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Global, Regional, and National Incidence and Year Lived with Disability for Benign Prostatic Hyperplasia from 1990 to 2019

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Abstract

The objective of this study is to provide comprehensive and up-to-date estimates on the disease burden of BPH in 204 countries and territories between 1990 and 2019. Data about incidence, year lived with disability (YLD), and their age-standardized rates (ASRs) for 21 regions, 5 Socio-demographic Index (SDI) quintiles, 204 countries and territories, and 12 age categories from 1990 to 2019 were obtained from the Global Burden of Disease 2019 study. Estimated annual percentage changes (EAPCs) of the ASRs and the associations between SDI and the ASRs were estimated. The effects of population growth, population aging, and age-specific rate on the changes in the absolute numbers of incidence and YLD were quantified. Globally, there were 11.26 million (95% uncertainty interval [UI]: 8.79, 14.46) new cases and 1.86 million (95%UI: 1.13, 2.78) YLD due to BPH in 2019. The global ASRs of incidence (EAPC: −0.031, 95% CI: −0.050, −0.012) and YLD (EAPC: −0.058, 95% CI: −0.084, −0.031) decreased slightly from 1990 to 2019, whereas the absolute numbers increased dramatically from 1990 (incidence by 105.7% and YLD by 110.6%), mainly driven by the population growth (53.5% for incidence and 54.4% for YLD) and population aging (55.7% for incidence and 63.2% for YLD). The burden of BPH varied markedly among different regions, socioeconomic status, and countries. As the population is growing and aging, great efforts are required to develop effective prevention, treatment and management strategies to meet the high and increasing burden of BPH worldwide.

Keywords

benign prostatic hyperplasia, disease burden; incidence, year lived with disability

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As one of the most common urological diseases among aging men, BPH is characterized by proliferation of both stromal and epithelial cells of the prostate in the transitional zone surrounding the urethra, often resulting in the lower urinary tract symptoms (LUTS, including urgency, frequency, nocturia, incomplete urination, and weak urinary stream) (Chughtai et al., 2016; Kim et al., 2016). It is a non-malignant disease and is often underappreciated and underdiagnosed. BPH induced LUTS is associated with reduced quality of life (Thorpe & Neal, 2003), impaired psychological well-being (Pinto et al., 2015) as well as increased health cost (Barry & Roehrborn, 2001). If left untreated, it can cause serious complications, such as urinary retention, renal insufficiency and renal failure (Lee et al., 2017). In view of these, in the context of global population growth and aging, understanding the disease burden of BPH is essential for allocating healthcare resources and developing health policy to relieve the burden.

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Although the epidemiological characteristics about BPH have been reported for different regions in previous studies (Arafa et al., 2015; Egan et al., 2015; Lee et al., 2016; Speakman et al., 2015; Zhang et al., 2019), the results varied substantially across studies and cannot be compared directly because of the inconsistences of the diagnostic criteria of BPH, sampling methods and compositions of population studied between literatures. One study reported the burden of BPH at the global level based on the GBD 2017 study (Launer et al., 2020). It only provided limited information about the YLD of BPH without comprehensive regional, national and age-specific data. To our knowledge, no study to date has quantified the effects of population growth and aging on the change of disease burden of BPH.

To provide comprehensive information about the burden of BPH from 1990 to 2019, using data obtained from the updated GBD 2019 study and focusing on the incidence and YLD, we reported the global, regional, national incidence and YLD for BPH by age and SDI, measured the ASR trends of the incidence and YLD, explored the associations between the ASRs of incidence and YLD with SDI, and analyzed the changes in incidence and YLD by decomposing those changes into the effects of three main component drivers.

Methods

Data Resource

Data analyzed in this article were obtained from the GBD 2019 study (http://ghdx.healthdata.org/gbd-results-tool). Briefly, GBD 2019 incorporated series of data sources, including surveys, censuses, vital statistics and claims data, to estimate epidemiological data for 204 countries and territories from 1990 to 2019. The 204 countries and territories were grouped into 21 regions according to their geographic locations (GBD 2019 Diseases and Injuries Collaborators, 2020). DisMod-MR 2.1 was used to model disease burden (incidence and YLD) (GBD 2019 Diseases and Injuries Collaborators, 2020). YLD was estimated as prevalence multiplied by the disability for the health state associated with the sequel (GBD 2019 Diseases and Injuries Collaborators, 2020). The details of the methodology of the GBD 2019 study have been introduced previously (GBD 2017 Disease and Injury Incidence and Prevalence Collaborators, 2018; GBD 2019 Diseases and Injuries Collaborators, 2020).

Annual male cases and the corresponding ASRs of the BPH incidence and YLD were extracted according to the locations (global, 21 regions, 204 countries and territories), SDI quintiles, and 12 age categories (5-year intervals between the ages of 40 and 94 years and ≥95 years) from 1990 to 2019.

SDI

SDI is used in GBD study as a summary measure to reflect the development status correlated with health outcomes in each location (GBD 2019 Diseases and Injuries Collaborators, 2020). In short, it is the geometric mean of 0 to 1 indices of total fertility rate for those under the age of 25, mean education for those aged 15 and older, and lag-distributed income per capita (GBD 2019 Diseases and Injuries Collaborators, 2020). Based on the SDI value in 2019, the 204 countries and territories were divided into five quintiles: high, high-middle, middle, low-middle, and low.

Statistic Methods

As a summary and widely used measure to reflect the ASR trend over a specified interval, EAPC was applied to illustrate the temporal trends for age-standardized incidence and YLD rate of BPH. A regression model with the equation $y=\alpha+\beta x+\varepsilon$ was fitted to the natural logarithm of ASR, where x stood for calendar year, and EAPC with its 95% confidence interval (95% CI) was estimated as $100 \times (\exp(\beta)-1)$ (Liu et al., 2019). A positive EAPC with 95% CI excluding zero was considered as a significant increasing trend for the ASR, while a negative EAPC with 95% CI excluding zero was considered as a significant decreasing trend for the ASR.

We employed a generalized additive model with gaussian process regression on SDI to estimate the associations between the ASRs of incidence and YLD and SDI using GBD 2019 estimates for the global and 21 regions from 1990 to 2019.

