

Global, Regional, and National Burden of Kidney, Bladder, and Prostate Cancers and Their Attributable Risk Factors, 1990-2019

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1 **Global, regional, and national burden of kidney, bladder, and prostate cancers and their**
2 **attributable risk factors, 1990-2019**

3

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26

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28

29 **Abstract**

30 **Background:** To investigate the burden and attributable risk factors for three genitourinary cancers
31 in 204 countries and territories during 30 years.

32 **Methods:** We extracted data of kidney, bladder, and prostate cancers from the Global Burden of
33 Disease 2019 database, including incidence, mortality, disability-adjusted life-years (DALYs), and
34 the attributable risk factors from 1990 to 2019. Estimated annual percentage changes (EAPC) were
35 calculated to assess the changes in age-standardized incidence rate, age-standardized mortality rate
36 (ASMR), and age-standardized DALYs rate (ASDR). The associations between cancers burden and
37 socio-demographic index (SDI) were also analyzed.

38 **Results:** Compared with 1990, the global incident cases of kidney, bladder, and prostate cancers
39 have increased by 154.78%, 123.34%, and 169.11% in 2019. The ASMR and ASDR of bladder
40 cancer (EAPC = -0.68 for ASMR, EAPC = -0.83 for ASDR) and prostate cancer (EAPC = -0.75 for
41 ASMR, EAPC = -0.71 for ASDR) showed a downward trend, but kidney cancer increased (EAPC
42 = 0.35 for ASMR, EAPC = 0.12 for ASDR). Of all cancers, incidence, mortality, and DALYs were
43 higher in the high-level SDI regions and countries. The burden of bladder cancer and prostate cancer
44 was mainly distributed among older men, while the burden of kidney cancer increases among

45 younger men. Smoking related mortality and DALYs decreased, but high body-mass index and high
46 fasting plasma glucose related mortality and DALYs increased among kidney, bladder, and prostate
47 cancers between 1990 and 2019.

48 **Conclusions:** Kidney, bladder, and prostate cancers remain the major global public health challenge
49 until 2019. We suggest the 204 countries and territories to take positive cancer prevention and
50 intervention strategies, especially the urologists and urological related academic associations.

51 **Key Words:** Genitourinary cancer; Kidney cancer; Bladder cancer; Prostate cancer; Incidence;
52 Mortality; Disability-adjusted life-years; Burden of disease

53

54 **Background**

55 Kidney, bladder, and prostate cancers are the most common genitourinary cancers, caused global
56 0.39, 0.47, and 1.33 million new cases in 2017 [1]. Previous studies have reported notable
57 heterogeneity in the disease burden of genitourinary cancers at the geographic location, temporal
58 trend, and socio-demographic index (SDI) levels [2-4]; however, none of them reported
59 comprehensive data and reflected the changed spectrum. The incidence and mortality on
60 genitourinary cancers have changed significantly in recent years, with the world population growth
61 and aging, the life expectancy increased, and the socioeconomic development [1, 5, 6]. Hence, long-
62 term, comprehensive, and accurate assessment of the disease burden is the necessary for health
63 policy decision making.

64

65 The Global Burden of Disease (GBD) 2019 evaluated 369 diseases and injuries worldwide and
66 compared their prevalence in different regions and countries, providing strategies for better

67 improving population health and also providing valuable information for health policy development
68 [7-9]. However, the information of kidney, bladder, and prostate cancers remain need to be further
69 clarified. In this study, we used the data from the GBD 2019 to analyze the incidence, mortality,
70 disability-adjusted life-years (DALYs) of these three cancers, and also analyzed their attributable
71 risk factors from 1990 to 2019.

72

73 **Materials and Methods**

74 *Data source*

75 GBD 2019 is updated and expanded on the basis of GBD 2017 and provide the most up-to-date
76 global health data. GBD 2019 includes data on mortality and morbidity in 204 countries and
77 territories, 369 diseases and injuries, and 87 risk factors from 1990 to 2019. In this study, incidence,
78 mortality, DALYs, and its corresponding age-standardized rates (ASR) by world standard
79 population of kidney, bladder, and prostate cancers were gathered by the Global Health Data
80 Exchange query tool (<http://ghdx.healthdata.org/gbd-results-tool>). Annual deaths and DALYs
81 attributable to 87 risk factors are also available from the GBD results tool. The GBD world
82 population standard was used for the calculation of ASR. The 95% uncertainty interval (UI) were
83 reported for all estimates. The SDI is a composite index of development status strongly correlated
84 with health outcomes, and the dataset are available online (<http://ghdx.healthdata.org/gbd-2019>). A
85 region or country with an SDI of 0 would have a theoretical minimum level of development relevant
86 to health, while a region or country with an SDI of 1 would have a theoretical maximum level. In
87 addition, age group and sex were also extracted from GBD results tool to analyze the burden of
88 kidney, bladder, and prostate cancers.

