Original Article

Estimates of over-time trends in incidence and mortality of prostate cancer from 1990 to 2030

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Background: This research aims to identify the current and future trends in the incidence and death rate of prostate cancer and to provide the necessary data support for making relevant health decisions.

Methods: This study used the collected data and methodologies to describe the incidence and mortality trends of prostate cancer from 1990 to 2016. Based on the data, this paper projected the future trends in prostate cancer incidence and death rate.

Results: In 2016, prostate cancer cases [1,435,742; 95% uncertainty interval (UI), 1,293,395–1,618,655] were nearly 2.5-fold the number in 1990 (579,457; 95% UI, 521,564–616,107). Deaths increased by 2.0-fold from 191,687 (95% UI, 168,885–209,254) in 1990 to 380,916 (95% UI, 320,808–412,868) in 2016. The global age-standardized incidence rate (ASIR) increased from 17.75 (95% UI, 18.91–15.95) in 1990 to 22.12 (95% UI, 19.92–24.91) in 2016, changing 24.62%. The global change of age-standardized death rate (ASDR) has declined slightly, but in some regions it shows a trend of growth. By sociodemographic index (SDI) sub-types, prostate cancer will frequently occur in high SDI countries from 1990 to 2030. Simultaneously, the highest mortality will present in low SDI countries.

Conclusions: Through projecting and analyzing incidence and mortality rate of prostate cancer, from 1990 to 2030, by different ages, regions and SDI sub-types, this result may reveal the relationship between prostate cancer and financial development. At the same time, the result also showed a sufficiently heavy burden of prostate cancer, but the burden varies greatly in each region. The burden is a challenge and will require attention for all levels of society. The current study is beneficial to formulate more specific and efficient policies.

Keywords: Prostate cancer; incidence; mortality; time trends; projection

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Introduction

Prostate cancer, a common urologic malignant tumor, has become one of the most significant reasons for male health problems (1), and contributes to increased mortality. Due to changes in current population habits, customs and age structure, the number of elder men with prostate cancer has rapidly increased (2), and cancer-related deaths have also grown substantially. Besides, the risk factors of prostate cancer are various containing modifiable behavioral, metabolic, and environmental factors.

Owing to cancer incidence and death rate variety, the interest in prostate cancer-related burdens reached unprecedented heights (3,4). For different regions, suitable health policies for prostate cancer, containing cancer control and implementation plans, are relatively rare and the difficulty in policies making must be the absence of necessary data. This study therefore aims to describe the global burden of prostate cancer from 1990 to 2016 by age, region, and sociodemographic index (SDI) (a summary indicator of income per capita, educational attainment, and fertility), and afterwards project the fluctuation tendency for age-standardized morbidity and death rate to 2030 worldwide. Understanding these factors is necessary for detecting prostate cancer etiologies and their trends over time, without which targeted prevention strategies are impossible to design and evaluate, and promote strategic investments into research and clinical resources. At present, there are many researches on the burden of prostate cancer, but almost are based on the summary and analysis of the existing data, and few studies combined with the prediction of future morbidity and mortality trends. The practical significance of this kind of research should also be given enough attention.

Herein, we estimated the incidence, mortality trends in 195 countries and regions of prostate cancer from 1990 to 2016, and then, predicted the future trends, to 2030.

Methods

Data collection

In this study, researchers in our research team collected existing data from Global Burden of Disease data base (GBD) (ghdx.healthdata.org) by logging in and download the relevant data.

Data analysis

Previous papers have reported the common data analysis method and malignant tumor estimation model (5-11). Herein we present methods pertaining to the cancer outcomes for the incidence, mortality, trends, and predictions of prostate cancer from 2016 through 2030. In study process, we observed the Guidelines for Accurate and Transparent Health Estimates Reporting (GATHER) (12).

The detailed approach also complies with the GATHER guidelines, and the percent change is −0.98% (95% UI, −2.71% to 0.95%) before and after Cod Correct (level 3) by prostate cancer for all ages, 2016. In Supplementary materials (*Tables S1-S9* and table online: http://fp.amegroups.cn/cms/f32730eb90bb505842fa7e703bdcab92/tau.2020.02.21-1.docx), the method and result of estimation are contained to help explain the work process (13,14). As in each prior study, the entire time series was re-estimated, and the results presented in this study supersede prior prostate cancer studies. Prostate cancers was defined in the International Classification of Diseases (ICD) were categorized into 4 cancer groups including C61-C61.9, Z12.5, Z80.42, Z85.46 in ICD-10 by incidence and 4 cancer groups containing C61-C61.9, D07.5, D29.1, D40.0 in also ICD-10 by mortality. For the collected data, we estimated national disease burden for 195 countries and territories. The incidence and death rates are reported per 100,000 person-years. The general world population is standardized by the calculation of age-standardized rates (1). 95% uncertainty intervals (UIs) are used for all estimates.

The present estimation process starts with cancer mortality. Prostate cancer death rates contain vital registration systems (85% of data in 2016), cancer registries (15% of data in 2016). Compared with 2015, the data increased respectively from 10,356 to 16,247 (57% increase) and 2,351 to 2,826 (20% increase), total change increasing 50%. For the absence of prostate cancer death data, previous study reported the estimation model which presents multiplying incidence with a separately modeled mortality-to-incidence ratio (MIR) to imitate real mortality. These mortality estimates are added to mortality data from the other sources and are used in a cause of death ensemble model (CODEm) (6). Simultaneously, we tested this model by real data and the test result was located in Supplementary materials. Covariates with the causal connection is used to estimate the prostate cancer data and we compared the GBD 2015 and GBD 2016 covariates, as well as displayed the covariates level. The prostate cancer incidence estimations are calculated by dividing MIR and prostate cancer specific mortality. Furthermore, we estimated the contribution of population ageing, population growth, and change in age-specific rates on the change in incident cases between 2006 and 2016. SDI is a summary indicator of income per capita, educational attainment, and fertility, and has been shown to correlate well with health outcomes and the SDI was grouped by geography, based on 2016 values. Data was analyzed by R software (x64 version 3.5.1), SAS (version 9.3) and SPSS (version 22.0).

Results

Over-time trends in incidence cases of prostate cancer from 1990 to 2016

There were 1,435,742 (95% UI, 1,293,395–1,618,655) incident cases of prostate cancer in 2016 (*Table 1*), and it was 2.5-fold to new diagnoses [579,456 (95% UI, 521,564–616,107)] in 1990 at a global scale. In regions, the largest incidence cases appeared in high-income North America, followed by Western Europe, East Asia and high-income Asia Pacific, while Central sub-Saharan Africa was the region with fewest cases. The odds of developing prostate cancer were 1 in 16, ranging from 1 in 56 in low-middle SDI countries to 1 in 7 in high SDI countries (Supplementary materials). The increasing incidence rates, together with an aging and growing population, have led to a 160% increase in prostate cancer cases since 1990. Overall, 20% of this increase can be attributed to a change of population age structure, 12% to a change of the population size, and 7% to a change of the age-specific incidence rates (Supplementary materials). New diagnoses in men aged 70 years or older increased by more than three-fold from 1990 to 2016 [253,961 (95% UI, 176,952–327,260) to 795,593 (95% UI, 622,258–1,111,133)], accounting for 55.9% of incident prostate cancer cases in 1990 and 55.1% of incident cases in 2016.

Over-time trends in mortality of prostate cancer from 1990 to 2016

Prostate cancer was the leading cause of cancer death in 24 countries, ranking eighth globally, 6th in developed countries, and 12th in developing countries. There was a 2.0-fold increase in deaths [191,687 (95% UI, 168,885–209,254) to 380,916 (95% UI, 320,808–412,868)] (*Table 1*) in global level. Among regions, Western Europe, high-income North America, East Asia had the three most death cases in 2016 (*Table 1*), but compared with incidence cases changes, high-income North America and Western Europe deaths increase range was relatively slight. The death cases increased almost all SDI countries and the largest changes reported in middle SDI about 61% (*Table 1*). The high SDI have the greatest number of death cases followed by middle SDI, high-middle SDI, low-middle SDI and low SDI (*Table 1*). Deaths from prostate cancer among men aged 70 years and older nearly doubled from 1990 [120,450 (95% UI, 87,865–155,845), 76.7% of all prostate cancer deaths], to 2016 [236,884 (95% UI, 184,562–320,346), 80.9% of all prostate cancer deaths] at the global level.

Over-time trends in age-standardized incidence rate (ASIR) of prostate cancer from 1990 to 2016

Globally, incidence and death rates raise considerably between 1990 and 2016, with the steep rise in ASIR of prostate cancer in men (1). According to the data, the global ASIR increased from 17.75 per 100,000 persons (95% UI, 18.91–15.95) in 1990 to 22.12 per 100,000 persons (95% UI, 19.92–24.91) in 2016. The change increases about 24.62% (*Figure 1* and *Table 2*). In region level, average annual percent change in ASIR for prostate cancer by geography and gender showed the districts of obvious increase including most Asia, Russia, Africa and south America. For some classification, America in both sexes had an average annual percent change with range from 0 to 1, and in male the range changed from −1 to 0. When we observed China, the range both beyond 2 whether in both sexes or male. The acutely change is in high-middle SDI countries reaching 199%, and for others the increase also appeared obviously (*Figure 1* and *Table 2*).