To quantify the contributions of driving factors on the changes of the incidence and YLD number from 1990 to 2019, we decomposed the changes into three factors: change in the total population, change in the age structure, and change in the age-specific rate. The observed net changes in the counts of incidence and YLD equaled to the sum of the changes of the three components. The method of decomposition analysis was developed by Das Gupta (Das Gupta, 1993) and widely used in the GBD study (GBD 2017 Risk Factor Collaborators, 2018).

Research Ethics and Patient Consent

This study was based upon publicly available data, so there are no issues about research ethics and patient consent.

Results

BPH Incidence and YLD

Globally, the estimated incidence case of BPH in 2019 was 11.26 million (95%UI: 8.79, 14.46), increasing from

5.48 million (95%UI: 4.20, 7.12) in 1990. However, the ASR of incidence of BPH decreased slightly from 285.46 (95%UI: 221.45, 370.09) per 1,00,000 persons in 1990 to 280.40 (95%UI: 219.62, 360.32) per 1,00,000 persons in 2019, with an EAPC of −0.031 (95% CI: −0.050, −0.012) (Table 1). The estimated number of YLD in 2019 was 1.86 million (95%UI: 1.13, 2.78), increasing from 0.88 million (95%UI: 0.53, 1.34) in 1990. Similar with the change trend of age-standardized incidence rate, the ASR of YLD of BPH declined slightly from 50.76 (95%UI: 30.39, 76.18) per 1,00,000 persons in 1990 to 48.90 (95%UI: 29.68, 72.63) per 1,00,000 persons in 2019, with an EAPC of −0.058 (95% CI: −0.084, −0.031) (Table 1).

From 1990 to 2019, the ASRs of incidence and YLD of BPH both increased in low-middle quintile (EAPC: 0.199, 95% CI: 0.113, 0.285; 0.264, 95% CI: 0.185, 0.342, respectively) and low quintile (EAPC: 0.336, 95% CI: 0.274, 0.399; 0.407, 95% CI:0.347, 0.466, respectively), decreased in high quintile (EAPC: −0.080, 95% CI: −0.125, −0.035; −0.073, 95% CI: −0.101, −0.044, respectively) and high-middle quintile (EAPC: −0.389, 95% CI: −0.421, −0.357; −0.443, 95% CI: −0.479, −0.408, respectively).

Among 21 GBD regions, the ASRs of incidence and YLD increased in most regions from 1990 to 2019, among which South Asia had the highest EAPCs for ASRs of incidence (0.295, 95% CI: 0.147, 0.444) and YLD (0.374, 95% CI: 0.225, 0.523) respectively. In the regions having a descending trend, Central Europe had the lowest EAPCs for ASRs of incidence (−0.172, 95% CI: −0.275, −0.069) and YLD (−0.180, 95% CI: −0.267, −0.092) respectively (Table 1).

The absolute numbers and ASRs of incidence and YLD for BPH in 204 countries and territories are displayed in eFigure 1–4 for 1990 and eFigure 5–8 for 2019. The EAPCs of age-standardized incidence and YLD rate for BPH in 204 countries and territories from 1990 to 2019 are presented in Figure 1. In terms of ASR of incidence, 16 countries had an increasing trend with the EAPCs higher than 0.2, among which India (EAPC: 0.311, 95% CI: 0.142, 0.480), Ecuador (EAPC: 0.311, 95% CI: 0.142, 0.480), Mauritius (EAPC: 0.424, 95% CI: 0.384, 0.464) increased faster, and New Zealand (EAPC: −0.303, 95% CI: −0.385, −0.221), Indonesia (EAPC: −0.319, 95% CI: −0.557, −0.080) and Poland (EAPC: −0.678, 95% CI: −0.996, −0.358) had a decreasing trend with the EAPCs lower than −0.2. The ASRs of YLD increased in 22 countries with the EAPCs higher than 0.2, among which Micronesia (EAPC: 0.3121, 95% CI: 0.270, 0.353), Pakistan (EAPC: 0.313, 95% CI: 0.297, 0.329), Vanuatu (EAPC: 0.326, 95% CI: 0.290, 0.362), India (EAPC: 0.349, 95% CI: 0.173, 0.525), Ecuador (EAPC: 0.384, 95% CI: 0.092, 0.676), Mauritius (EAPC: 0.456, 95% CI: 0.420, 0.492) increased faster. In New Zealand (EAPC: −0.323, 95% CI: −0.233, −0.221), Indonesia (EAPC: −0.434, 95% CI: −0.744, −0.124), and Poland (EAPC: −0.692, 95% CI: −1.032, −0.352), the ASRs of YLD declined with the EAPCs lower than −0.2.

Age-Specific Incidence and YLD

Globally, the counts of incidence and YLD in 1990 and 2019 both increased initially with age, peaking at 65–69 years of age, and then decreased. The incidence rate peaked between ages 65 and 69 years both in 1990 and 2019, whereas the YLD rate peaked at 75–79 years of age (Table 2). For most GBD regions and SDI quintiles in 2019, the peaking age groups for incidence and YLD case and age-specific rate were similar with those globally (eFigure 9 and eFigure 10).

Associations Between SDI and ASRs of Incidence and YLD

The relations between SDI and age-standardized incidence and YLD rate for each GBD region from 1990 to 2019 were illustrated in Figure 2. The estimated associations between SDI and expected ASRs of incidence and YLD had similar pattern, as both increasing firstly and then declining gradually with the increase of SDI. For most GBD regions, the ASRs of BPH incidence and YLD remained stable with the gains in SDI over time. South Asia, Southeast Asia, Central Europe, Eastern Europe, Andean Latin America, Central Latin America, Oceania had a higher age-standardized BPH incidence and YLD rate than expected values based on their SDI for all years from 1990 to 2019, among which Eastern Europe had the highest age-standardized rates.

Decomposition Analysis

From 1990 to 2019, the global numbers of incidence and YLD increased by 105.7% and 110.6% respectively. All SDI quintiles and GBD regions experienced increases in the incidence and YLD number, with three SDI quintiles (low-middle, low and middle quintile) increasing by more than 100% for both these two numbers. Simultaneously, the incident cases in 12 GBD regions and the YLDs in 13 GBD regions increased exceeding 100% respectively. The growths of the incidence and YLD number for Andean Latin America were greatest, both exceeding 200% (Figure 3). The effects of driving factors on the changes of the incidence and YLD number were analogous. Population growth and population aging were the main contributors (Figure 3).