89

90 ***Cancer definition***

91 For GBD 2019, all cancers were defined by International Classification of Diseases (ICD) diagnostic
92 criteria. The associated ICD-9 and ICD-10 codes of kidney, bladder, and prostate cancers for
93 incidence and mortality data were as follows: kidney cancer (C64-C64.2, C64.9-C65.9, Z80.51,
94 Z85.52-Z85.54, 189-189.1, 189.5-189.6, 209.24, C64-C65.9, D30.0-D30.1, D41.0-D41.1, and
95 223.0-223.1), bladder cancer (C67-C67.9, Z12.6-Z12.79, Z80.52, Z85.51, 188-188.9, V10.51,
96 V16.52, V76.3, D09.0, D30.3, D41.4-D41.8, D49.4, 223.3, 233.7, 236.7, and 239.4), and prostate
97 cancer (C61-C61.9, Z12.5, Z80.42, Z85.46, 185-185.9, V10.46, V16.42, V76.44, D07.5, D29.1,
98 D40.0, 222.2, and 236.5). The incidence, mortality, and DALYs estimation for genitourinary cancers
99 were described in the GBD 2019 study [7].

100

101 ***Attributable risk factors***

102 The attributable risk factors for the kidney cancer related death and DALYs were smoking, high
103 body-mass index, and occupational exposure to trichloroethylene. The attributable risk factors for
104 the bladder cancer related death and DALYs were smoking and high fasting plasma glucose. The
105 attributable risk factor for the prostate cancer related death and DALYs was smoking. The
106 percentage of cancer related death and DALYs are available in GBD results tool. Details about the
107 definitions of these risk factors and their relative risk for kidney, bladder, and prostate cancers were
108 described elsewhere [8].

109

110 ***Statistical analysis***

111 The general methodology and estimation process of GBD 2019 have been introduced in previous
112 publications [7]. The ASR (per 100,000 population) was calculated by the sum of the products of
113 age-specific rates (a_i , where i denotes the i^{th} age) and the number of population (or weight w_i) in the
114 same age group i of the selected reference standard population, divided by the sum of the standard
115 population weights: $ASR = \frac{\sum_{i=1}^A a_i w_i}{\sum_{i=1}^A w_i} \times 100,000$. We used estimated annual percentage changes (EAPC)
116 to describe the trend of ASR within a specified time interval. The natural logarithm of ASR is linear
117 with time. The EAPC were estimated by a linear regression model: $y = \alpha + \beta x + \varepsilon$, where y is $\ln(ASR)$,
118 x is the calendar year, and ε is the error term. The EAPC were calculated as $100 \times (\exp(\beta) - 1)$ and
119 its 95% confidence interval (CI) can be obtained from the linear regression model. When the
120 estimated EAPC value and its lower 95% CI were both >0 , ASR is considered as an upward trend.
121 Conversely, if the estimated EAPC value and its upper 95% CI were both <0 , ASR is considered a
122 downward trend. Data visualization and statistics were performed using R software (Version 4.0.5)
123 and Microsoft Excel (Version 2016).

124

125 **Results**

126 ***Global incidence, mortality and DALYs***

127 In 2019, the global incident cases of kidney, bladder, and prostate cancers were 371,747 (95% UI
128 344,594 to 402,350), 524,305 (95% UI 475,952 to 569,434) and 1,410,452 (95% UI 1,227,900 to
129 1,825,766) (Table 1). Compared with 1990, prostate cancer (169.11%) had the largest increase,
130 followed by kidney cancer (154.78%) and bladder cancer (123.34%). Between 1990 and 2019,
131 prostate cancer had the highest percentage of incident cases among genitourinary cancers, followed
132 by bladder and kidney cancers (Figure S1a). From 1990 to 2019, the age-standardized incidence

133 rate (ASIR) of prostate cancer has been much higher than kidney and bladder cancers (Figure S2a).

