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ORIGINAL ARTICLE

Benign prostatic hyperplasia burden comparison between China and United States based on the Global Burden of Disease Study 2019

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Abstract

Purpose To determine the difference in the burden of benign prostatic hyperplasia (BPH) between China and the United States from 1990 to 2019.

Methods The prevalence, incidence, Years Lived with Disability (YLD), and their age-standardized rates for BPH in China and USA from 1990 to 2019 were based on the Global Burden of Disease Study 2019 (GBD 2019). The annual percentage changes (APC) of the age-standardized incidence rate (ASIR) and the age-standardized YLD rates (ASYR) were calculated using joinpoint regression analysis. The YLD numbers of six urinary tract diseases were also compared in both countries.

Results The absolute burden of BPH increased continuously in both countries, but it was much higher in China than in the United States. The ASIR and ASYR of BPH decreased in China but remained stable or decreased slightly in the United States. BPH incidence and YLD rates decreased in all age groups in China from 1990 to 2019. In the USA, they varied by age group. BPH caused more YLD number than any other urinary tract disease in China. In the USA, prostate cancer (PCa) caused more YLDs than BPH.

Conclusions This research reveals marked BPH burden differences between China and the US (1990–2019). China's higher burden necessitates targeted interventions, while unique trends in both countries demand tailored strategies. These insights enhance understanding of BPH dynamics, informing effective interventions across diverse contexts.

Keywords Benign prostatic hyperplasia · GBD 2019 · China · USA · Burden of disease

Introduction

Benign prostatic hyperplasia (BPH) is pathologically characterised by proliferation of prostate epithelial and stromal cells in the prostate gland [1]. As age advances, there is an increase in prostate volume, consequently leading to a gradual rise in the incidence of BPH [2]. The clinical features of BPH are the progressive development of lower urinary tract symptoms (LUTS). These can include nocturia, inadequate voiding, hesitancy, frequency and the onset of acute urinary retention [3].

BPH is the leading cause of lower urinary tract symptoms (LUTS), affecting approximately 1/4 of men worldwide [4]. Statistics state that 15 million men over the age of 30 in the United States suffer from BPH/LUTS [5]. Approximately 45% of men over the age of 45 will develop BPH, with the prevalence increasing to approximately 80% in men over the age of 70 [6, 7]. Another meta-analysis conducted in China found that the overall prevalence of BPH in men aged 40 years or older during 1989–2014 was 36.6% [8]. According to the National Bureau of Statistics of China, the proportion of the population aged 60 years and above increased from 10.8% in 2000 to 18.7% in 2020, and it is expected to reach 34% by 2050 [9].

According to the former studies, it showed that the prevalence and burden of BPH differed between high and middle Social Demographic Index (SDI) countries [10]. However, the specific differences are not further explored in this study. According to GBD 2019, China and the United States are the world's most populous middle SDI and high SDI countries

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respectively [10]. To the best of our knowledge, China and the USA have not been compared in these areas. Based on the GBD 2019 data, this research compared the burden of BPH in China and the USA from 1990 to 2019. In addition, the research also aims to advance knowledge of the epidemiological characteristics of BPH in China and the United States to provide evidence for BPH treatment and prevention.

Methods

Data resource

The data analysed in this study come from the GBD 2019 study (https://ghdx.healthdata.org/gbd-2019). The GBD 2019 database, provided by the Global Health Data Exchange (GHDx), is a creation of the Institute for Health Metrics and Evaluation (IHME) at the University of Washington, United States. An analysis of 369 diseases and injuries of different sexes and ages in 203 countries and territories was conducted in GBD 2019 to determine incidence, prevalence, Years Lived with Disability (YLD) and age-standardised rates [11].

DisModMR 2.1, a Bayesian meta-regression tool, was used in the study to produce estimates based on age, gender, year, and country [12]. The ASR (per 100,000 population) was calculated on the basis of the formula: $\mathrm{ASR} = \frac{\sum_{i=1}^{A} a_i w_i}{\sum_{i=1}^{A} w_i} \times 100,000$ (a_i, where i denotes the ith age class, and the number of people (or weight w_i) in the same age subgroup i of the selected reference standard population). The details of the methodology of the GBD 2019 study have been presented previously [11, 12].