Table 1. The Incidence, YLDs and ASR of BPH in 1990 and 2019, and Their Temporal Trends in 1990 and 2019.

	Incidence					YLD				
	Cases in 1990 (No.×10^3)	ASR in 1990 (per 1,00,000 persons)	Cases in 2019 (No.×10^3)	ASR in 2019 (per 1,00,000 persons)	EAPC	Cases in 1990 (No.×10^3)	ASR in 1990 (per 1,00,000 persons)	Cases in 2019 (No.×10^3)	ASR in 2019 (per 1,00,000 persons)	EAPC
Global	5476.30 (4199.88, 7115.78)	285.46 (221.45, 370.09)	11264.99 (8790.18, 14455.39)	280.40 (219.62, 360.32)	−0.031 (−0.050, −0.012)	884.19 (526.63, 1337.22)	50.76 (30.39, 76.18)	1861.78 (1127.72, 2782.26)	48.90 (29.68, 72.63)	−0.058 (−0.084, −0.031)
SDI quintile										
High SDI	981.71 (775.22, 1238.17)	214.15 (169.84, 269.58)	1730.15 (1389.43, 2152.77)	207.64 (167.64, 257.88)	−0.080 (−0.125, −0.035)	173.31 (104.78, 255.28)	38.70 (23.49, 56.82)	321.40 (198.49, 468.42)	37.08 (22.77, 54.05)	−0.073 (−0.101, −0.044)
High-middle SDI	1745.27 (1348.38, 2255.77)	352.31 (275.41, 452.00)	3036.92 (2373.11, 3888.57)	311.27 (243.32, 398.47)	−0.389 (−0.421, −0.357)	285.18 (170.74, 429.06)	63.91 (38.19, 95.49)	509.49 (308.29, 760.32)	55.03 (33.36, 81.73)	−0.443 (−0.479, −0.408)
Middle SDI	1621.80 (1229.67, 2132.04)	316.71 (244.15, 415.65)	3416.26 (2663.68, 4409.73)	272.30 (212.87, 351.87)	0.074 (−0.085, 0.232)	249.82 (147.04, 384.16)	55.91 (33.14, 84.48)	598.43 (357.82, 897.79)	52.61 (31.72, 78.37)	−0.004 (−0.086, 0.079)
Low-middle SDI	881.63 (665.87, 1163.21)	279.79 (213.18, 367.70)	2076.02 (1581.86, 2702.60)	307.22 (235.58, 400.80)	0.199 (0.113, 0.285)	137.66 (81.47, 212.69)	49.59 (29.24, 76.75)	341.66 (202.40, 518.23)	55.28 (33.08, 83.44)	0.264 (0.185, 0.342)
Low SDI	242.96 (182.09, 324.55)	191.48 (143.31, 253.13)	516.63 (392.22, 676.49)	200.15 (151.88, 264.06)	0.336 (0.274, 0.399)	37.73 (22.03, 59.07)	33.77 (19.80, 52.22)	89.79 (53.32, 137.70)	39.24 (23.19, 59.44)	0.407 (0.347, 0.466)
Region										
Andean Latin America	35.50 (26.85, 46.87)	354.22 (268.42, 466.13)	106.98 (80.93, 137.81)	394.79 (298.63, 508.45)	0.153 (0.026, 0.279)	5.96 (3.46, 9.36)	64.25 (37.38, 101.12)	18.84 (11.26, 28.59)	71.93 (43.12, 108.59)	0.135 (0.005, 0.265)
Australasia	27.57 (20.53, 36.49)	246.18 (184.92, 325.79)	54.58 (41.27, 72.35)	237.28 (179.69, 313.44)	−0.051 (−0.078, −0.024)	4.30 (2.57, 6.65)	39.88 (23.82, 61.76)	9.36 (5.48, 14.38)	39.09 (22.85, 60.23)	−0.040 (−0.060, −0.020)
Caribbean	38.78 (29.20, 51.03)	305.91 (230.47, 402.96)	77.99 (58.73, 103.13)	314.62 (237.33, 417.48)	0.056 (0.002, 0.111)	6.74 (3.96, 10.48)	54.40 (32.05, 84.58)	13.32 (7.80, 20.60)	55.16 (32.24, 85.06)	0.018 (−0.017, 0.052)
Central Asia	54.16 (40.99, 71.95)	279.30 (213.07, 367.62)	100.19 (76.66, 130.50)	289.42 (224.58, 376.01)	0.094 (0.037, 0.151)	8.62 (5.00, 12.97)	50.03 (29.18, 75.35)	15.19 (8.92, 22.99)	51.71 (30.52, 77.53)	0.054 (0.013, 0.095)
Central Europe	258.55 (205.25, 326.67)	382.29 (305.97, 482.97)	325.71 (260.32, 407.13)	341.13 (276.85, 420.80)	−0.172 (−0.275, −0.069)	43.41 (26.49, 63.78)	69.32 (42.13, 102.01)	58.44 (36.42, 85.66)	61.83 (38.57, 90.21)	−0.180 (−0.267, −0.092)
Central Latin America	175.33 (138.83, 218.54)	431.93 (340.13, 542.27)	485.51 (389.26, 604.65)	436.91 (349.50, 544.21)	0.037 (0.014, 0.060)	30.42 (18.61, 45.60)	82.16 (50.27, 122.85)	86.21 (52.66, 127.62)	81.77 (50.21, 120.62)	−0.001 (−0.027, 0.025)
Central Sub-Saharan Africa	14.24 (10.47, 19.36)	127.34 (94.42, 170.47)	31.65 (22.98, 43.41)	127.43 (94.12, 171.33)	0.011 (0.002, 0.020)	2.12 (1.23, 3.37)	21.75 (12.74, 34.10)	4.52 (2.57, 7.24)	21.78 (12.59, 34.10)	0.029 (0.021, 0.037)
East Asia	1334.10 (984.38, 1811.65)	314.93 (236.36, 429.43)	2965.32 (2275.86, 3916.14)	280.96 (216.89, 368.91)	−0.087 (−0.201, 0.026)	189.93 (109.56, 295.34)	52.36 (30.24, 81.30)	427.49 (253.82, 656.07)	45.04 (26.69, 68.95)	−0.160 (−0.297, −0.022)
Eastern Europe	686.65 (536.06, 874.52)	624.31 (495.41, 780.83)	904.12 (705.18, 1146.06)	629.82 (500.32, 790.30)	0.036 (0.002, 0.070)	116.72 (69.31, 177.85)	126.51 (76.32, 188.23)	167.50 (99.12, 253.41)	128.09 (76.46, 189.95)	0.034 (0.023, 0.045)
Eastern Sub-Saharan Africa	50.85 (37.24, 68.01)	132.28 (97.47, 177.32)	104.51 (77.35, 140.44)	132.58 (97.64, 177.49)	0.004 (−0.011, 0.018)	7.84 (4.54, 12.27)	22.85 (13.30, 35.48)	15.94 (9.17, 24.82)	22.97 (13.18, 35.54)	0.022 (0.012, 0.032)

