	Female	1,142 (796 to 1,596)	121.2 (84.9 to 168.2)	1.01 (0.55 to 1.47)
	Both sexes	2,036 (1,451 to 2,768)	117.8 (83.8 to 161.6)	1.06 (0.6 to 1.52)
	Global			
	Male	6,108 (4,916 to 7,531)	166.2 (133.2 to 205.8)	0.11 (0.01 to 0.2)
	Female	8,136 (6,184 to 10,619)	189.8 (144.2 to 247.2)	0.04 (-0.06 to 0.15)
	Both sexes	14,244 (11,095 to 18,064)	182.5 (141.9 to 230.9)	0.01 (-0.08 to 0.11)
Prevalence	**China**			
	Male	1,115 (1,003 to 1,233)	121.2 (109.1 to 134.3)	1.41 (1.04 to 1.78)
	Female	1,511 (1,360 to 1,669)	151.8 (136.6 to 168.2)	1.43 (1.04 to 1.83)
	Both sexes	2,626 (2,360 to 2,897)	139.8 (125.7 to 154.7)	1.41 (1.02 to 1.8)
	Global			
	Male	9,821 (8,891 to 11,104)	261.4 (237.3 to 293.5)	0.37 (0.33 to 0.41)
	Female	13,826 (12,584 to 15,311)	319.9 (291.1 to 356.2)	0.2 (0.15 to 0.26)
	Both sexes	23,647 (21,561 to 26,278)	298.1 (271.6 to 331.6)	0.22 (0.17 to 0.26)

Abbreviations: EAPC, estimated annual percentage change; UI, uncertainty interval; CI, confidence interval.

Table 2
The YLDs of hip fractures in China in 2019 and the temporal trends from 1990 to 2019.

	Number in 2019 (×1000) (95 % UI)	Age standardized rate per 100,000 in 1990 (95 % UI)	Age standardized rate per 100,000 in 2019 (95 % UI)	EAPC of age standardized rate from 1990 to 2019 (95 % CI)
China				
Male	101 (67 to 146)	14.6 (10.11 to 19.7)	11.4 (7.5 to 16.6)	−1.7 (-2.2 to −1.2)
Female	132 (87 to 191)	17.2 (11.98 to 23.2)	13.5 (8.9 to 19.7)	−1.8 (-2.33 to −1.2)
Both sexes	233 (154 to 336)	16.3 (11.31 to 21.9)	12.7 (8.4 to 18.5)	−1.8 (-2.3 to −1.2)
Global				
Male	1,291 (885 to 1,745)	39.8 (27.55 to 54.2)	33.7 (23.1 to 45.5)	−0.7 (-0.75 to −0.6)
Female	1,645 (1,150 to 2,195)	43.5 (30.58 to 58.7)	38.4 (26.9 to 51.6)	−0.6 (-0.67 to −0.5)
Both sexes	2,936 (2,030 to 3,955)	42.7 (29.72 to 58.1)	36.8 (25.5 to 49.6)	−0.7 (-0.73 to −0.6)

Abbreviations: EAPC, estimated annual percentage change; UI, uncertainty interval; CI, confidence interval.

Table 3
The causes for hip fractures and the related incidence and YLD in 2019.

Causes	Incidence		YLD	
	Number in 2019 (x1000) (95 % UI)	Age standardized rate per 100,000 in 2019 (95 % UI)	Number in 2019 (x1000) (95 % UI)	Age standardized rate per 100,000 in 2019 (95 % UI)
Falls	1,658 (1,090 to 2,373)	97.2 (64.15 to 139.6)	134 (81 to 213)	7.7 (4.65 to 12.3)
Road injuries	249 (150 to 384)	13.1 (8.03 to 20.2)	80 (55 to 110)	4 (2.74 to 5.5)
Mechanical forces	51 (21 to 105)	2.7 (1.11 to 5.5)	5 (3 to 9)	0.3 (0.15 to 0.4)
Interpersonal violance	28 (13 to 54)	1.6 (0.72 to 3)	6 (4 to 8)	0.3 (0.18 to 0.4)

Abbreviations: YLD, years lived disability; UI, uncertainty interval; CI, confidence interval.

of falls is also of great importance. This study shows that falls are the leading cause of hip fractures and that most fall-induced fractures occur in the elderly. Preventing falls in old people will help to reduce the risk of hip fractures and the burden associated with them. A previous study showed that many fall-prevention strategies, including medical management of psychotropics, physical activities like tai chi, vitamin D supplementation, or home modifications, are cost-effective to prevent hip fractures (Frick et al., 2010). Another study found that supplementation of vitamin D appears to be more cost-effective (Torgerson and Kanis, 1995). In addition to these measures, public education on the risk factors of falls and on how to prevent falls, and enhanced community healthcare facilities for old people are also effective to reduce the incidence and related burden of hip fractures.