Over-time trends in age-standardized death rate (ASDR) of prostate cancer from 1990 to 2016

The global change of ASDR of prostate cancer has declined slightly, but in many regions, it still shows a trend of growth (*Figure 2* and *Table 2*), for example: high-income Asia Pacific, central Latin America, southern Latin America, Tropical Latin America and so on (*Figure 2* and *Table 2*). The most obvious decline has been found in high-income North America and acute increase observed in Oceania (*Figure 2* and *Table 2*). Furthermore, the average annual percent change in ASDR for prostate cancer by geography and gender indicated the Russia, Africa and the Middle East change range was almost from 0 to 1 (*Figure 3*). For

Table 1 Global and regional prostate cancer incident and death cases by geography, gender and SDI quintile, 1990 and 2016

Location	Incident cases, global and regional						Death cases, global and regional					
	1990			2016			1990			2016		
	Male	Female	Both	Male	Female	Both	Male	Female	Both	Male	Female	Both
Global	579,457 (521,564–616,107)	NA	579,457 (521,564–616,107)	1,435,742 (1,293,395–1,618,655)	NA	1,435,742 (1,293,395–1,618,655)	191,687 (168,885–209,254)	NA	191,687 (168,885–209,254)	380,916 (320,808–412,868)	NA	380,916 (320,808–412,868)
High SDI	419,216 (359,752–440,972)	NA	419,216 (359,752–440,972)	899,317 (836,795–1,065,763)	NA	899,317 (836,795–1,065,763)	94,371 (78,850–97,740)	NA	94,371 (78,850–97,740)	143,631 (133,214–169,376)	NA	143,631 (133,214–169,376)
High-middle SDI	75,319 (70,733–95,856)	NA	75,319 (70,733–95,856)	226,521 (205,520–255,438)	NA	226,521 (205,520–255,438)	32,169 (29,878–42,512)	NA	32,169 (29,878–42,512)	68,310 (60,988–78,134)	NA	68,310 (60,988–78,134)
Low SDI	11,285 (7,082–14,139)	NA	11,285 (7,082–14,139)	29,805 (16,591–34,971)	NA	29,805 (16,591–34,971)	11,821 (7,208–15,132)	NA	11,821 (7,208–15,132)	32,446 (17,531–39,196)	NA	32,446 (17,531–39,196)
Low-middle SDI	25,137 (16,938–30,797)	NA	25,137 (16,938–30,797)	74,721 (51,286–82,781)	NA	74,721 (51,286–82,781)	20,396 (13,466–25,976)	NA	20,396 (13,466–25,976)	51,352 (34,889–58,859)	NA	51,352 (34,889–58,859)
Middle SDI	49,747 (43,072–58,016)	NA	49,747 (43,072–58,016)	207,679 (178,146–237,617)	NA	207,679 (178,146–237,617)	32,786 (28,161–39,141)	NA	32,786 (28,161–39,141)	84,694 (71,158–97,677)	NA	84,694 (71,158–97,677)
High-income Asia Pacific	16,467 (15,546–19,071)	NA	16,467 (15,546–19,071)	85,642 (71,670–93,517)	NA	85,642 (71,670–93,517)	5,070 (4,801–5,967)	NA	5,070 (4,801–5,967)	15,442 (12,173–17,262)	NA	15,442 (12,173–17,262)
Western Europe	164,672 (152,239–182,575)	NA	164,672 (152,239–182,575)	375,952 (344,140–442,907)	NA	375,952 (344,140–442,907)	52,881 (46,745–57,930)	NA	52,881 (46,745–57,930)	80,669 (73,701–96,797)	NA	80,669 (73,701–96,797)
Andean Latin America	2,257 (1,967–2,818)	NA	2,257 (1,967–2,818)	8,553 (7,475–10,484)	NA	8,553 (7,475–10,484)	1,545 (1,322–1,934)	NA	1,545 (1,322–1,934)	4,304 (3,573–5,393)	NA	4,304 (3,573–5,393)
Central Latin America	10,467 (9,614–11,919)	NA	10,467 (9,614–11,919)	51,394 (47,507–58,602)	NA	51,394 (47,507–58,602)	5,574 (5,182–6,402)	NA	5,574 (5,182–6,402)	16,274 (14,767–18,084)	NA	16,274 (14,767–18,084)
Southern Latin America	6,921 (6,430–8,373)	NA	6,921 (6,430–8,373)	21,104 (19,218–24,043)	NA	21,104 (19,218–24,043)	3,913 (3,581–5,064)	NA	3,913 (3,581–5,064)	8,113 (7,012–9,481)	NA	8,113 (7,012–9,481)
Tropical Latin America	9,741 (9,243–12,740)	NA	9,741 (9,243–12,740)	48,685 (45,991–64,672)	NA	48,685 (45,991–64,672)	6,171 (5,784–8,072)	NA	6,171 (5,784–8,072)	19,630 (18,359–25,716)	NA	19,630 (18,359–25,716)
North Africa and Middle East	7,164 (5,910–9,079)	NA	7,164 (5,910–9,079)	31,201 (23,957–37,058)	NA	31,201 (23,957–37,058)	5,635 (4,617–7,346)	NA	5,635 (4,617–7,346)	14,039 (10,767–17,458)	NA	14,039 (10,767–17,458)
High-income North America	231,022 (185,970–243,268)	NA	231,022 (185,970–243,268)	399,835 (373,886–520,463)	NA	399,835 (373,886–520,463)	34,645 (25,808–36,145)	NA	34,645 (25,808–36,145)	41,121 (38,198–55,836)	NA	41,121 (38,198–55,836)
Oceania	157 (122–209)	NA	157 (122–209)	527 (372–647)	NA	527 (372–647)	109 (84–154)	NA	109 (84–154)	272 (197–360)	NA	272 (197–360)
Central sub-Saharan Africa	1,407 (910–1,707)	NA	1,407 (910–1,707)	3,822 (2,255–4,585)	NA	3,822 (2,255–4,585)	1,388 (888–1,750)	NA	1,388 (888–1,750)	3,840 (2,270–4,895)	NA	3,840 (2,270–4,895)
Eastern sub-Saharan Africa	7,340 (4,005–9,488)	NA	7,340 (4,005–9,488)	19,869 (9,715–24,432)	NA	19,869 (9,715–24,432)	7,723 (4,045–10,266)	NA	7,723 (4,045–10,266)	21,161 (9,757–27,150)	NA	21,161 (9,757–27,150)
Central Asia	1,549 (1,428–1,761)	NA	1,549 (1,428–1,761)	4,097 (3,368–4,403)	NA	4,097 (3,368–4,403)	905 (829–1,040)	NA	905 (829–1,040)	1,814 (1,483–2,017)	NA	1,814 (1,483–2,017)
Southern sub-Saharan Africa	3,723 (2,982–4,657)	NA	3,723 (2,982–4,657)	11,677 (8,821–13,485)	NA	11,677 (8,821–13,485)	2,479 (1,986–3,243)	NA	2,479 (1,986–3,243)	5,739 (4,026–6,575)	NA	5,739 (4,026–6,575)

Table 1 (*continued*)

Table 1 (*continued*)