Based on the GBD 2019, the incidence, prevalence, years lived with disability (YLD) and age-standardised rates of BPH in China and the USA were calculated from 1990 to 2019. In addition, data from the GBD 2019 were examined to determine incidence and YLD rates for 9 different age groups. These included 8 5-year periods from 40 to 80 years and a final period ≥ 80 years. Data from five other urinary tract diseases (prostate cancer, bladder cancer, urolithiasis, urinary tract infections and interstitial nephritis, male infertility) from GBD 2019 were selected for comparative analysis to further analyse the burden of disease in BPH.

Joinpoint regression analysis

Long-term trends are important for the analysis of disease incidence and YLD data. We performed joinpoint regression analysis, the Joinpoint Regression Program version 4.9.1.0 (National Cancer Institute, Rockville, MD, USA), to determine BPH incidence rates and YLD rates.

Joinpoint regression analysis used Logarithmic transformation of the rates and binomial approximation to calculate standard errors [13]. Epidemiological patterns are measured using annual percentage change (APC) and its 95% confidence interval (CI). During the period when APC values and their 95% confidence intervals were > 0, the incidence of BPH and its YLD rate increased; conversely, a decrease in the YLD and incidence rate of BPH occurred when these values were < 0; when the P value was greater than 0.05, there were no significant changes in the YLD or incidence rate of BPH during this time [14]. Monte Carlo methods were used to determine P values, and the overall significance level is asymptotically maintained by Bonferroni corrections. We calculated the average annual percentage change (AAPC) as a geometrically weighted average of different annual percent change (APC) values.

Results

Burden of BPH in China and USA

In 1990, the number of BPH incidence cases in China was 1.2755 million, and the number of prevalence cases was 9.0392 million. By 2019, these numbers had increased to 2.8365 million incidence cases and 20.3432 million prevalence cases. Compared with 1990, the incidence, prevalence, and YLD numbers for BPH in China had increased by 122.38%, 125.06%, and 123.93%, respectively, by 2019. The incidence, prevalence, and YLD number of BPH in the USA and globally had also increased in 2019 when compared to 1990. In 2019, the age-standardized prevalence, incidence, and YLD rates of BPH in China were significantly higher than those in the USA, while slightly lower than those globally (Table 1).

ASIR and ASYR trends of BPH in China and the USA

Figure s1 displays the ASIR and ASYR of BPH in China and the USA between 1990 and 2019. The results of joinpoint regression analysis are shown in Fig. 1.

The ASIR in the USA was consistently lower than China and the global average in any given year (Fig. s1a). China's ASIR was not stable, and has declined after undergoing three joinpoints. From 1990 to 2019, the ASIR decreased from 372.14/100,000 to 277.34/100,000 (AAPC − 0.40; 95% CI − 0.44 to − 0.35). The ASIR trend of the USA was also not stable, but it did not change significantly with five joinpoints. From 1990 to 2019, the ASIR varied from 195.71/100,000 to 195.60/100,000 persons (AAPC 0.00; 95% CI − 0.09 to 0.10).

Table 1 The BPH number and age-standardized rate of incidence, prevalence and YLD in China, USA and Global from 1990 to 2019

Variables	China			USA			Global		
	1990	2019	PC (%)	1990	2019	PC (%)	1990	2019	PC (%)
Incidence numbers ($\times 10^4$)	127.55 (93.98–173.63)	283.65 (217.64–374.61)	122.38	26.08 (21.24–32.33)	49.28 (41.45–59.44)	88.95	547.63 (419.99–711.58)	1126.5 (879.02–1445.54)	105.7
ASIR ($/10^5$)	312.14 (233.96–426.56)	277.34 (213.73–364.34)	− 11.15	195.71 (160.43–241.42)	195.6 (165.95–231.87)	− 0.06	285.46 (221.45–370.09)	280.4 (219.62–360.32)	− 1.77
YLD numbers ($\times 10^4$)	18.14 (10.46–28.23)	40.62 (24.13–62.31)	123.96	4.76 (2.9–6.96)	8.94 (5.68–13.2)	87.88	88.42 (52.66–133.72)	186.18 (112.77–278.23)	110.56
ASYR ($/10^5$)	51.71 (29.86–80.45)	44.04 (26.1–67.53)	− 14.82	35.55 (21.6–51.97)	34.89 (22.08–51.56)	− 1.85	50.76 (30.39–76.18)	48.9 (29.68–72.63)	− 3.67
Prevalence numbers ($\times 10^4$)	903.92 (666.37–1223.27)	2034.32 (1546.97–2617.42)	125.06	243.61 (200.40–300.18)	462.65 (412.85–525.28)	89.92	4454.05 (3452.46–5746.47)	9400.08 (7321.09–11804.76)	111.05
ASPR ($/10^5$)	2603.36 (1942.89–3477.99)	2220.85 (1713.68–2842.83)	− 14.69	1819.05 (1510.55–2222.81)	1803.06 (1617.07–2033.02)	− 0.88	2572.03 (2002.92–3265.15)	2476.97 (1942.53–3093.12)	− 3.7