As the data were obtained from the GBD 2019 database, the current study could not avoid some inherent limitations. First, the incidence, prevalence, and disability of hip fractures were estimated for the whole country, and the estimates at the province level were not available. China has an unbalanced economic development and medical resource distribution among different provinces, and it is undoubtedly the case that the epidemiology and burden of hip fractures will differ among provinces. Thus, more detailed data are needed to guide medical practice and policy-making in each country in China. Second, hip fracture can result from high-energy causes in everyone and from non-traumatic causes in patients with osteoporosis. Due to the data structure in the GBD 2019, the estimates of hip fractures were made by counting both traumatic and non-traumatic causes. It is not possible to determine the proportion of fragile hip fractures caused by low trauma causes in patients with osteoporosis. However, hip fractures in people over 60 years of age are mainly caused by low-energy trauma, and the incidence is higher in women than that in men (Papapoulos et al., 2021), which may be explained by the high incidence of postmenopausal osteoporosis in women. Besides, our study revealed that the incidence and disease burden of hip fractures are mainly seen in the elderly, suggesting that a great proportion of hip fractures estimated for China are fragile fractures. Given the ageing society in China, the screening and treatment of osteoporosis is a fundamental strategy to reduce the burden of hip fractures.

In conclusion, data from GBD 2019 showed that the incidence and prevalence of hip fractures in China has increased from 1990 to 2019. Due to population growth and ageing, the country will face more challenges associated with hip fractures in the future. Screening and treatment for osteoporosis, preventing falls, enhancing physician training and public education, in combination with relative health policies will help to reduce the incidence and related burden of hip fractures.

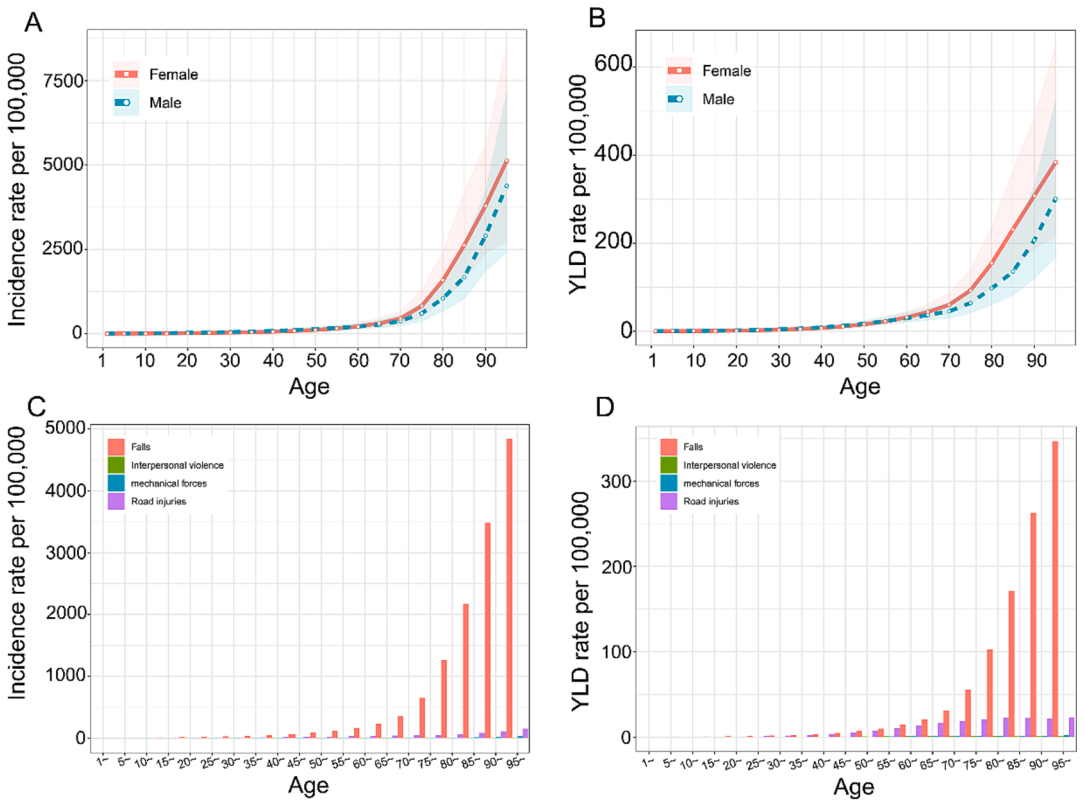

Fig. 5. The incidence and disease burden of hip fractures in China by age. The incidence and disease burden of hip fractures in China by age. (A) The incidence rate of hip fractures in 2019 by age for male and female people in China. (B) The YLD rate of hip fractures in 2019 by age for male and female people in China. (C) The incidence rate of hip fractures in China in 2019 due to the four leading causes in different age groups. (D) The YLD rate of hip fractures in China in 2019 due to the four leading causes in different age groups.

CRediT authorship contribution statement

Wenyu Yang: Writing – original draft, Formal analysis, Data curation. **Guanghui Li:** Validation, Resources, Methodology, Formal analysis. **Jie Liu:** Supervision, Project administration, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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