Location	Incident cases, global and regional						Death cases, global and regional					
	1990			2016			1990			2016		
	Male	Female	Both	Male	Female	Both	Male	Female	Both	Male	Female	Both
Western sub-Saharan Africa	9,061 (4,828–12,427)	NA	9,061 (4,828–12,427)	22,584 (11,119–28,610)	NA	22,584 (11,119–28,610)	8,437 (4,674–11,763)	NA	8,437 (4,674–11,763)	19,896 (10,570–26,468)	NA	19,896 (10,570–26,468)
East Asia	26,162 (20,717–32,019)	NA	26,162 (20,717–32,019)	112,174 (88,822–136,702)	NA	112,174 (88,822–136,702)	15,784 (12,056–20,149)	NA	15,784 (12,056–20,149)	35,754 (27,217–44,151)	NA	35,754 (27,217–44,151)
South Asia	13,190 (9,546–15,525)	NA	13,190 (9,546–15,525)	41,887 (31,849–48,560)	NA	41,887 (31,849–48,560)	10,199 (7,234–12,606)	NA	10,199 (7,234–12,606)	26,631 (20,065–32,156)	NA	26,631 (20,065–32,156)
Southeast Asia	9,408 (7,484–10,881)	NA	9,408 (7,484–10,881)	37,873 (27,675–41,876)	NA	37,873 (27,675–41,876)	6,557 (5,075–7,878)	NA	6,557 (5,075–7,878)	18,986 (13,745–21,339)	NA	18,986 (13,745–21,339)
Australasia	10,897 (9,904–11,937)	NA	10,897 (9,904–11,937)	33,213 (28,029–39,937)	NA	33,213 (28,029–39,937)	2,429 (2,122–2,671)	NA	2,429 (2,122–2,671)	4,688 (4,075–5,721)	NA	4,688 (4,075–5,721)
Caribbean	6,765 (6,328–7,903)	NA	6,765 (6,328–7,903)	19,592 (16,495–20,920)	NA	19,592 (16,495–20,920)	3,607 (3,282–4,414)	NA	3,607 (3,282–4,414)	8,455 (6,993–9,295)	NA	8,455 (6,993–9,295)
Central Europe	17,913 (16,650–22,343)	NA	17,913 (16,650–22,343)	45,678 (39,663–50,801)	NA	45,678 (39,663–50,801)	8,676 (8,128–11,626)	NA	8,676 (8,128–11,626)	15,757 (13,941–17,355)	NA	15,757 (13,941–17,355)
Eastern Europe	23,172 (20,803–33,216)	NA	23,172 (20,803–33,216)	60,383 (48,375–68,435)	NA	60,383 (48,375–68,435)	7,816 (6,828–12,446)	NA	7,816 (6,828–12,446)	17,849 (13,640–22,233)	NA	17,849 (13,640–22,233)

Data in the parentheses indicates 95% uncertainty interval (95% UI). SDI, Sociodemographic index (a summary indicator of income per capita, educational attainment, and fertility); NA, not available.

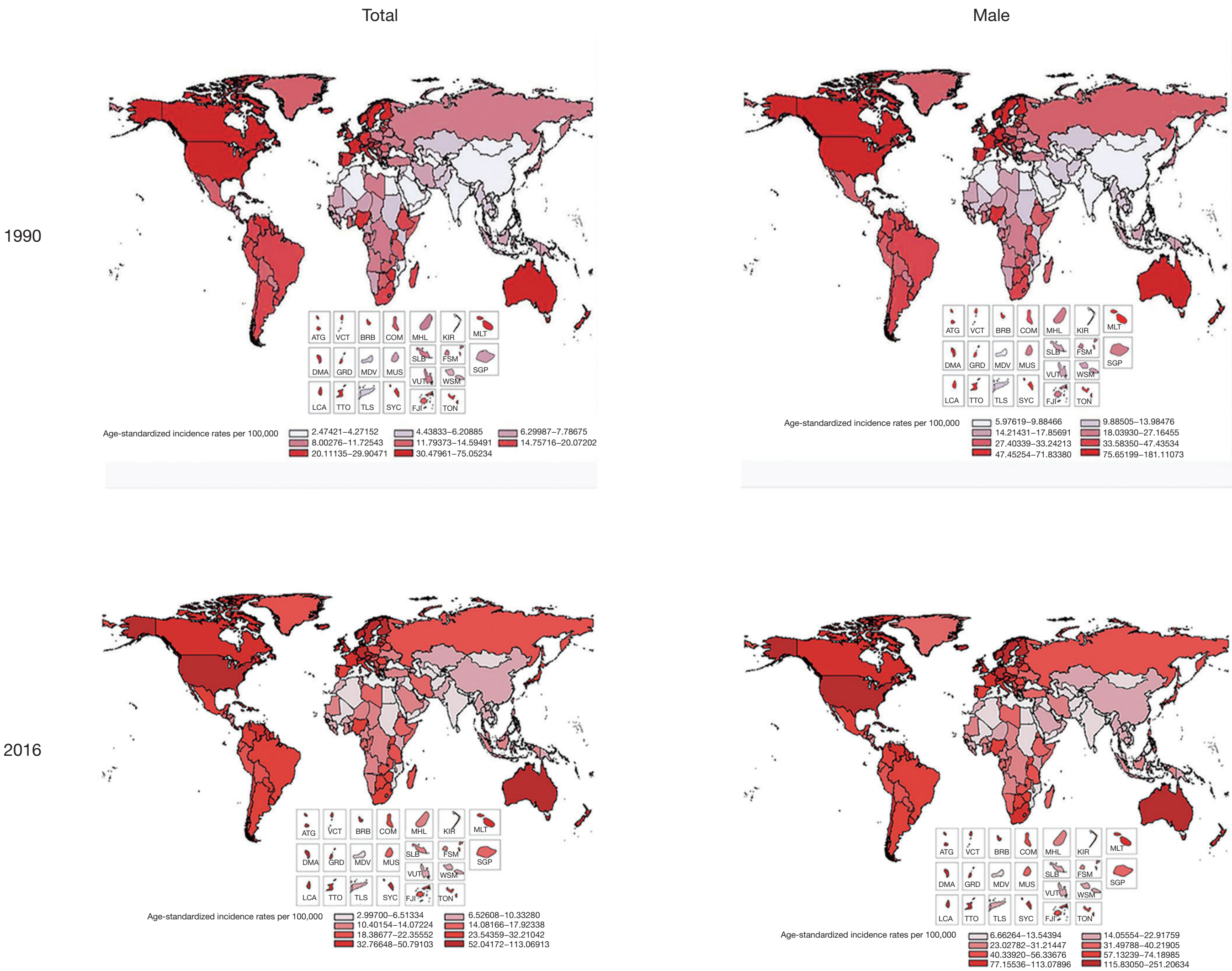

Figure 1 Global and regional prostate cancer ASIR by geography and gender, 1990 and 2016. ASIR, age-standardized incidence rate; ATG, Antigua and Barbuda; VCT, Saint Vincent and the Grenadines; BRB, Barbados; COM, Comoros; MHL, Marshall Islands; KIR, Kiribati; MLT, Malta; DMA, Dominica; GRD, Grenada; MDV, Maldives; MUS, Mauritius; SLB, Solomon Islands; FSM, Federated States of Micronesia; VUT, Vanuatu; WSM, Samoa. SGP, Singapore; LCA, Saint Lucia; TTO, Trinidad and Tobago; TLS, Timor-Leste; SYC, Seychelles; FJI, Fiji; TON, Tonga.

America, in both sexes the change ranges from −1 to 0 as well as in only male the range from −3 to −2, and for China, it also was same in both sexes and male from −1 to 0 (*Figure 3*).

Projections of prostate cancer incidence and mortality from 2017 to 2030

This study also forecast the trends in the incidence and mortality of prostate cancer from 2017 to 2030. Globally, the trend in prostate cancer incidence rate is increasing substantially (*Figure 4*). By SDI sub-types, the highest incidence rate of prostate cancer will occur with the greatest frequency in high SDI countries over the next years, followed by high-middle SDI countries, low SDI countries, middle SDI countries, and low-middle SDI countries (*Figure 4*). However, trends in prostate cancer deaths will slightly decrease from 2017 to 2030 worldwide (*Figure 4*). The highest death rates will occur in low SDI countries, followed by high SDI countries, high-middle SDI countries,

Table 2 Global and regional age-standardized prostate cancer incidence and death rates with 95% uncertainty interval and percent change by SDI and sex between 1990 and 2016