134 The EAPC of ASIR in genitourinary cancers showed an upward trend, except for female bladder
135 cancer (EAPC = -0.24, 95% CI -0.29 to -0.18).

136

137 Worldwide, prostate cancer caused 486,836 male deaths in 2019, which was 4.48 times of kidney
138 cancer and 2.88 times of bladder cancer. Compared with 1990, the percentage of deaths from
139 prostate and kidney cancers increased, while the percentage of deaths from bladder cancer decreased
140 in 2019 (Figure S1b). General, the age-standardized mortality rate (ASMR) for bladder cancer and
141 prostate cancer showed a downward trend from 1990 to 2019 (Figure S2b). The ASMR for kidney
142 cancer showed an upward trend before 2010, and has gradually declined in recent years. Over the
143 past 30 years, the EAPC of ASMR showed an upward trend only in kidney cancer (EAPC = 0.35,
144 95% CI 0.26-0.45).

145

146 Prostate cancer caused 8,644,870 (95% UI 7,548,021 to 10,559,866) DALYs in 2019, more than the
147 sum of bladder and kidney cancers. The percentage of DALYs due to prostate and kidney cancers
148 continues to expand from 1990 to 2019 (Figure S1c). The age-standardized DALYs rate (ASDR) of
149 these three cancers had a consistent trend with ASMR in the past three decades (Figure S2c). The
150 EAPC of ASDR had the most significant downward trend in female bladder cancer (EAPC = -1.04,
151 95% CI -1.08 to -0.99).

152

153 ***Regional incidence, mortality and DALYs***

154 In 2019, the regions had the most incident cases of prostate cancer were High-income North

155 America (331,890, 95% UI 262,386 to 494,583), Western Europe (325,494, 95% UI 267,128 to
156 469,919), and East Asia (161,969, 95% UI 126,342 to 213,686) (Table S1). It is worth noting that
157 most of the new cases of bladder and kidney cancers were also distributed in these three regions. In
158 addition, the ASIR of bladder and kidney cancers showed the most significant upward trend in East
159 Asia, while the ASIR of prostate cancer showed a downward trend only in High-income North
160 America (Figure 1).

161

162 Western Europe had the most deaths of prostate (95,769, 95% UI 79,228 to 133,047), bladder
163 (50,511, 95% UI 45,163 to 54,465) and kidney cancers (34,359, 95% UI 31,508 to 36,302) in 2019
164 (Table S2). The highest ASMR of kidney, bladder, and prostate cancers were Southern Latin
165 America (5.05, 95% UI 4.59 to 5.51), Central Europe (5.29, 95% UI 4.66 to 5.99), and Southern
166 Sub-Saharan Africa (45.08, 95% UI 34.35 to 50.53). Stark regional differences were observed in
167 ASMR of genitourinary cancers during the past 30 years (Figure S3). For example, the fastest
168 increase of ASMR in kidney cancer were observed in East Asia, followed by Central Europe, North
169 Africa and Middle East, and Eastern Sub-Saharan Africa.

170

171 The highest DALYs of kidney and bladder cancers were observed in East Asia, and prostate cancer
172 were observed in High-income North America in 2019 (Table S3). The ASDR of kidney, bladder,
173 and prostate cancers were highest in Southern Latin America (124.32, 95% UI 113.32 to 135.49),
174 Central Europe (107.36, 95% UI 93.95 to 122.07), and Southern Sub-Saharan Africa (726.31, 95%
175 UI 574.70 to 822.50). From 1990 to 2019, East Asia, Oceania, and Western Sub-Saharan Africa had
176 the fastest increase in ASDR for kidney, bladder and prostate cancers, respectively (Figure S4).

177

178 *National incidence, mortality and DALYs*

179 Among 204 countries and territories, USA (308,584, 95% UI 240,778 to 460,979), China (153,448,
180 95% UI 118,400 to 204,943), and Germany (75,380, 95% UI 53,645 to 104,000) had the most
181 prostate cancer incident cases in 2019 (Table S4). The most incident cases of bladder cancer and
182 kidney cancer were found in China (100,020, 95% UI 83,242 to 118,654) and USA (61,541, 95%
183 UI 52,477 to 71,382). The ASIR of kidney, bladder, and prostate cancers were highest in Czechia
184 (15.66, 95% UI 12.62 to 19.55), Monaco (31.92, 95% UI 23.32 to 56.95), and Saint Kitts and Nevis
185 (235.26, 95% UI 184.24 to 287.38). From 1990 to 2019, the Bulgaria (EAPC = 6.24, 95% CI 5.32
186 to 7.16), Cabo Verde (EAPC = 3.88, 95% CI 3.19 to 4.57), and Estonia (EAPC = 4.31, 95% CI 3.94
187 to 4.69) had the most significant increase in the ASIR of kidney, bladder, and prostate cancers,
188 respectively (Figure 2).