YLD years lived with disability, *ASIR* age-standardized incidence rate, *ASYR* age-standardized years lived with disability rate, *ASPR* age-standardized prevalence rate, *PC* percentage change

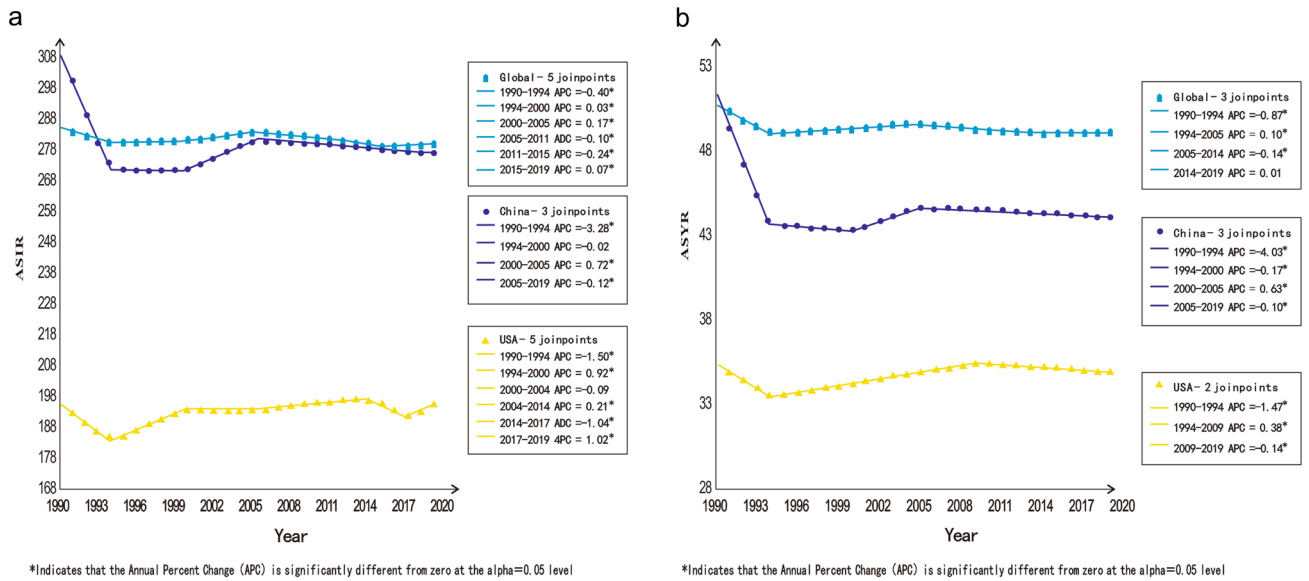

Fig. 1 The trends of ASIR (**a**) and ASYR (**b**) of BPH in China, USA and global from 1990 to 2019. *ASIR* age-standardized incidence rate, *ASYR* age-standardized years lived with disability rate

The ASYR in the USA was consistently lower than China and the global average in any given year (Fig. s1b). In China, there was a general downward trend in the ASYR from 51.71/100,000 in 1990 to 44.04/100,000 in 2019 (AAPC − 0.54; 95% CI − 0.56 to − 0.51). Similarly, there were two joinpoints in the trend of ASYR in the USA. The ASYR in the USA decreased from 1990 to 1994 and from 2009 to 2019, and increased from 1994 to 2009, despite an overall decreasing trend from 1990 to 2019 (AAPC − 0.06; 95% CI − 0.07 to − 0.04).

Incidence and YLD Rates at different ages in China and the USA

Table s1 shows that the incidence and YLD rates of BPH for various age groups in China and the USA from 1990 to

2019, together with their AAPC. In China, the incidence and YLD rates decreased in all age groups from 1990 to 2019. In the USA, the incidence rate increased in the 40–44 and 55–74 age groups, while it decreased in the 45–54 and ≥ 75 age groups from 1990 to 2019. At the same time, in 2019, the YLD rates increased in the 40–49 and ≥ 70 age groups, but decreased in the 50–69 age group compared with 1990.