Location	Sex	Age-standardized incidence rates per 100,000			Age-standardized death rates per 100,000		
		1990	2016	Change (%)	1990	2016	Change (%)
Global	Both	17.75 (18.91–15.95)	22.12 (19.92–24.91)	24.62	6.39 (5.66–6.98)	6.14 (5.19–6.65)	–3.91
	Male	43.17 (38.75–46.09)	49.93 (44.99–56.05)	15.66	16.70 (14.94–18.33)	14.92 (12.70–16.15)	–10.66
	Female	NA	NA	NA	NA	NA	NA
High SDI	Both	39.18 (33.74–41.15)	51.65 (47.92–61.39)	31.83	8.64 (7.25–8.94)	7.13 (6.60–8.44)	–17.48
	Male	97.97 (83.92–102.86)	115.11 (107.14–136.22)	17.5	24.26 (20.22–25.26)	17.90 (16.62–21.01)	–26.22
	Female	NA	NA	NA	NA	NA	NA
High-middle SDI	Both	6.06 (5.30–7.15)	18.14 (16.46–20.52)	199.34	5.01 (4.66–6.62)	5.59 (5.01–6.38)	11.58
	Male	28.72 (27.07–36.88)	43.04 (39.04–48.72)	49.86	14.35 (13.37–18.96)	14.43 (12.92–16.51)	0.56
	Female	NA	NA	NA	NA	NA	NA
Middle SDI	Both	6.06 (5.30–7.15)	10.66 (9.11–12.18)	75.91	4.50 (3.92–5.45)	4.92 (4.12–5.66)	9.33
	Male	13.79 (12.09–16.30)	23.51 (20.09–26.80)	70.49	10.65 (9.30–12.97)	11.47 (9.61–13.16)	7.7
	Female	NA	NA	NA	NA	NA	NA
Low-middle SDI	Both	5.07 (3.52–60.6)	6.62 (4.65–7.29)	30.57	4.35 (2.98–5.40)	4.97 (3.48–5.64)	14.25
	Male	10.90 (7.60–12.98)	14.39 (10.16–15.80)	32.02	9.44 (6.51–11.66)	11.01 (7.74–12.48)	16.63
	Female	NA	NA	NA	NA	NA	NA
Low SDI	Both	10.08 (6.40–12.38)	12.13 (6.77–14.19)	20.34	11.20 (7.02–14.01)	14.16 (7.72–16.99)	26.43
	Male	21.79 (13.84–26.70)	26.05 (14.56–30.49)	19.55	24.32 (15.27–30.35)	30.59 (16.70–36.68)	25.78
	Female	NA	NA	NA	NA	NA	NA
High-income Asia Pacific	Both	9.76 (9.23–11.34)	21.98 (18.74–24.12)	125.2	3.14 (2.97–3.73)	3.36 (2.71–3.77)	7.01
	Male	24.98 (23.63–29.18)	50.75 (42.84–55.45)	103.16	8.41 (7.99–10.1)	8.82 (7–9.84)	4.88
	Female	NA	NA	NA	NA	NA	NA
Western Europe	Both	30.94 (28.89–34.55)	48.24 (43.93–57.13)	55.91	9.47 (8.42–10.45)	8.63 (7.87–10.42)	–8.87
	Male	79.16 (73.27–87.81)	107.91 (98.62–126.91)	36.32	27.23 (23.99–29.72)	21.67 (19.83–25.96)	–20.42
	Female	NA	NA	NA	NA	NA	NA
Andean Latin America	Both	14.71 (12.86–18.45)	20.60 (18.01–25.30)	40.04	11.09 (9.56–13.97)	10.63 (8.84–13.34)	–4.15
	Male	32.85 (28.76–41.22)	45.88 (40.1–56.39)	39.67	25.27 (21.81–31.72)	24.65 (20.48–30.87)	–2.45
	Female	NA	NA	NA	NA	NA	NA
Central Latin America	Both	14.85 (13.69–16.91)	28.66 (26.37–32.55)	93	8.6 (8.06–9.9)	9.54 (8.66–10.61)	10.93
	Male	33.68 (31.02–38.37)	63.63 (58.28–71.94)	88.93	20 (18.78–23.07)	22.22 (20.12–24.63)	11.1
	Female	NA	NA	NA	NA	NA	NA
Southern Latin America	Both	16.81 (15.63–20.5)	28.84 (26.26–33.03)	71.56	9.9 (9.09–12.86)	10.53 (9.08–12.35)	6.36
	Male	40.85 (37.97–50.3)	70.51 (64.25–80.06)	72.61	25.2 (23.14–32.87)	28.52 (24.71–33.22)	13.17
	Female	NA	NA	NA	NA	NA	NA
Tropical Latin America	Both	15.49 (14.68–20.14)	26.99 (25.49–35.6)	74.24	11.17 (10.45–14.58)	11.77 (11.03–15.31)	5.37
	Male	38.32 (36.3–49.64)	64.53 (61.01–84.39)	68.4	28.87 (26.9–37.54)	30.14 (28.21–38.77)	4.4
	Female	NA	NA	NA	NA	NA	NA

Table 2 (*continued*)

Table 2 (*continued*)

Location	Sex	Age-standardized incidence rates per 100,000			Age-standardized death rates per 100,000		
		1990	2016	Change (%)	1990	2016	Change (%)
North Africa and Middle East	Both	5.68 (4.78–7.29)	10.22 (7.92–12.32)	79.93	4.8 (3.96–6.37)	5.16 (4.01–6.48)	7.5
	Male	12.9 (10.92–16.59)	22.34 (17.33–27.08)	73.18	11.15 (9.19–14.89)	11.76 (9.16–14.78)	5.47
	Female	NA	NA	NA	NA	NA	NA
High-income North America	Both	71.92 (57.81–75.78)	75.49 (70.55–98.38)	4.96	10.35 (7.7–10.8)	7.22 (6.69–9.85)	–30.24
	Male	173.28 (139.7–182.34)	165.37 (154.64–215.32)	–4.56	28.15 (20.91–29.37)	17.53 (16.28–23.75)	–37.73
	Female	NA	NA	NA	NA	NA	NA
Oceania	Both	9 (7.01–11.72)	12.03 (8.61–14.55)	33.67	7.02 (5.14–8.90)	16.8 (12.34–21.23)	139.32
	Male	20.54 (16.01–26.67)	28.02 (20.12–33.76)	36.42	1.38 (1.18–1.79)	1.58 (1.35–2.02)	14.49
	Female	NA	NA	NA	NA	NA	NA
Central sub-Saharan Africa	Both	9.52 (6.11–11.13)	11.72 (6.91–14.13)	23.11	10.07 (6.47–12.51)	12.73 (7.58–16.35)	26.42
	Male	23.44 (15.05–27.32)	27.13 (15.97–32.71)	15.74	25.09 (16.27–31.06)	29.91 (17.9–38.54)	19.21
	Female	NA	NA	NA	NA	NA	NA
Eastern sub-Saharan Africa	Both	13.15 (7.18–16.86)	16.02 (7.87–19.67)	21.83	14.72 (7.85–19.27)	18.28 (8.55–23.24)	24.18
	Male	28.61 (15.58–36.59)	35.49 (17.44–43.54)	24.05	32.28 (17.21–42.20)	40.73 (19.08–51.73)	26.18
	Female	NA	NA	NA	NA	NA	NA
Central Asia	Both	3.93 (3.62–4.48)	6.93 (5.64–7.46)	76.34	2.47 (2.28–2.84)	3.32 (2.70–3.69)	34.41
	Male	10.93 (10.1–12.4)	17.32 (14.14–18.64)	58.46	7.25 (6.66–8.35)	8.92 (7.18–9.86)	23.03
	Female	NA	NA	NA	NA	NA	NA
Southern sub-Saharan Africa	Both	17.03 (13.71–21.45)	28.71 (21.47–32.84)	68.58	12.23 (9.90–16.00)	15.51 (10.85–17.74)	26.82
	Male	41.09 (33.12–51.84)	73.03 (54.27–83.3)	77.73	30.06 (24.37–39.44)	42.57 (29.8–48.56)	41.62
	Female	NA	NA	NA	NA	NA	NA
Western sub-Saharan Africa	Both	14.84 (8.39–19.72)	18.85 (9.67–23.34)	27.02	15.27 (9.10–20.62)	18.85 (10.54–24.33)	23.44
	Male	32.84 (18.66–43.48)	40.8 (21.09–50.42)	24.24	34.10 (20.47–45.86)	41.36 (23.23–53.21)	21.29
	Female	NA	NA	NA	NA	NA	NA
East Asia	Both	4.00 (3.19–5.02)	7.46 (5.87–9.17)	86.5	2.70 (2.13–3.52)	2.69 (2.04–3.31)	–0.37
	Male	9.10 (7.35–11.56)	16.09 (12.58–19.77)	76.81	6.49 (5.18–8.52)	6.19 (4.7–7.56)	–4.62
	Female	NA	NA	NA	NA	NA	NA
South Asia	Both	3.40 (2.51–4.08)	4.38 (3.32–5.14)	28.82	3.72 (2.88–4.45)	4.83 (3.50–5.44)	29.84
	Male	6.87 (5.07–8.26)	9.18 (6.96–10.78)	33.62	9.05 (7.03–10.77)	11.91 (8.63–13.39)	31.6
	Female	NA	NA	NA	NA	NA	NA
Southeast Asia	Both	4.93 (3.9–5.74)	8.68 (6.33–9.61)	76.06	3.72 (2.88–4.45)	4.83 (3.50–5.44)	29.84
	Male	11.68 (9.24–13.64)	20.39 (14.81–22.54)	74.57	9.05 (7.03–10.77)	11.91 (8.63–13.39)	31.6
	Female	NA	NA	NA	NA	NA	NA
Australasia	Both	49.84 (45.34–54.35)	80.39 (67.94–97.34)	61.3	11.31 (9.87–12.41)	10.14 (8.80–12.50)	–10.34
	Male	119.1 (108.25–130.47)	170.44 (144.26–206.27)	43.11	30.29 (26.61–33.23)	23.67 (20.63–28.84)	–21.86
	Female	NA	NA	NA	NA	NA	NA

Table 2 (*continued*)

Table 2 (*continued*)