189

190 In 2019, China had the most deaths of kidney, bladder, and prostate cancers, followed by USA and
191 Russian Federation (Table S4). The ASMR of kidney cancer was highest in Uruguay (6.56, 95% UI
192 5.90 to 7.23), and lowest in Papua New Guinea (0.49, 95% UI 0.34 to 0.75). Lebanon (10.38, 95%
193 UI 8.08 to 13.72) and Dominica (126.28, 95% UI 93.14 to 156.53) showed the highest ASMR of
194 bladder cancer and prostate cancer. The EAPC of ASMR showed that kidney, bladder, and prostate
195 cancers had the most significant increase in Bulgaria (EAPC = 5.83, 95% CI 4.92 to 6.75), Northern
196 Mariana Islands (EAPC = 3.22, 95% CI 2.62 to 3.84), and Cabo Verde (EAPC = 2.53, 95% CI 1.74
197 to 3.33), respectively (Figure S5).

198

199 The most DALYs caused by kidney, bladder, and prostate cancers were also found among China
200 and USA in 2019 (Table S4). The number of DALYs for kidney, bladder, and prostate cancers in
201 China was 1.5 times, 2.1 times, and 1.1 times higher than USA, respectively. The highest ASDR for
202 kidney, bladder, and prostate cancers was Uruguay (166.63, 95% UI 149.92 to 184.54), Egypt
203 (201.75, 95% UI 132.14 to 294.39), and Dominica (1,923.95, 95% UI 1,428.24 to 2,394.31). The
204 Bulgaria (EAPC = 5.71, 95% CI 4.80 to 6.62), Northern Mariana Islands (EAPC = 3.37, 95% CI
205 2.73 to 4.02), and Georgia (EAPC = 2.67, 95% CI 2.07 to 3.27) were the most significant increase
206 in ASDR for kidney, bladder, and prostate cancers from 1990 to 2019, respectively (Figure S6).

207

208 ***Burden of genitourinary cancers by SDI***

209 High-level SDI regions had higher ASIR of kidney cancer in global and 21 regions (Figure 3a).
210 Similarly, the ASMR and ASDR of kidney cancer in high-level SDI regions were higher than the
211 low-level SDI regions (Figure S7-8). Among the 204 countries and territories, the ASIR of kidney
212 cancer in Czechia were much higher than the expected levels in 2019 (Figure 3b). The associations
213 between ASIR and SDI were also found among bladder and prostate cancers at the regional and
214 national level (Figure S9-10). However, no associations between ASMR, ASDR and SDI were
215 observed among bladder and prostate cancers (Figure S11-14).

216

217 ***Burden of genitourinary cancers by age and sex***

218 The 65-69 years age group had the most incident cases of kidney cancer in 2019 (Figure 4a). The
219 incidence rate of kidney cancer was highest in 85-89 years age group among men (47.97, 95% UI
220 41.44 to 52.79) and 90-94 years age group among women (23.06, 95% UI 17.53 to 26.68). The

221 highest mortality rate of kidney cancer was observed in the oldest age groups. The incident cases of
222 bladder cancer increase with age, peaking in 70-74 years old, and then decreases (Figure 4d). In the
223 95 years or older age group, the incidence rate, mortality rate, and DALYs rate of bladder cancer in
224 men were 3.4 times, 3.3 times, and 3.3 times higher than women, respectively. The incident cases
225 of prostate cancer started climbing at 55-59 years old, reached a peak at 70-74 years old, and
226 dropped in the oldest age groups (Figure 4g).

227

228 *Attributable risk factors*

229 Between 1990 and 2019, the percentage of kidney cancer DALYs were attributable to the smoking
230 dropped from 18.19% to 16.95%, while high body-mass index rose from 13.98% to 18.55% (Table
231 S5). Smoking and high fasting plasma glucose were mainly attributable risk factors of bladder
232 cancer death and DALYs. In 2019, 6.01% of deaths and 6.6% of DALYs caused by prostate cancer
233 were attributable to smoking.