(continued)

Table 1. (continued)

	Incidence					YLD				
	Cases in 1990 (No.×10^3)	ASR in 1990 (per 1,00,000 persons)	Cases in 2019 (No.×10^3)	ASR in 2019 (per 1,00,000 persons)	EAPC	Cases in 1990 (No.×10^3)	ASR in 1990 (per 1,00,000 persons)	Cases in 2019 (No.×10^3)	ASR in 2019 (per 1,00,000 persons)	EAPC
High-income Asia Pacific	138.15 (104.12, 183.83)	145.99 (108.92, 195.22)	247.62 (186.28, 325.12)	137.75 (104.23, 181.27)	−0.085 (−0.142, −0.028)	21.85 (12.69, 33.70)	25.04 (14.60, 38.42)	47.67 (28.00, 73.05)	23.84 (14.03, 36.17)	−0.099 (−0.138, −0.06)
High-income North America	289.32 (234.63, 362.04)	195.54 (159.35, 242.02)	553.97 (463.54, 666.92)	195.81 (165.90, 233.77)	0.119 (0.062, 0.176)	52.55 (32.09, 77.07)	35.44 (21.50, 51.65)	100.74 (64.28, 147.67)	34.93 (22.38, 51.39)	0.118 (0.065, 0.171)
North Africa and Middle East	97.72 (71.19, 131.71)	107.68 (80.00, 145.08)	253.20 (187.05, 337.53)	110.72 (81.62, 147.69)	0.084 (0.073, 0.096)	15.72 (9.10, 24.75)	19.16 (11.09, 29.77)	40.59 (23.34, 63.44)	19.59 (11.40, 30.30)	0.065 (0.054, 0.077)
Oceania	5.41 (4.02, 7.16)	354.92 (267.43, 471.02)	13.40 (10.06, 17.56)	374.69 (282.76, 494.07)	0.190 (0.161, 0.219)	0.78 (0.45, 1.18)	61.04 (35.55, 92.34)	1.92 (1.12, 2.94)	64.36 (38, 97.96)	0.222 (0.192, 0.252)
South Asia	916.98 (689.61, 1223.11)	291.64 (220.06, 382.81)	2518.04 (1903.73, 3283.56)	348.05 (264.35, 455.89)	0.295 (0.147, 0.444)	143.27 (83.82, 222.59)	52.71 (30.93, 82.02)	417.82 (244.56, 640.90)	63.57 (37.47, 96.51)	0.374 (0.225, 0.523)
Southeast Asia	535.28 (409.90, 690.56)	427.79 (330.15, 552.17)	1167.68 (900.54, 1504.08)	390.85 (305.31, 505.60)	−0.089 (−0.186, 0.007)	87.08 (51.55, 131.60)	79.20 (46.98, 119.43)	184.29 (108.34, 277.06)	69.74 (41.80, 104.04)	−0.139 (−0.261, −0.017)
Southern Latin America	31.27 (23.05, 42.04)	145.96 (108.11, 195.20)	53.83 (39.53, 72.34)	143.46 (105.41, 192.59)	0.065 (0.022, 0.108)	5.09 (2.93, 7.91)	24.83 (14.28, 38.04)	9.21 (5.31, 14.39)	24.82 (14.39, 38.57)	0.067 (0.043, 0.092)
Southern Sub-Saharan Africa	23.13 (17.20, 31.02)	188.09 (140.91, 250.78)	48.02 (35.78, 63.81)	193.24 (143.27, 257.61)	0.117 (0.087, 0.147)	3.75 (2.21, 5.89)	33.70 (19.43, 52.93)	7.64 (4.50, 12.04)	34.61 (20.18, 53.54)	0.119 (0.090, 0.148)
Tropical Latin America	92.73 (74.07, 116.44)	210.71 (167.50, 265.51)	229.27 (183.75, 282.70)	201.11 (161.30, 249.09)	−0.033 (−0.093, 0.028)	14.38 (8.80, 21.42)	35.81 (22.08, 52.80)	36.95 (22.67, 54.74)	34.28 (20.95, 50.33)	−0.047 (−0.102, 0.009)
Western Europe	611.35 (482.72, 776.22)	247.33 (195.98, 312.59)	907.71 (718.68, 1141.31)	243.82 (194.49, 304.81)	−0.035 (−0.106, 0.037)	114.49 (69.22, 169.61)	46.44 (28.09, 68.84)	180.11 (110.46, 263.37)	44.90 (27.41, 65.65)	−0.082 (−0.107, −0.058)
Western Sub-Saharan Africa	59.23 (43.56, 79.17)	127.23 (94.01, 169.28)	115.68 (85.77, 155.25)	127.28 (94.42, 170.92)	0.031 (0.02, 0.042)	9.17 (5.35, 14.39)	22.13 (12.85, 34.14)	18.03 (10.42, 28.17)	22.18 (12.73, 34.32)	0.042 (0.031, 0.053)

Note. YLD = years lived with disability; ASR = age-standardized rate; BPH = benign prostatic hyperplasia; EAPC = estimated annual percentage change; SDI = socio-demographic index.