Location	Sex	Age-standardized incidence rates per 100,000			Age-standardized death rates per 100,000		
		1990	2016	Change (%)	1990	2016	Change (%)
Caribbean	Both	29.56 (27.65–34.51)	45.19 (38.09–48.31)	52.88	16.26 (14.82–19.89)	19.42 (16.06–21.35)	19.43
	Male	63.93 (59.81–74.65)	100.31 (83.9–107.09)	56.91	35.84 (32.68–43.8)	44.88 (37.05–49.30)	25.22
	Female	NA	NA	NA	NA	NA	NA
Central Europe	Both	13.67 (12.72–17.21)	23.94 (20.65–26.73)	75.13	6.89 (6.46–9.26)	7.94 (7.03–8.74)	–5.62
	Male	34.53 (32.15–43.91)	57.89 (50.10–64.36)	67.65	18.43 (17.24–24.92)	21.13 (18.75–23.20)	–6.9
	Female	NA	NA	NA	NA	NA	NA
Eastern Europe	Both	9.19 (8.27–13.26)	19.30 (15.49–21.89)	110.01	3.23 (2.83–5.18)	5.60 (4.30–6.99)	73.37
	Male	29.29 (26.41–43.53)	54.41 (44.44–61.83)	85.76	11.63 (10.21–19.19)	17.62 (13.70–21.74)	51.5
	Female	NA	NA	NA	NA	NA	NA

Data in the parentheses indicates 95% uncertainty interval (95% UI). SDI, Sociodemographic index (a summary indicator of income per capita, educational attainment, and fertility); NA, not available.

and low-middle SDI countries (*Figure 4*). Trends in incident rates and deaths by sexes are listed in *Figure 4*. However, enough attention should also be paid to other trends in 95% UI because the real trend of change is likely to be in it, and may even be different from the fluctuation described above.

Discussion

On the global level, consistent growth tendency happened in both incident and death cases from 1990 to 2016. However, the incidence and mortality numbers of prostate cancer, in different ages, SDI countries and regions, reveal obvious differences. For instance, in low SDI countries, the patient numbers are significantly small when compared with other countries, especially, high SDI with the higher average life expectancy. Among urologic cancers worldwide, prostate cancer had continuously the largest growth in incident cases both in all SDI countries and in most regions from 1990 to 2016. As prostate cancer is more common in older men, the increase in population and age is bound to increase the incidence and death cases and increase the burden of prostate cancer.

However, the estimates presented in this study reveal remarkable differences in trends of incidence and death rates in prostate cancer. Analyzing time trends in prostate cancer, this study found a higher ASIR (change 24.62%) and a relatively lower ASDR (change −3.91%) through 1990 to 2016 on a worldwide scale. Enough diagnosis and treatment measures contribute to the less adverse cancer outcome. However, these services need adequate health care expenditures (15). Therefore, for these changes, the key factor is more and more health investment and government funding. Surely, the advancing treatment means and residents' health awareness are also important reasons.

Population growth and average life expectancy rise could be used to explain the question that prostate cancer incidence substantially increase (16). However, the contribution of population ageing vs population growth to changes in incident cases differs substantially based on socioeconomic development. This leads to very different compositions of prostate cancer incidence reason in each country with different development level. Simultaneously, every disease, especially cancer, has a certain incidence probability. If some factors can increase the incidence probability of this disease in the population, it is called risk factor. By controlling these risk factors, the incidence of the disease in the population can be reduced. For example, fat, older age, family history, geographic location, ethnic origin, lack of exercise, environmental factors, dietary habits (dietary fat or specific fatty foods), tobacco smoking have all been suggested as contributing to the development of prostate cancer (17-21). In addition, exogenous factors such as patterns of sexual behavior, alcohol consumption, exposure to ultraviolet radiation, chronic inflammation (22), and occupational exposure can contribute to the development of prostate cancer. Conversely, based on the limited available evidence, reducing saturated dietary fats, for example eating more fish and less red meat and dairy products, more cruciferous vegetables (such as cabbage), and increasing the intake of soy, vitamin E, and selenium,

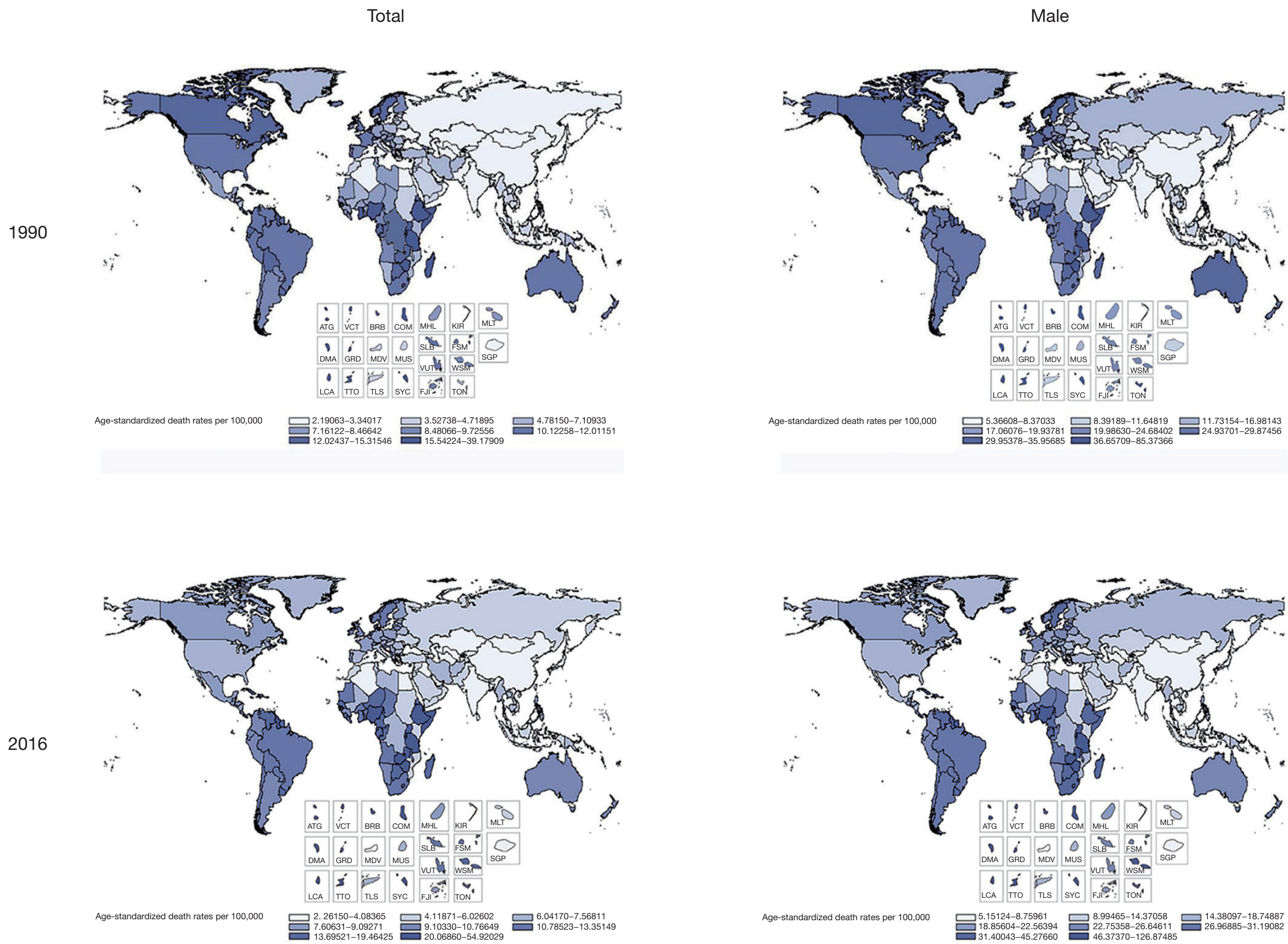

Figure 2 Global and regional prostate cancer ASDR by geography and gender, 1990 and 2016. ASDR, age-standardized death rate; ATG, Antigua and Barbuda; VCT, Saint Vincent and the Grenadines; BRB, Barbados; COM, Comoros; MHL, Marshall Islands; KIR, Kiribati; MLT, Malta; DMA, Dominica; GRD, Grenada; MDV, Maldives; MUS, Mauritius; SLB, Solomon Islands; FSM, Federated States of Micronesia; VUT, Vanuatu; WSM, Samoa. SGP, Singapore; LCA, Saint Lucia; TTO, Trinidad and Tobago; TLS, Timor-Leste; SYC, Seychelles; FJI, Fiji; TON, Tonga.

may reduce the risk of prostate cancer (23). Prostate-specific antigen (PSA) screening has increased the number of screen-detected prostate cancer cases, although this "gold standard" method has also led to more questions.