234

235 **Discussion**

236 This study revealed that the global, regional, and national burden of genitourinary cancers and their
237 attributable risk factors have changed in the past 30 years. Compared with 1990, the proportion of
238 prostate cancer new cases expanded and still accounted for the majority among these cancers, the
239 proportion of bladder cancer decreased and ranked 2th among them, and the proportion of kidney
240 cancer remained stable in 2019. We observed the significant increase in ASIR for kidney cancer
241 (EAPC = 0.87), followed by prostate cancer (EAPC = 0.26) and bladder cancer (EAPC = 0.07) at
242 the global level. From these changes, we found the kidney cancer still represent a small percentage

243 of genitourinary cancers, compared with bladder and prostate cancers, even though kidney cancer
244 has the fastest increase in ASIR. The changed global incidence of genitourinary cancers indicated
245 the evolution of early detection of disease, such as prostate-specific antigen screening for prostate
246 cancer and cross-sectional imaging for kidney cancer [10,11]. For example, the widespread use of
247 routine prostate-specific antigen testing led to a rapid increase in the incidence of prostate cancer in
248 the early 1990's among USA; however, prostate cancer incidence has been declining in recent years
249 with the reduction in routine prostate-specific antigen testing [12-14]. Likewise, advances in
250 imaging technology have led to an increase in the detection rate of kidney cancer in developed
251 countries [10]. Other reasons may partly explain the accelerated incidence of genitourinary cancers,
252 included aging population and changed lifestyles. Besides, deaths caused by genitourinary cancers
253 were increased but fortunately we see the opposite trend in the ASMR, especially for prostate and
254 bladder cancers. This trend was also showed in DALYs and ASDR among these three genitourinary
255 cancers. Therefore, the decline in mortality and DALYs proves the effectiveness of current cancer
256 prevention and treatment strategies. In the future, the global epidemiological studies of cancer, such
257 as the GBD program and the Global Cancer Observatory project [15], should continue to provide
258 evidence to guide decision-making.

259

260 The variation in incidence, mortality, and DALYs of genitourinary cancers was noted at the regional
261 and national level. In the past three decades, the incidence of bladder cancer has shown a downward
262 trend in 8 regions, while prostate cancer and kidney cancer has shown an upward trend almost in 21
263 regions. This results of these three cancers were consistent with the previous studies [2, 4, 16]. The
264 prevalence of risk factors associated with genitourinary cancer and the spread of early detection

265 could partially explain the incidence trend in these regions. Mortality and DALYs of genitourinary
266 cancers showed significant decrease in developed regions such as Australasia and High-income
267 North America. Better health care policies and disease prevention awareness may play an important
268 role in reducing the burden of genitourinary cancers. Moreover, SDI was associated with the
269 incidence, mortality, and DALYs of genitourinary cancers. For all cancer, high-level SDI regions
270 and countries have higher incidence, mortality and DALYs. However, we have noticed that the
271 mortality and DALYs of genitourinary cancers in high-level SDI regions and countries showed a
272 steady or downward trend. This downward trend was most obvious in prostate cancer, followed by
273 bladder cancer and kidney cancer. The appropriate cancer prevention and intervention strategies is
274 needed in different social development degree countries.

275

276 The incidence and burden of genitourinary cancers were significantly higher among the elderly men.
277 Previous studies based on the GBD 2017 data have also shown that the burden of genitourinary
278 cancers in the elderly was more serious [2-4, 17, 18]. The aging population and the increase in life
279 expectancy are one of the factors that affect the burden of disease, but cancer-related risk factors
280 also play an important role [19-23]. Smoking is a shared risk factor for these three cancers and
281 shows a decreasing contribution to cancer death and DALYs in the past 30 years. Notably, the burden
282 of disease associated with high fasting plasma glucose and high body-mass index is increasing. This
283 shows the effectiveness of previous tobacco control strategies, but also suggests the necessary to
284 explore new preventive measures to address the increased metabolic risk factors. In addition, there
285 are excellent international health programs that are worth learning and replicating [24]. For example,
286 the Universal Health Coverage program led by the WHO enables everyone to access the health

287 services and ensures that the quality of those services is good enough to improve the health of the
288 people who receive them. As such, urologists and urological related academic associations could
289 develop standards and tools to provide guidance for the implementation of cancer prevention,
290 screening and treatment.