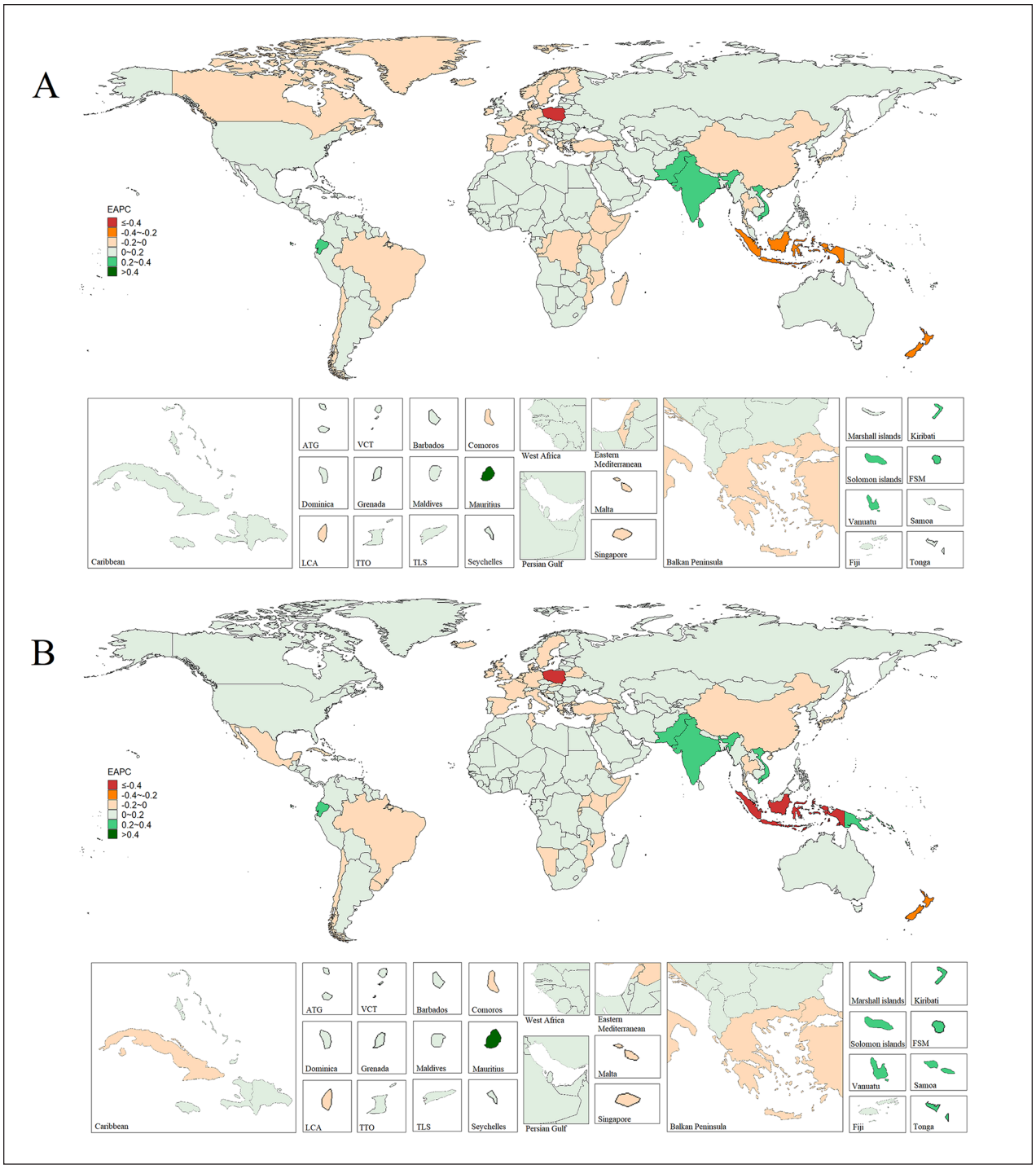

Figure 1. EAPCs of ASRs of incidence and YLD for BPH, 1990–2019.
(A) Incidence. (B) YLD. EAPC = estimated annual percentage change; ASR = age-standardized rate; YLD = year lived with disability; BPH = benign prostatic hyperplasia; ATG =Antigua and Barbuda; FSM = Federated States of Micronesia; LCA = Saint Lucia; TLS = Timor-Leste; TTO = Trinidad and Tobago; VCT = Saint Vincent and the Grenadines.

Population aging led to the increased incidence and YLD numbers for most GBD regions and SDI quintiles. For incidence case, the contributions ranged from lower than 30% in Oceania to greater than 100% in East Asia and Central Latin America. For YLDs, the contributions ranged from lower than 30% in Central Asia and Oceania

Table 2. The Incidence and YLD of BPH of Different Age Group Globally in 1990 and 2019.