Likewise, multiple factors can affect prostate cancer mortality rates together, such as high body mass index (BMI), smoking and alcohol consumption. Diabetes, heart disease, and severe malnutrition also have significantly influence in mortality of prostate cancer. At the same time, late findings make the prostate cancer that commonly have been advanced prostate cancer more difficult to treat, and also will progress the increase in mortality. The main reasons for late discovery are insufficient medical resources, weak health awareness and imperfect policies. Simultaneously, improved treatment, including radical prostatectomy, radiation therapy (24), and hormone therapy (25), appear to be reasonable explanations for the declining mortality trends in prostate cancer. In addition, increased detection of early stage prostate cancer as a result of the PSA test can reduce mortality by 20% (26,27). However, from our clinical observations, more prostate cancer patients have died of metabolic diseases, cardiovascular diseases, accidents, and psychological disease, problems for which there is lack of concern but play crucial roles in

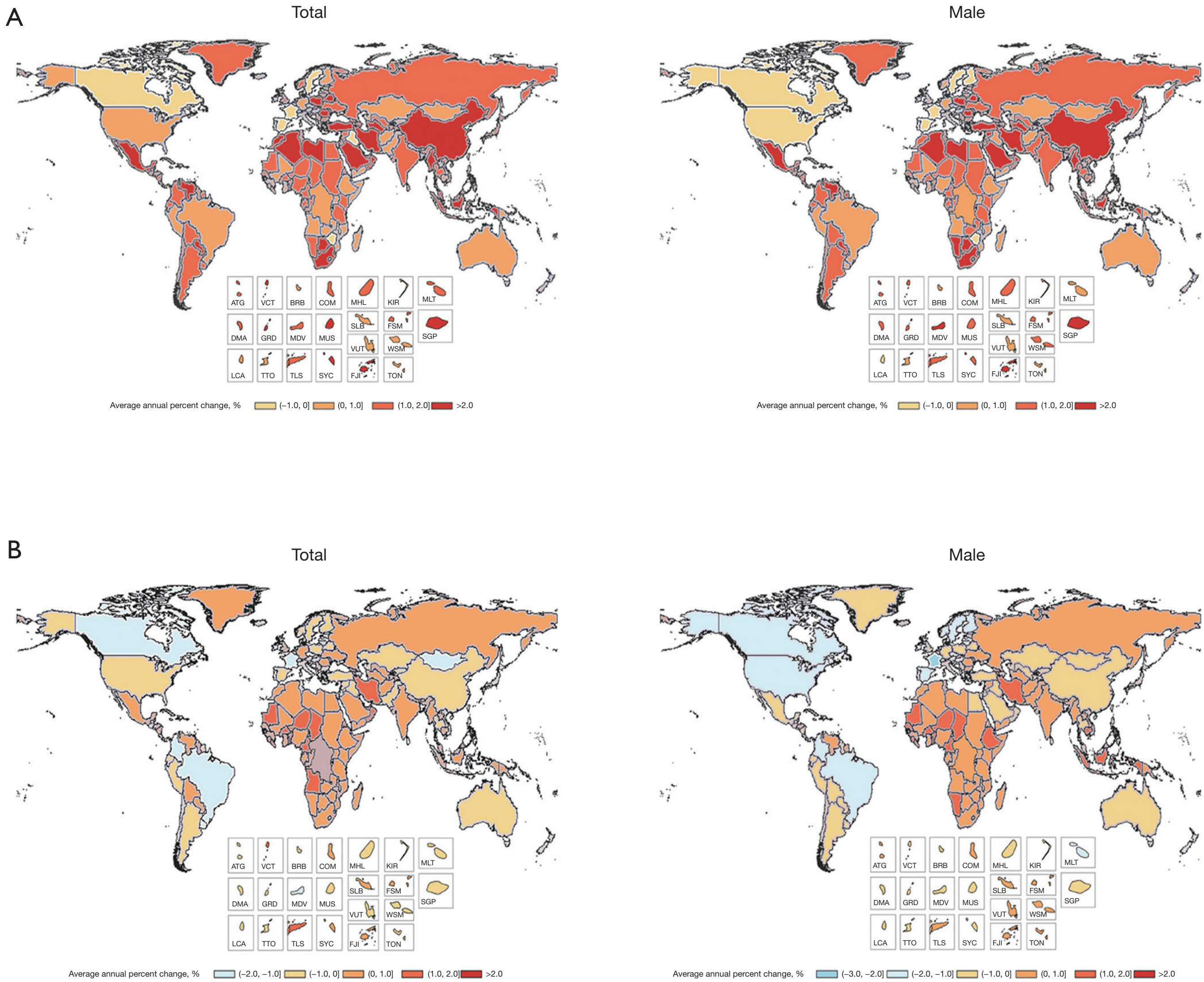

Figure 3 Global and regional average annual percent change in age-standardized incidence and death rates for prostate cancer by geography and gender, 1990–2016. (A) Average annual percent change in age-standardized incidence rates for prostate cancer by geography and gender, 1990–2016; (B) average annual percent change in age-standardized death rates for prostate cancer by geography and gender, 1990–2016. ATG, Antigua and Barbuda; VCT, Saint Vincent and the Grenadines; BRB, Barbados; COM, Comoros; MHL, Marshall Islands; KIR, Kiribati; MLT, Malta; DMA, Dominica; GRD, Grenada; MDV, Maldives; MUS, Mauritius; SLB, Solomon Islands; FSM, Federated States of Micronesia; VUT, Vanuatu; WSM, Samoa. SGP, Singapore; LCA, Saint Lucia; TTO, Trinidad and Tobago; TLS, Timor-Leste; SYC, Seychelles; FJI, Fiji; TON, Tonga.

prostate cancer mortality. Future studies will further explore these issues.

Based on the collection data, we forecast the future fluctuations for ASIR and ASDR used to reflect the incidence and death rate separately. These change trends are from the calculation by using statistics method and professional tool, and at the same time, the operators have a wealth of statistical knowledge and practical experience. The prediction results of each region are quite different, and the fluctuation of incidence and mortality is not exactly the same. The change reason may be related to economic development, but the further explanation is not completely clear and needs further study.

Preventing cancer occurrence and reducing adverse

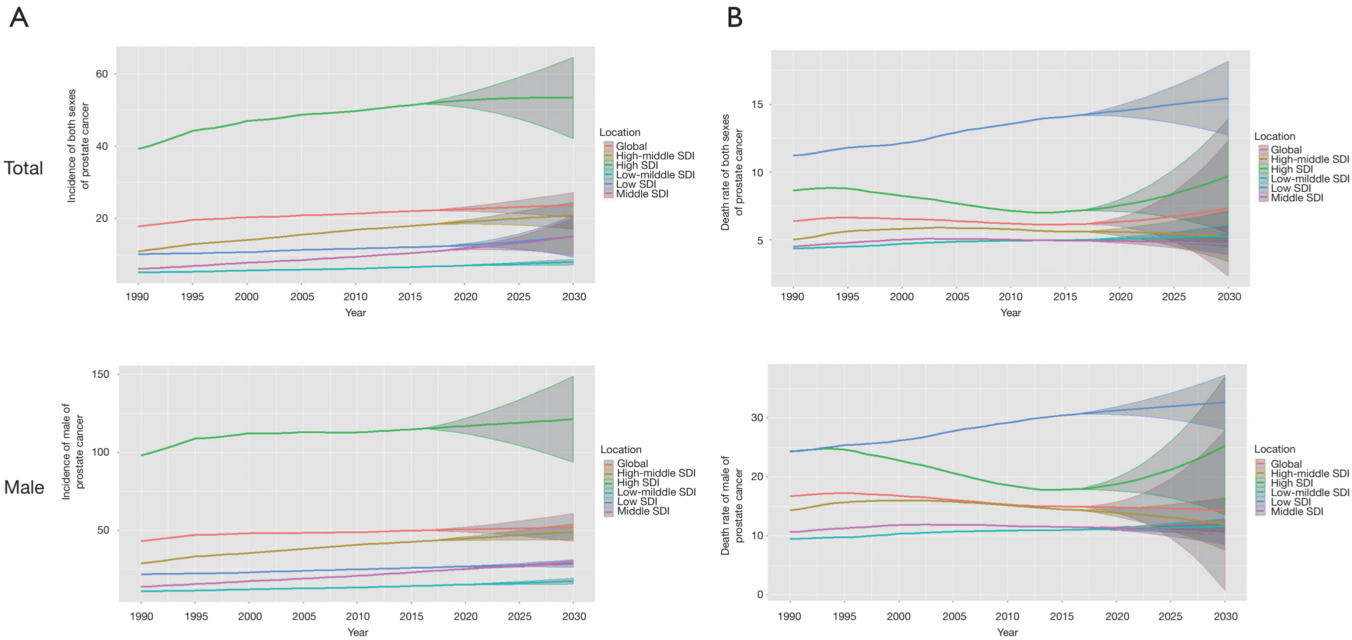

Figure 4 Global and regional trends and predictions in age-standardized incidence and death rates for prostate cancer by SDI quintile, 1990–2030. (A) Trends and predictions in age-standardized incidence rates for prostate cancer by SDI quintile, 1990–2030; (B) trends and predictions in age-standardized death rates for prostate cancer by SDI quintile, 1990–2030. SDI, sociodemographic index.

cancer-relate outcome are challenging goals and will require commitments from all levels of society. Efforts to improve global urologic, medical oncology, and radiation oncology workforces are needed to prepare for the increasing number of prostate cancer patients worldwide and to prevent widening disparities in cancer outcomes. Simultaneously, improving the existing surgical workforce, promoting temporary task shifting, increasing the profile of surgery within public health through research and advocacy, and integrating surgical services with existing policies and initiatives such as the Millennium Development Goals and the Sustainable Development Goals have been cited as potential priority action areas. Moreover, the time trends as presented herein help highlight aspects of prostate cancer epidemiology that can guide intervention programs and advance research into cancer determinants and outcomes. Trends in cancer incidence will especially assist with resource allocation planning as a window into the future, which is sine qua non to inform health policy.