291

292 Today and in the near future, the epidemiological studies of genitourinary cancers under the
293 COVID-19 pandemic will face the unprecedented challenges. First, epidemiological data of
294 genitourinary cancers may not be as accurate as in the past. A global survey showed COVID-19 had
295 led to significant delay in outpatient care and surgery in urology, with an average delay of more than
296 8 weeks [25]. Delays in the normal medical order, which may result in a large number of patients
297 not being accounted for the morbidity and mortality. Second, COVID-19 may increase the disease
298 burden of genitourinary cancers. Joint effects of COVID-19 and cancer sequelae may be seen in
299 DALYs, including physical and mental health [26]. Finally, the ongoing effects of the pandemic
300 may not end in a short time. Hence, to divide the death cause of died genitourinary cancers patients
301 who also undergo COVID-19 may help to accurately assess the disease burden.

302

303 Although our research was based on GBD 2019 data and methods, it still had some limitations. First,
304 the accuracy of the GBD data depends on the quality of the existing data in each country, we believe
305 the quality was different among countries with different social, economic and cultural backgrounds;
306 hence, the results of smaller countries or countries with low levels of development should be
307 interpreted with caution. Second, differences in reporting approaches and case definitions may cause
308 information to be missed. We suggest the WHO perform a unified design methodology and

309 procedure to collect data. Finally, although there are available data on genitourinary cancers in GBD
310 2019, it does not include all risk factors and etiologies, so the disease burden cannot be fully assessed.

311

312 **Conclusions**

313 In conclusion, kidney, bladder, and prostate cancers remain the major global public health challenge
314 until 2019. We suggest the 204 countries and territories to take positive cancer prevention and
315 intervention strategies, especially the urologists and urological related academic associations.

316

317 **Abbreviations**

318 ASDR: age-standardized DALYs rate

319 ASIR: age-standardized incidence rate

320 ASMR: age-standardized mortality rate

321 ASR: age-standardized rates

322 CI: confidence interval

323 DALYs: disability-adjusted life-years

324 EAPC: estimated annual percentage changes

325 GBD: Global Burden of Disease

326 ICD: International Classification of Diseases

327 SDI: socio-demographic index

328 UI: uncertainty interval

329

330 **Declarations**

331 **Ethics approval and consent to participate**

332 Not applicable.

333

334 **Consent for publication**

335 Not applicable.

336

337 **Availability of data and materials**

338 The datasets generated during the current study are available in the Global Health Data Exchange

339 query tool (<http://ghdx.healthdata.org/gbd-results-tool>).

340

341 **Competing interests**

342 The authors declare that they have no competing interests.

343

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345 None.

346

347 **Authors' contributions**

348 Conception and design: SY, XHW, DLH, and XTZ; Data acquisition: HZ, XYL, XFX, HW, SHH,

349 CZ, LYL, JMG, and DJM; Data analysis and interpretation: HZ, QH, XHL, and XDL; Drafting the

350 manuscript: HZ, QH, and XHL; Critical revision of the manuscript for scientific and factual content:

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355

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424

425

426 **Table**

427 **Table 1.** Global incidence, mortality and DALYs of genitourinary cancers from 1990 to 2019

428

429 **Figure Legends**

430 **Figure 1.** The EAPC of ASIR for genitourinary cancers in global and 21 regions. **a**, kidney cancer;
431 **b**, bladder cancer; **c**, prostate cancer. ASIR, age-standardized incidence rate; EAPC, estimated
432 annual percentage change.

433 **Figure 2.** The EAPC of ASIR for genitourinary cancers in 204 countries and territories. **a**, kidney
434 cancer; **b**, bladder cancer; **c**, prostate cancer. ASIR, age-standardized incidence rate; EAPC,
435 estimated annual percentage change.

436 **Figure 3.** ASIR of kidney cancer for 21 regions and 204 countries and territories by SDI. **a**, 21
437 regions; **b**, 204 countries and territories. ASIR, age-standardized incidence rate; SDI:
438 sociodemographic index.

439 **Figure 4.** Global incidence, mortality, and DALYs of genitourinary cancers by age and sex in 2019.