	Incidence				YLD			
Age group	Cases in 1990 (No.$\times 10^3$)	Rate in 1990 (per 1,00,000 persons)	Cases in 2019 (No.$\times 10^3$)	Rate in 2019 (per 1,00,000 persons)	Cases in 1990 (No.$\times 10^3$)	Rate in 1990 (per 1,00,000 persons)	Cases in 2019 (No.$\times 10^3$)	Rate in 2019 (per 1,00,000 persons)
40–44	67.82 (39.84, 112.74)	46.40 (27.26, 77.12)	108.39 (66.81, 176.08)	43.57 (26.86, 70.79)	2.12 (1.01, 4.08)	1.45 (0.69, 2.79)	3.63 (1.80, 6.60)	1.46 (0.72, 2.65)
45–49	199.60 (107.80, 350.69)	168.41 (90.96, 295.89)	332.08 (175.28, 589.76)	139.31 (73.53, 247.41)	14.81 (6.95, 27.66)	12.49 (5.87, 23.33)	25.86 (12.44, 46.59)	10.85 (5.22, 19.55)
50–54	536.58 (338.24, 786.34)	498.43 (314.19, 730.44)	892.45 (559.55, 1299.35)	410.16 (257.16, 597.17)	46.83 (23.99, 81.24)	43.50 (22.29, 75.46)	77.04 (40.14, 130.83)	35.41 (18.45, 60.13)
55–59	891.26 (469.08, 1446.15)	957.90 (504.16, 1554.28)	1562.48 (838.41, 2487.26)	854.93 (458.74, 1360.93)	102.85 (52.77, 169.59)	110.54 (56.71, 182.27)	176.71 (91.98, 289.59)	96.69 (50.33, 158.45)
60–64	1265.35 (883.50, 1739.59)	1610.22 (1124.30, 2213.72)	2343.17 (1663.74, 3183.65)	1539.99 (1093.46, 2092.38)	168.90 (90.16, 280.12)	214.93 (114.74, 356.47)	291.35 (159.70, 479.49)	191.48 (104.96, 315.14)
65–69	1242.07 (739.36, 1919.21)	2169.26 (1291.28, 3351.88)	2830.14 (1711.92, 4239.40)	2289.45 (1384.86, 3429.47)	190.55 (109.88, 295.00)	332.79 (191.91, 515.21)	399.45 (233.10, 619.52)	323.13 (188.57, 501.16)
70–74	761.58 (480.68, 1084.48)	2029.70 (1281.08, 2890.27)	1889.91 (1249.03, 2636.57)	2145.10 (1417.68, 2992.58)	161.63 (90.47, 256.18)	430.77 (241.11, 682.74)	384.08 (216.26, 607.66)	435.94 (245.47, 689.71)
75–79	369.47 (236.12, 552.22)	1474.47 (942.30, 2203.77)	880.95 (577.17, 1301.51)	1539.99 (1008.96, 2275.16)	117.91 (68.44, 184.64)	470.53 (273.14, 736.86)	269.46 (159.25, 416.98)	471.04 (278.38, 728.93)
80–84	119.37 (56.25, 211.67)	905.60 (426.76, 1605.81)	344.22 (172.13, 593.24)	976.84 (488.48, 1683.54)	57.43 (33.77, 89.13)	435.64 (256.18, 676.17)	158.16 (93.42, 245.34)	448.84 (265.11, 696.25)
85–89	20.36 (11.56, 32.56)	409.32 (232.52, 654.74)	69.56 (40.69, 109.86)	427.19 (249.89, 674.70)	17.51 (9.91, 27.39)	352.07 (199.20, 550.68)	59.39 (34.49, 91.87)	364.73 (211.84, 564.21)
90–94	2.32 (1.05, 4.29)	186.39 (84.64, 345.50)	9.32 (4.21, 17.08)	175.60 (79.40, 321.86)	3.16 (1.80, 5.00)	254.56 (145.26, 402.28)	14.15 (8.17, 21.82)	266.59 (153.99, 411.17)
≥95	0.53 (0.21, 1.15)	207.45 (81.71, 451.73)	2.31 (0.91, 5.07)	180.71 (71.60, 397.51)	0.50 (0.29, 0.79)	195.38 (112.79, 308.27)	2.50 (1.49, 3.88)	195.79 (116.42, 304.23)

Note. YLD = years lived with disability; BPH = benign prostatic hyperplasia.

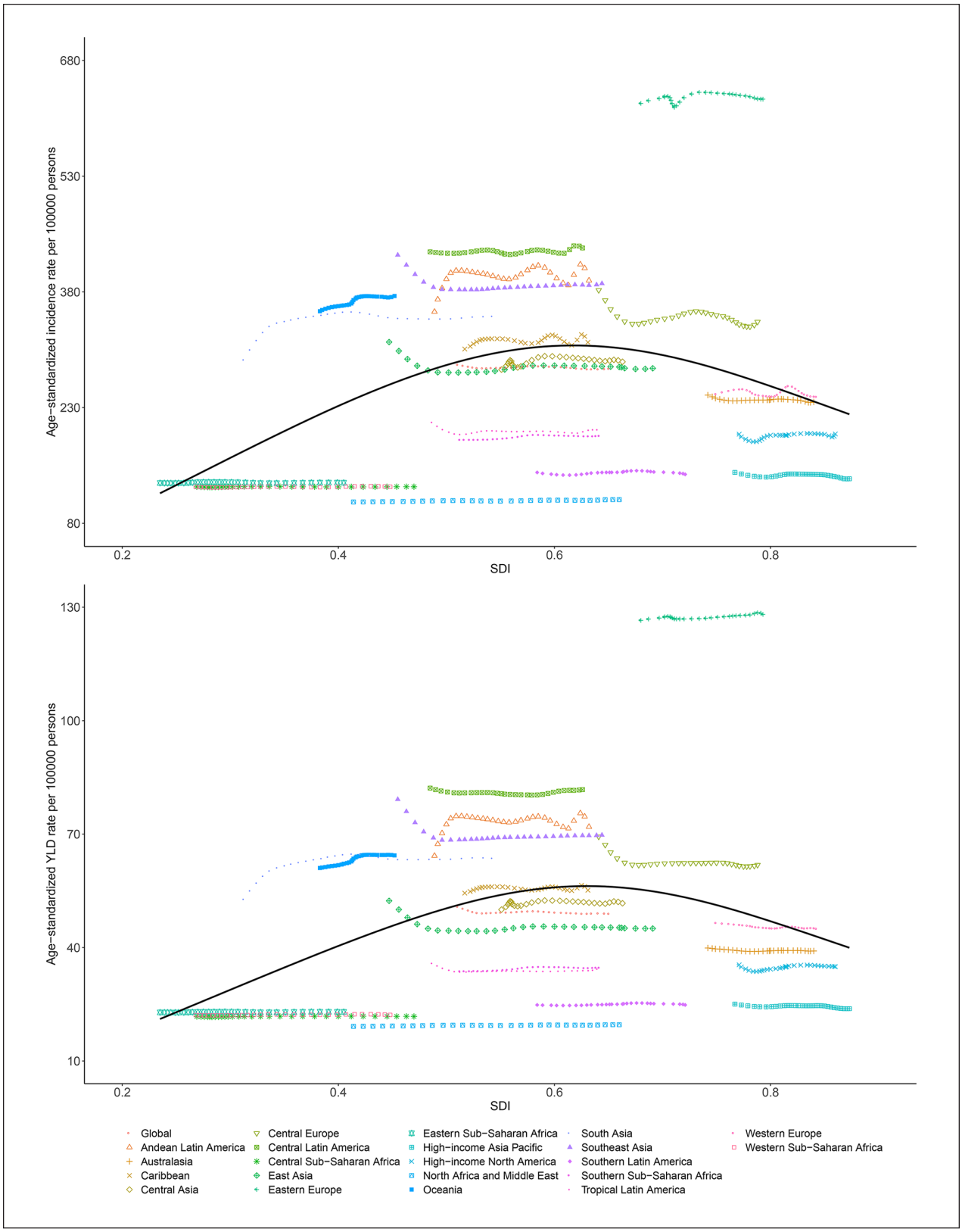

Figure 2. The associations between SDI with ASRs of incidence and YLD of BPH for GBD regions, 1990–2019.
(A) Incidence. (B) YLD. Each point represents actual global and region values for ASR starting at 1990 and ending at 2017. Black line represents expected values on the basis of SDI alone. ASR = age-standardized rate; YLD = year lived with disability; BPH = benign prostatic hyperplasia; SDI = socio-demographic index; GBD = global burden of diseases.