As far as we know, this is the first and unique research to analyze and estimate the trends in prostate cancer incidence and death rates from 1990 to 2030. Prior study researched incidence and mortality trends only on a country or only global level by analyzing the current data. Compared with it, our research contained existing data and projection with specific subgroup including age, region and SDI. This study also has some limitations. The data until 2016 is hysteresis and the projection range with only until 2030 may be not enough to instruct the control of disease.

Conclusions

After a detail analysis of time trend of collection data and projection about the prostate cancer incidence and death rate to 2030, the outcome shows that the incidence has substantially increased in the setting of population expansion and the change in age structure, while death rate has declined slightly for multiple factors. For different ages, regions and SDI countries, the detail results exhibit apparent difference. Our study combined with the specific national situation can help to formulate more suitable and efficient policies, adjust health care decision and innovate screening guideline by analyzing current data and predicting future.

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Footnote

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at http://dx.doi.org/10.21037/tau.2020.02.21). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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Supplementary

Table S1 GATHER Guidelines checklist

Objectives and funding	Reported in the manuscript/Supplementary materials
1. Define the indicator(s), populations (including age, sex, and geographic entities), and time period(s) for which estimates were made	See Supplementary materials
2. List the funding sources for the work	See main manuscript
Data inputs	
For all data inputs from multiple sources that are synthesized as part of the study	
3. Describe how the data were identified and how the data were accessed	See Supplementary materials
4. Specify the inclusion and exclusion criteria. Identify all *ad-hoc* exclusions	See Supplementary materials
5. Provide information about all included data sources and their main characteristics. For each data source used, report reference information or contact name/institution, population represented, data collection method, year(s) of data collection, sex and age range, diagnostic criteria or measurement method, and sample size, as relevant	http://ghdx.healthdata.org/gbd-2016/data-input-sources
6. Identify and describe any categories of input data that have potentially important biases (e.g., based on characteristics listed in item 5)	See Supplementary materials
For data inputs that contribute to the analysis but were not synthesized as part of the study	
7. Describe and give sources for any other data inputs	http://ghdx.healthdata.org/gbd-2016/data-input-sources
For all data inputs	
8. Provide all data inputs in a file format from which data can be efficiently extracted (e.g., a spreadsheet rather than a PDF), including all relevant meta-data listed in item 5. For any data inputs that cannot be shared because of ethical or legal reasons, such as third-party ownership, provide a contact name or the name of the institution that retains the right to the data	http://ghdx.healthdata.org/gbd-2016/data-input-sources
Data analysis	
9. Provide a conceptual overview of the data analysis method. A diagram may be helpful	–
10. Provide a detailed description of all steps of the analysis, including mathematical formulae. This description should cover, as relevant, data cleaning, data pre-processing, data adjustments and weighting of data sources, and mathematical or statistical model(s)	See Supplementary materials: “Data analysis”
11. Describe how candidate models were evaluated and how the final model(s) were selected	See Supplementary materials “CODEm models”; see *Table S2*: Covariates selected for CODEm for GBD prostate cancer group and expected direction of covariate
12. Provide the results of an evaluation of model performance, if done, as well as the results of any relevant sensitivity analysis	See *Table S3*: Results for CODEm model testing
13. Describe methods of calculating uncertainty of the estimates. State which sources of uncertainty were, and were not, accounted for in the uncertainty analysis	See Supplementary materials “Data analysis”
14. State how analytic or statistical source code used to generate estimates can be accessed	http://ghdx.healthdata.org/gbd-2016-code
Results and discussion	
15. Provide published estimates in a file format from which data can be efficiently extracted	GBD 2016 estimates are available online (http://vizhub.healthdata.org/gbd-compare)
16. Report a quantitative measure of the uncertainty of the estimates (e.g., uncertainty intervals)	Done
17. Interpret results in light of existing evidence. If updating a previous set of estimates, describe the reasons for changes in estimates	*Table S4*: Comparison of GBD 2015 and GBD 2016 covariates used and level of covariates; table online: http://fp.amegroups.cn/cms/f32730eb90bb505842fa7e703bdcab92/tau.2020.02.21-1.docx
18. Discuss limitations of the estimates. Include a discussion of any modelling assumptions or data limitations that affect interpretation of the estimates	See main manuscript “Limitations”

GATHER, Guidelines for Accurate and Transparent Health Estimates Reporting; CODEm, cause of death ensemble model; GBD, Global Burden of Disease data base.

Table S2 Covariates selected for CODEm for GBD prostate cancer group and expected direction of covariate

Cause	Sex	Age start	Age end	Direction	Covariate
Prostate cancer	Male	15–19 years	95+ years	0	Education (years per capita)
Prostate cancer	Male	15–19 years	95+ years	0	LDI (I$ per capita)
Prostate cancer	Male	15–19 years	95+ years	1	Percent of total calories consumed as saturated fat
Prostate cancer	Male	15–19 years	95+ years	1	Log-transformed SEV scalar: Prostate C
Prostate cancer	Male	15–19 years	95+ years	0	Sociodemographic index
Prostate cancer	Male	15–19 years	95+ years	–1	Healthcare access and quality index

CODEm, cause of death ensemble model; GBD, Global Burden of Disease data base.

Table S3 Results for CODEm model testing

Cause	Sex	Age start	Age end	Predictive validity					
				RMSE in	RMSE out	Trend in	Trend out	Coverage in	Coverage out
Prostate cancer [Data Rich]	Male	15–19 years	95+ years	0.25085	0.303217	0.204423	0.237726	0.996921	0.994794
Prostate cancer [Global]	Male	15–19 years	95+years	0.29197	0.370344	0.218901	0.21368	0.996743	0.986557

CODEm, cause of death ensemble model; RMSE, root mean square of errors.

Table S4 Comparison of GBD 2015 and GBD 2016 covariates used and level of covariates

Cause	Sex	Covariate	GBD 2015			GBD 2016		
			Level 1	Level 2	Level 3	Level 1	Level 2	Level 3
Prostate cancer	Male	Sociodemographic index			X			X
Prostate cancer	Male	Log-transformed SEV scalar: Prostate C	X			X		
Prostate cancer	Male	Education (years per capita)			X			X
Prostate cancer	Male	LDI (I$ per capita)			X			X

GBD, Global Burden of Disease data base.

Table S5 List of International Classification of Diseases (ICD) codes mapped to the Global Burden of Disease cause list for prostate cancer incidence and mortality data

Cause	ICD-10	ICD9
Incidence	C61-C61.9, Z12.5, Z80.42, Z85.46	185-185.9, V10.46, V16.42, V76.44
mortality	C61-C61.9, D07.5, D29.1, D40.0	185-185.9, 222.2, 236.5