YLD of 6 urinary system diseases in China, USA and global

Table s2 shows that the number of YLD for six urinary tract diseases continued to increase from 1990 to 2019 in China, the USA and Global. In 1990, the YLD numbers of BPH in China were 174,700 person-years, which was about 2.77 times that of male infertility, and accounted for 60.18% of all urinary tract diseases. In 2019, the YLD numbers of BPH increased to 406,200 person-years, which was 4.11 times that of PCa, and accounted for 61.2% of urinary tract diseases. In the USA, the YLD numbers of prostate cancer were 129,100 person-years in 1990, accounting for 63.8% of all urinary tract diseases. In 2019, the YLD numbers of PCa increased to 213,800 person-years, about 2.39 times that of BPH, and accounting for 62.9% of all urinary tract diseases (Fig. 2).

Discussion

In this study, we compared the number of incidence, prevalence, YLD and their age-standardized rate of BPH in China and USA from 1990 to 2019. The results showed an increase in the incidence, prevalence, and YLD number of BPH from 1990 to 2019 in China and USA. The ASIR and ASYR of BPH decreased in China but remained stable or decreased slightly in the United States. BPH incidence and YLD rates decreased in all age groups in China from 1990 to 2019. In the USA, they varied by age group. BPH caused more YLD number than any other urinary tract disease in China. In the USA, prostate cancer (PCa) caused more YLDs than BPH.

Compared to the year 1990, there has been a significant increase in the incidence and prevalence of BPH in 2019. This is likely attributed to advancements in diagnostic techniques and improvements in medical technology [15]. This study also found that in 2019, the number of incidence, prevalence, and YLD of BPH in China were slightly lower than the global level but much higher than in the USA. This may be due to differences in population structure [15]. For example, China has a larger population and a higher proportion of older adults than the USA, which may contribute to the higher burden of BPH in China [9, 16]. At the same time, BPH is also affected by diabetes, periodontal disease and so on. Hyperglycemia can