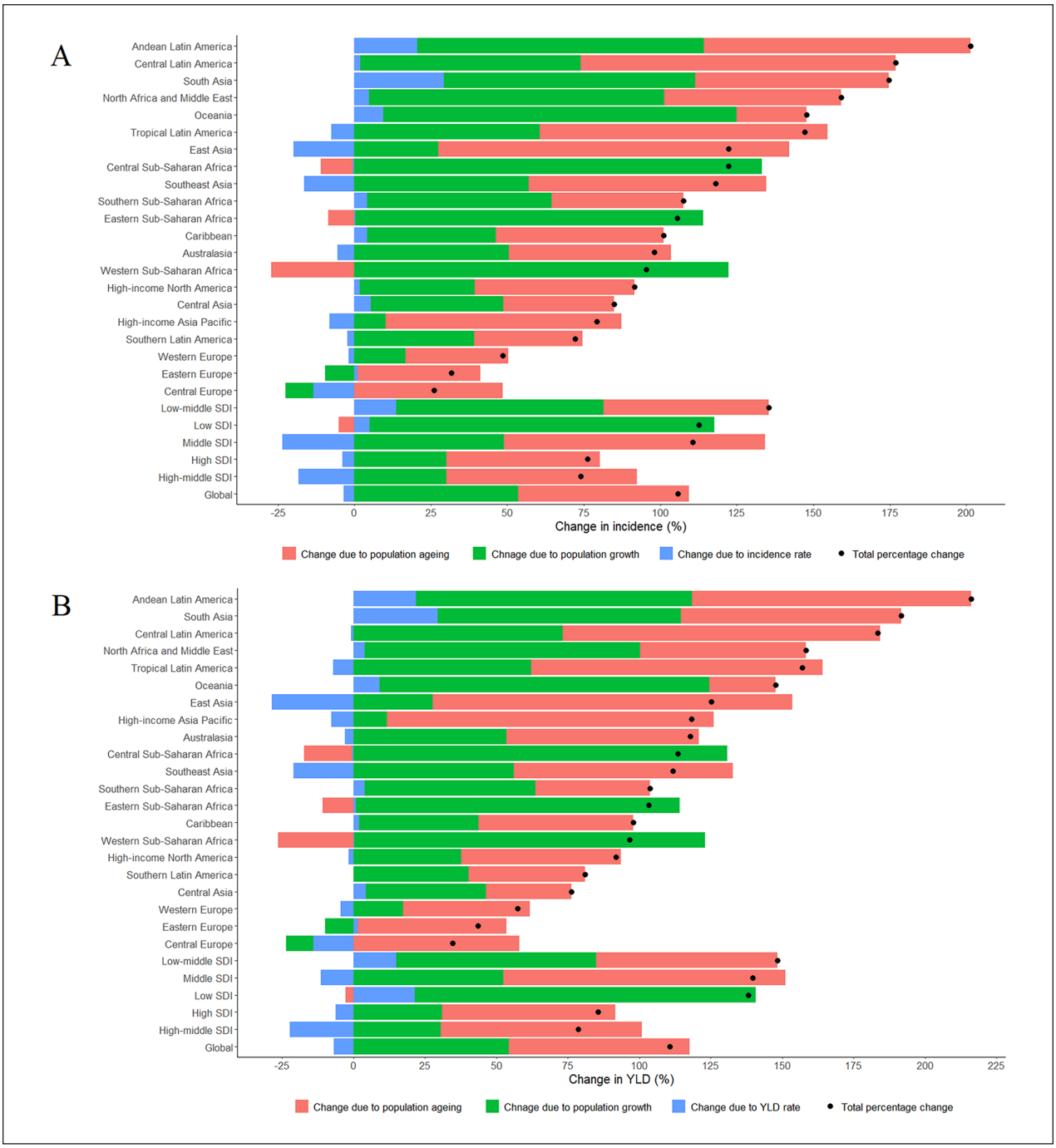

Figure 3. Percentage changes in absolute numbers of incidence and YLD for BPH due to population growth, population ageing, and age-specific rate, 1990–2019.
(A) Incidence. (B) YLD. YLD=Year lived with disability. BPH=Benign prostatic hyperplasia.

to greater than 100% in East Asia, High-income Asia Pacific, Central Latin America and Tropical Latin America. Conversely, population aging resulted in the reductions in incidence numbers for Western Sub-Saharan Africa (−27.0%), Central Sub-Saharan Africa (−10.6%), Eastern Sub-Saharan Africa (−8.5%) and low SDI quintile (−5.0%), and in YLDs for Western Sub-Saharan Africa (−26.4%), Central Sub-Saharan Africa (−17.0%), Eastern Sub-Saharan Africa (−10.8%) and low SDI quintile (−2.7%) (Figure 3).

Except for Central Europe and Eastern Europe, population growth had a positive effect on the increases in

incidence and YLD number in other GBD regions and all SDI quintiles. The contributions in Central Sub-Saharan Africa (133.3% for incidence case and 130.7% for YLD), Western Sub-Saharan Africa (122.3% for incidence case and 122.7% for YLD), Oceania (115.3% for incidence case and 115.3% for YLD), Eastern Sub-Saharan Africa (113.8% for incidence case and 113.1% for YLD) and low SDI quintile (112.6% for incident case and 119.2% for YLD) exceeding 100% (Figure 3).

The contributions of age-specific rates on the changes of absolute cases varied markedly among GBD regions and SDI quintiles. The contributions of age-specific rate of incidence on the growth of absolute number of incidence for 21 GBD regions and 5 SDI quantiles ranged from −23.5% to 29.4%. It contributed to the declines in 10 GBD regions and 3 SDI quintiles, and to the growths in 11 GBD regions and 2 SDI quintiles. For the age-specific rate of YLD, it caused the declines of the absolute number of YLD in 10 GBD regions and 3 SDI quintiles, and caused the growths of the absolute number of YLD in 11 GBD regions and 2 SDI quintiles, ranging from −28.4% to 29.5% (Figure 3).