Table S6 Sociodemographic Index groupings by geography, based on 2016 values

Location	SDI quintile
Andorra	High SDI
Australia	High SDI
Austria	High SDI
Belgium	High SDI
Brunei	High SDI
Canada	High SDI
Croatia	High SDI
Cyprus	High SDI
Czech Republic	High SDI
Denmark	High SDI
Estonia	High SDI
Finland	High SDI
France	High SDI
Georgia	High SDI
Germany	High SDI
Greece	High SDI
Iceland	High SDI
Ireland	High SDI
Italy	High SDI
Japan	High SDI
Latvia	High SDI
Lithuania	High SDI
Luxembourg	High SDI
Malta	High SDI
Netherlands	High SDI
New Zealand	High SDI
Norway	High SDI
Poland	High SDI
Puerto Rico	High SDI
Singapore	High SDI
Slovakia	High SDI
Slovenia	High SDI
South Korea	High SDI
Sweden	High SDI
Switzerland	High SDI
Taiwan	High SDI
United Kingdom	High SDI
United States	High SDI
Virgin Islands, United States	High SDI
Antigua and Barbuda	High-middle SDI
Argentina	High-middle SDI
Armenia	High-middle SDI
Azerbaijan	High-middle SDI
Barbados	High-middle SDI
Belarus	High-middle SDI
Bermuda	High-middle SDI
Bulgaria	High-middle SDI
Chile	High-middle SDI
Cuba	High-middle SDI
Georgia	High-middle SDI
Greenland	High-middle SDI
Guam	High-middle SDI
Hungary	High-middle SDI
Iran	High-middle SDI
Israel	High-middle SDI
Kazakhstan	High-middle SDI
Kuwait	High-middle SDI
Lebanon	High-middle SDI
Libya	High-middle SDI
Macedonia	High-middle SDI
Malaysia	High-middle SDI
Mauritius	High-middle SDI
Montenegro	High-middle SDI
Northern Mariana Islands	High-middle SDI
Panama	High-middle SDI
Portugal	High-middle SDI
Qatar	High-middle SDI
Romania	High-middle SDI
Russia	High-middle SDI
Saudi Arabia	High-middle SDI
Serbia	High-middle SDI
Spain	High-middle SDI
The Bahamas	High-middle SDI
Trinidad and Tobago	High-middle SDI
Turkey	High-middle SDI
Turkmenistan	High-middle SDI
Ukraine	High-middle SDI
United Arab Emirates	High-middle SDI
Albania	Middle SDI
Algeria	Middle SDI
American Samoa	Middle SDI
Bahrain	Middle SDI
Bosnia and Herzegovina	Middle SDI
Botswana	Middle SDI
Brazil	Middle SDI
China	Middle SDI
Colombia	Middle SDI
Costa Rica	Middle SDI
Dominica	Middle SDI
Dominican Republic	Middle SDI
Ecuador	Middle SDI
Egypt	Middle SDI
El Salvador	Middle SDI
Equatorial Guinea	Middle SDI
Fiji	Middle SDI
Grenada	Middle SDI
Guyana	Middle SDI
Indonesia	Middle SDI
Jamaica	Middle SDI
Jordan	Middle SDI
Maldives	Middle SDI
Mexico	Middle SDI
Moldova	Middle SDI
Mongolia	Middle SDI
Oman	Middle SDI
Paraguay	Middle SDI
Peru	Middle SDI
Philippines	Middle SDI
Saint Lucia	Middle SDI
Saint Vincent and the Grenadines	Middle SDI
Seychelles	Middle SDI
South Africa	Middle SDI
Sri Lanka	Middle SDI
Suriname	Middle SDI
Thailand	Middle SDI
Tunisia	Middle SDI
Uruguay	Middle SDI
Uzbekistan	Middle SDI
Venezuela	Middle SDI
Vietnam	Middle SDI
Bangladesh	Low-middle SDI
Belize	Low-middle SDI
Bhutan	Low-middle SDI
Bolivia	Low-middle SDI
Cambodia	Low-middle SDI
Cameroon	Low-middle SDI
Cape Verde	Low-middle SDI
Congo	Low-middle SDI
Federated States of Micronesia	Low-middle SDI
Gabon	Low-middle SDI
Ghana	Low-middle SDI
Guatemala	Low-middle SDI
Honduras	Low-middle SDI
India	Low-middle SDI
Iraq	Low-middle SDI
Kenya	Low-middle SDI
Kyrgyzstan	Low-middle SDI
Laos	Low-middle SDI
Lesotho	Low-middle SDI
Marshall Islands	Low-middle SDI
Mauritania	Low-middle SDI
Morocco	Low-middle SDI
Myanmar	Low-middle SDI
Namibia	Low-middle SDI
Nepal	Low-middle SDI
Nicaragua	Low-middle SDI
Nigeria	Low-middle SDI
North Korea	Low-middle SDI
Pakistan	Low-middle SDI
Samoa	Low-middle SDI
Sudan	Low-middle SDI
Swaziland	Low-middle SDI
Syria	Low-middle SDI
Tajikistan	Low-middle SDI
Timor-Leste	Low-middle SDI
Tonga	Low-middle SDI
Vanuatu	Low-middle SDI
Zambia	Low-middle SDI
Zimbabwe	Low-middle SDI
Afghanistan	Low SDI
Angola	Low SDI
Benin	Low SDI
Burkina Faso	Low SDI
Burundi	Low SDI
Central African Republic	Low SDI
Chad	Low SDI
Comoros	Low SDI
Cote d'Ivoire	Low SDI
Democratic Republic of the Congo	Low SDI
Djibouti	Low SDI
Eritrea	Low SDI
Ethiopia	Low SDI
Guinea	Low SDI
Guinea-Bissau	Low SDI
Haiti	Low SDI
Kiribati	Low SDI
Liberia	Low SDI
Madagascar	Low SDI
Malawi	Low SDI
Mali	Low SDI
Mozambique	Low SDI
Niger	Low SDI
Palestine	Low SDI
Papua New Guinea	Low SDI
Rwanda	Low SDI
Sao Tome and Principe	Low SDI
Senegal	Low SDI
Sierra Leone	Low SDI
Solomon Islands	Low SDI
Somalia	Low SDI
South Sudan	Low SDI
Tanzania	Low SDI
The Gambia	Low SDI
Togo	Low SDI
Uganda	Low SDI
Yemen	Low SDI

SDI, sociodemographic index.

Table S7 Disability weights

Health state	Lay description	Estimate	Uncertainty interval	
Cancer, diagnosis and primary therapy	Has pain, nausea, fatigue, weight loss and high anxiety	0.288	0.193	0.399
Cancer, controlled phase	Has a chronic disease that requires medication every day and causes some worry but minimal interference with daily activities	0.049	0.031	0.072
Cancer, metastatic	Has severe pain, extreme fatigue, weight loss and high anxiety	0.451	0.307	0.600
Terminal phase, with medication	Has lost a lot of weight and regularly uses strong medication to avoid constant pain. The person has no appetite, feels nauseous, and needs to spend most of the day in bed	0.540	0.377	0.687

Table S8 Decomposition analysis of prostate cancer incidence trends at the global and regional levels, and by SDI quintiles, both sexes, 2006 to 2016

Location	Incidence cases, No.		Expected incidence cases, 2016, No.		Change in incidence cases, 2006 to 2016, %			Overall change, %
	2006	2016	Given population growth alone	Given population growth and aging	Due to population growth	Due to change in age structure	Due to change in incidence rate	
Global	1,024,737 (941,906 to 1,133,813)	1,435,742 (1,293,396 to 1,618,655)	1,152,101	1,360,610	12.4	20.3	7.3	40.1
High SDI	686,576 (627,394 to 774,210)	899,318 (836,795 to 1,065,763)	723,248	851,446	5.3	18.7	7	31
High-middle SDI	152,657 (143,626 to 178,410)	226,521 (205,520 to 255,438)	169,605	196,941	11.1	17.9	19.4	48.4
Middle SDI	119,754 (101,660 to 134,274)	207,679 (178,146 to 237,617)	128,549	167,105	7.3	32.2	33.9	73.4
Low-middle SDI	47,737 (32,584 to 55,265)	74,721 (51,286 to 82,781)	55,671	65,261	16.6	20.1	19.8	56.5
Low SDI	20,214 (11,526 to 23,402)	29,805 (16,591 to 34,971)	26,743	27,715	32.3	4.8	10.3	47.4

Data in the parentheses indicates 95% uncertainty interval (95% UI). SDI, sociodemographic index.

Table S9 Probability of developing prostate cancer within selected age intervals, global, and by SDI quintile, by sex, 2006–2016 in % (odds)

Location/SDI quintile	Birth to age 49		Age 50 to 59		Age 60 to 69		Age 70 to 79		Age 30 to 70		Birth to age 79	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Global	0.06 (1 in 1,609)	NA	0.46 (1 in 219)	NA	1.99 (1 in 50)	NA	3.90 (1 in 26)	NA	6.30 (1 in 16)	NA	6.30 (1 in 16)	NA
High-middle SDI	0.07 (1 in 1,492)	NA	0.39 (1 in 255)	NA	1.72 (1 in 58)	NA	3.45 (1 in 29)	NA	5.54 (1 in 18)	NA	5.55 (1 in 18)	NA
High SDI	0.19 (1 in 522)	NA	1.47 (1 in 68)	NA	5.27 (1 in 19)	NA	8.15 (1 in 12)	NA	14.43 (1 in 7)	NA	14.44 (1 in 7)	NA
Low-middle SDI	0.02 (1 in 5,364)	NA	0.11 (1 in 938)	NA	0.53 (1 in 190)	NA	1.15 (1 in 87)	NA	1.79 (1 in 56)	NA	1.79 (1 in 56)	NA
Low SDI	0.03 (1 in 3,858)	NA	0.17 (1 in 605)	NA	0.92 (1 in 109)	NA	2.08 (1 in 48)	NA	3.16 (1 in 32)	NA	3.16 (1 in 32)	NA
Middle SDI	0.04 (1 in 2,366)	NA	0.20 (1 in 501)	NA	0.83 (1 in 120)	NA	1.90 (1 in 53)	NA	2.94 (1 in 34)	NA	2.95 (1 in 34)	NA

SDI, sociodemographic index; NA, not available.