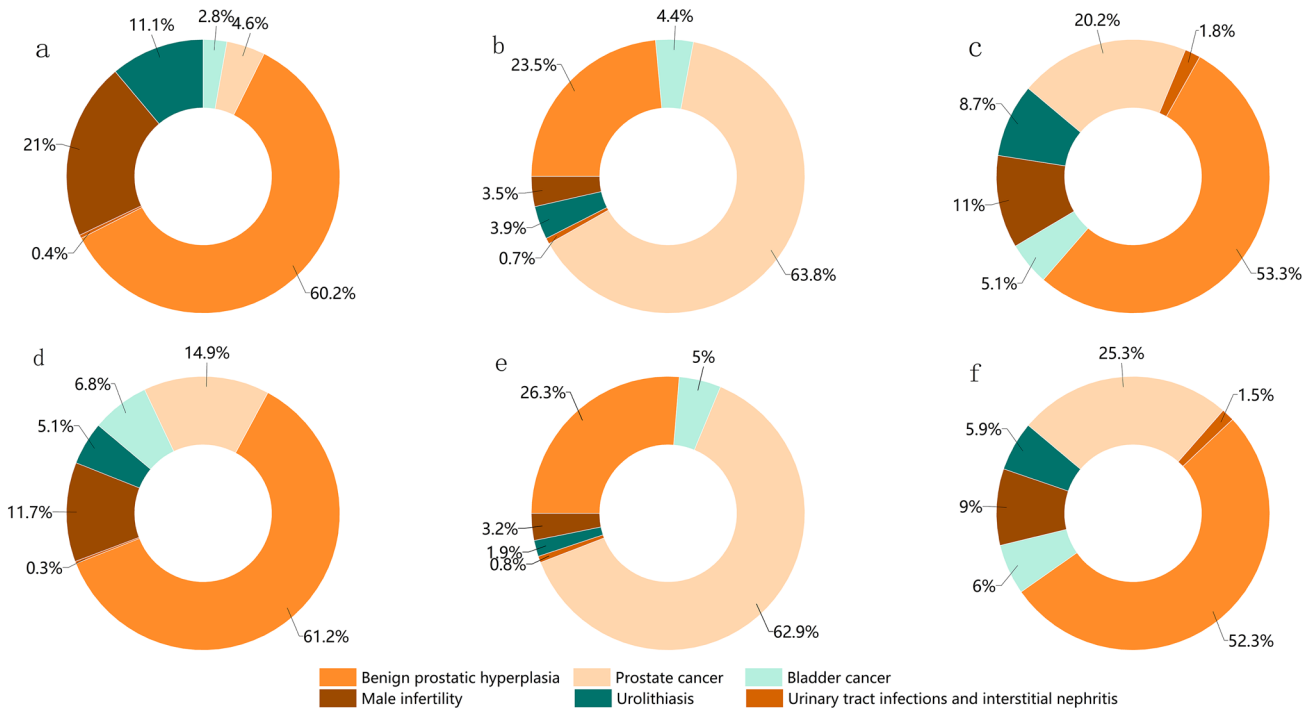

Fig. 2 Proportion of YLD numbers of 6 urinary system diseases in China 1990 (**a**) and 2019 (**d**), USA 1990 (**b**) and 2019 (**e**) and Global 1990 (**c**) and 2019 (**f**). *YLD* years lived with disability

contribute to both the incidence and progression of benign prostatic hyperplasia (BPH), as it leads to an increase in prostate volume and exacerbates lower urinary tract symptoms (LUTS) [17]. Additionally, periodontal disease has been implicated in promoting the onset and advancement of BPH by triggering systemic and local inflammatory responses within the prostate [18]. Notably, the prevalence of diabetes and periodontal disease in China surpasses that in the United States [19–21]. In addition, Yu et al. reported that geographical and ethnic factors may also be one of the reasons why the burden of BPH in China is slightly lower than the global level but much higher than the USA. A higher level of glandular density was found in Chinese prostate tissue, while a higher percentage of stroma was found in American prostate tissue [22].

The decreasing trend in the ASIR and ASYR of BPH in all age groups in China between 1990 and 2019 may be due to improvements in healthcare and increased awareness of the condition, leading to earlier detection and treatment of BPH.

In the USA, the decreasing trend in ASYR may be due to improvements in treatment and management of BPH-related complications [23]. However, the lack of a statistically significant change in ASIR in the USA suggests that the incidence of BPH has remained relatively stable over time. The YLD rates of BPH in the USA increased at 40–49, ≥ 70 years age groups and decreased at 50–69 years age group compared to 1990. This may indicate that BPH is becoming more prevalent in younger age groups in the USA. The decrease in YLD rates in the 50–69 age group may indicate better access to health care and better management of BPH in this age group.

In terms of the burden of disease, the burden of BPH ranks first among the six urinary tract diseases in China and Global, far exceeding other diseases. This may be due to the aging population in China and the high prevalence of BPH among men over the age of 50[8]. In contrast, in the USA, the burden of PCa ranks first and far exceeds other urinary tract diseases such as BPH. This may be explained by the fact that the USA has higher PCa incidence and mortality rates than other nations [24].

The disability burden of BPH is largely caused by associated complications such as acute urinary retention, recurrent urinary tract infections and renal dysfunction [18]. These complications not only affect patients' quality of life, but also place a significant financial burden on the system. According to the former study, It estimated that men over 65 years of age in the global population were burdened with $73 billion annually due to BPH [25]. In addition, BPH remains asymptomatic in the majority of cases, and when lower urinary tract symptoms (LUTS) are present, patients typically seek medical attention only when these symptoms become bothersome, which may lead to a significant underestimation of the incidence and years lived with disability (YLD) attributed to BPH [10].

Given that the data is based on the GBD 2019 study, each GBD research has a number of drawbacks. First, although the GBD team regularly updates the data and estimation model, the data may still be inaccurate. Second, the burden of BPH may be underestimated due to the clinical characteristics discussed above. Finally, specific risk factors do not appear to be associated with the burden of BPH. BPH is a non-fatal disease, and the GBD database has limited indicators available to accurately assess its disease burden. Comparing urinary diseases using YLD alone does not fully reflect the difference in disease burden. However, despite these limitations, this study still provides an important reference for determining the disease burden of BPH in China.

Conclusion

In conclusion, both in China and the United States, the absolute burden of benign prostatic hyperplasia is increasing at an astonishing rate. BPH ranked first in China and globally in terms of YLD numbers, while prostate cancer had the highest YLD numbers in the USA, followed by BPH. These insights enhance understanding of BPH dynamics, informing effective interventions across diverse contexts.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s00345-023-04658-8.

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Data availability Data will be made available on this website: (https://ghdx.healthdata.org/gbd-2019).

Declarations

Conflict of interest The authors have disclosed that they have not received any financial consideration from any person or organization to support the preparation, analysis, results, or discussion of this article. The author declares that he has no conflict of interest.

Research involving human participants and/or animals This article does not contain any studies with human participants or animals performed by any of the authors.

Informed consent For this type of study formal consent is not required.

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