Discussion

The global ASRs of incidence and YLD decreased slightly from 1990 to 2019, but the absolute numbers of incidence and YLD increased considerably from 5.48 million in 1990 to 11.26 million in 2019 and from 0.88 million in 1990 to 1.86 million in 2019 respectively. The increases were mainly driven by the population growth (53.5% for incidence and 54.4% for YLD) and population aging (55.7% for incidence and 63.2% for YLD).

We have observed that the growths of ASRs of incidence and YLD juxtaposed with the increases of absolute numbers of corresponding index occurred in most countries and territories. Notably, more than half of the GBD regions have a doubled counts of incident case and YLD. And our results proved that the increases were mainly driven by the population growth and aging. These phenomena suggest that the current efforts and health services are not sufficient and effective to alleviate the BPH burden. With the global population growing and the population aging aggravating continuously, and the incidence rate specifically increasing with age and peaking at the 65–69 years of age group as reported in this study, the burden of BPH is likely to continue increasing, placing considerable pressure on the healthcare system(Devlin et al., 2020; Speakman et al., 2015).

The burden of BPH varied markedly among countries and territories. China had the largest new incident case (2.83 million) and YLD (0.41 million) in 2019, whereas the annual new cases and YLDs in Tolelau, Niue, Nauru were far less than one thousand. The ASRs of incidence and YLD in Lithuania were 6-fold and 7-fold higher than those in Syria, Yemen and Turkey, respectively. The total population and ageing population are the most important factors accounting for the variability. In addition, the heterogeneity in research methods of different data sources, especially the BPH definition, is another factor. Although BPH is a histological diagnosis, it is typically diagnosed on the basis of LUTS in clinical practice. For example, Garraway et al. (Garraway et al., 1991) defined BPH based on the ultrasound determined prostate enlargement and urinary symptom. Chokkalingam et al. (Chokkalingam et al., 2012) defined BPH with the combination of digital rectal examination and self-reported International Prostate Symptom Score. A study identified that the difference in patient management by urologists across Europe was great with 10% of patients in France receiving no examinations at presentation, compared with 0.5% in Poland (Hutchison et al., 2006). It indicates that different healthcare tradition, manpower and training may influence the diagnosis of BPH, resulting in the diversity of BPH burden.

Although the BPH burden reported in this study is tremendous and increasing, the actual situation may be more serious, as there is a probability that the incidence and YLD of BPH are underreported. Not all BPH is symptomatic (Sarma & Wei, 2012) and it becomes a clinical entity only when LUTS associated with it are bothersome enough for a patient to seek medical care (Egan, 2016). Thus, men with asymptomatic BPH may not be diagnosed. Simultaneously, although rare, BPH can cause deaths as a consequence of LUTS induced renal failure and infection (Launer et al., 2020). But the methodology of the GBD study assigned no deaths to the diagnosis of BPH, resulting in the underestimate of the total impact of this disease.

Our results imply that the socioeconomic status might be associated with the burden of BPH. Considering the growth of BPH burden in different SDI categories, the increases of incidence and YLD case in the low, low-middle and middle quintile were all over 100%, much higher than those in the high-middle and high quintile. At the same time, the change trends of ASRs of incidence and YLD were negative in the high-middle and high quintile, stable in the middle quintile, whilst positive in the low, low-middle and middle quintile. These are aligned with the results that expected ASRs elevated first and then declined with the increase of SDI. Before an SDI of 0.6, the increases of ASRs might be attributed to the better healthcare access and disease recognition with the development of socioeconomic level. When socioeconomic status developed to a certain level, the high quality of medical care reduces the impact of BPH on the health of patients, resulting in a decrease in ASR of YLD. But this cannot explain the decline in ASR of incidence in regions

with high SDI, as the risk factors of BPH, such as obesity (Chughtai et al., 2016; Li et al., 2019), diabetes (Chughtai et al., 2016) and periodontal disease (Fang et al., 2021; Wu et al., 2019), are prevalent in countries with high socioeconomic status (Afshin et al., 2017; Khan et al., 2020).

The study findings have important health service implications. First, the increase in number of people affected by BPH means that more human resources are needed for their management. For example, studies estimated that the ratio of urologist to population was about 4.3 per 100,000 in South Korean(Oh, 2017), 3.50 per 10,0000 in USA (McKibben et al., 2016), and anticipated that the growth rate of manpower could not keep up with the rate of population aging, resulting in the shortage of manpower. Second, financial burden related to BPH will increase significant in the next several decades. In 2006, a cross-sectional survey in six European countries revealed that the mean one-year treatment costs were €858 per patient, three quarters of which concerned medication costs (van Exel et al., 2006). In 2006, UK spent £44 million on primary care, £69 million on drug treatment, and £101 million for treating BPH associated complications, such as AUR (Devlin et al., 2020). In 2019, an estimate based on a cost and treatment pattern reflective of USA Medicare costs reported that the global medical service costs of BPH reached $73.8 billion annually (Launer et al., 2020). The financial impact of BPH has increased dramatically and will continue to do so. Third, researches on pathogenesis, treatment and intervention of BPH need to be enhanced. The pathophysiology of BPH is still poorly understood, restricting the development of new effective medications (Chughtai et al., 2016; Sarma & Wei, 2012). A review compared newer drugs, which were approved or studied for BPH since 2008, with medications which were approved before 2008 (Dahm et al., 2017). The results identified that none of the new drugs or drug combinations had outcomes superior to traditional alpha-blockers medications (Dahm et al., 2017). Interventions targeting risk factors of BPH also should be explored to reduce the risk of development or deterioration of BPH.

As data were abstracted from the GBD 2019 study, several limitations shared by all GBD studies should be acknowledged. First, although extensive efforts had been made by GBD collaborations to identify data sources, data is sparse in many countries. To solve this problem, the DisMod 2.1, a complicated mathematical model, and the assumption of similarity through geographical proximity were based on for calculation. Second, as discussed above, the burden of BPH might be underestimated due to the disease characteristic and study methodology. Finally, it does not provide information about the BPH burden attributable to specific risk factors. Calculating contributions of risk factors can help to interpret geographic and temporal patterns of burden, as well as implement interventions and non-pharmaceutical management.

In conclusion, attributed to the population growth and aging, the burden of BPH is high and increasing worldwide, and it may associate with the socioeconomic status. There still exists disparity between the burden and the health service response. Great efforts, including policy, research and health service, are required to tackle this challenge.

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Supplemental Material

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