440 **a**, **b**, and **c**, incidence, mortality, and DALYs of kidney cancer; **d**, **e**, and **f**, incidence, mortality, and

441 DALYs of bladder cancer; **g**, **h**, and **i**, incidence, mortality, and DALYs of prostate cancer. DALYs.
442 DALYs, disability-adjusted life-years.

443

444 **Supplementary material**

445 **Tables**

446 **Table S1.** Regional incident cases and age-standardized incidence rate of genitourinary cancers in
447 2019.

448 **Table S2.** Regional deaths and age-standardized mortality rate of genitourinary cancers in 2019.

449 **Table S3.** Regional DALYs and age-standardized DALYs rate of genitourinary cancers in 2019.

450 **Table S4.** The incidence, mortality and DALYs of genitourinary cancers among the top three and
451 bottom three countries in 2019.

452 **Table S5.** The percentage of genitourinary cancers deaths and DALYs attributable to risk factors
453 in 1990 and 2019.

454

455 **Figure Legends**

456 **Figure S1.** The percentage of incident cases, deaths, and DALYs for genitourinary cancers in 1990
457 and 2019. **a**, incident cases; **b**, deaths; **c**, DALYs. DALYs, disability-adjusted life-years.

458 **Figure S2.** The global ASIR, ASMR, and ASDR of genitourinary cancers from 1990 to 2019. **a**,
459 ASIR; **b**, ASMR; **c**, ASDR. ASIR, age-standardized incidence rate; ASMR, age-standardized
460 mortality rate; ASDR, age-standardized DALYs rate; DALYs, disability-adjusted life-years.

461 **Figure S3.** The EAPC of ASMR for genitourinary cancers in global and 21 regions. ASMR, age-
462 standardized mortality rate; EAPC, estimated annual percentage change.

463 **Figure S4.** The EAPC of ASDR for genitourinary cancers in global and 21 regions. ASDR, age-
464 standardized DALYs rate; EAPC, estimated annual percentage change.

465 **Figure S5.** The EAPC of ASMR for genitourinary cancers in 204 countries and territories. **a**, kidney
466 cancer; **b**, bladder cancer; **c**, prostate cancer. ASMR, age-standardized mortality rate; EAPC,
467 estimated annual percentage change.

468 **Figure S6.** The EAPC of ASDR for genitourinary cancers in 204 countries and territories. **a**, kidney
469 cancer; **b**, bladder cancer; **c**, prostate cancer. ASDR, age-standardized DALYs rate; EAPC,
470 estimated annual percentage change.

471 **Figure S7.** ASMR of kidney cancer for 21 regions and 204 countries and territories by SDI. **a**, 21
472 regions; **b**, 204 countries and territories. ASMR, age-standardized mortality rate; SDI:
473 sociodemographic index.

474 **Figure S8.** ASDR of kidney cancer for 21 regions and 204 countries and territories by SDI. **a**, 21
475 regions; **b**, 204 countries and territories. ASDR, age-standardized DALYs rate; SDI:
476 sociodemographic index.

477 **Figure S9.** ASIR of bladder cancer for 21 regions and 204 countries and territories by SDI. **a**, 21
478 regions; **b**, 204 countries and territories. ASIR, age-standardized incidence rate; SDI:
479 sociodemographic index.

480 **Figure S10.** ASIR of prostate cancer for 21 regions and 204 countries and territories by SDI. **a**, 21
481 regions; **b**, 204 countries and territories. ASIR, age-standardized incidence rate; SDI:
482 sociodemographic index.

483 **Figure S11.** ASMR of bladder cancer for 21 regions and 204 countries and territories by SDI. **a**, 21
484 regions; **b**, 204 countries and territories. ASMR, age-standardized mortality rate; SDI:

485 sociodemographic index.

486 **Figure S12.** ASDR of bladder cancer for 21 regions and 204 countries and territories by SDI. **a**, 21
487 regions; **b**, 204 countries and territories. ASDR, age-standardized DALYs rate; SDI:
488 sociodemographic index.

489 **Figure S13.** ASMR of prostate cancer for 21 regions and 204 countries and territories by SDI. **a**,
490 21 regions; **b**, 204 countries and territories. ASMR, age-standardized mortality rate; SDI:
491 sociodemographic index.

492 **Figure S14.** ASDR of prostate cancer for 21 regions and 204 countries and territories by SDI. **a**, 21
493 regions; **b**, 204 countries and territories. ASDR, age-standardized DALYs rate; SDI:
494 sociodemographic index.

Figures

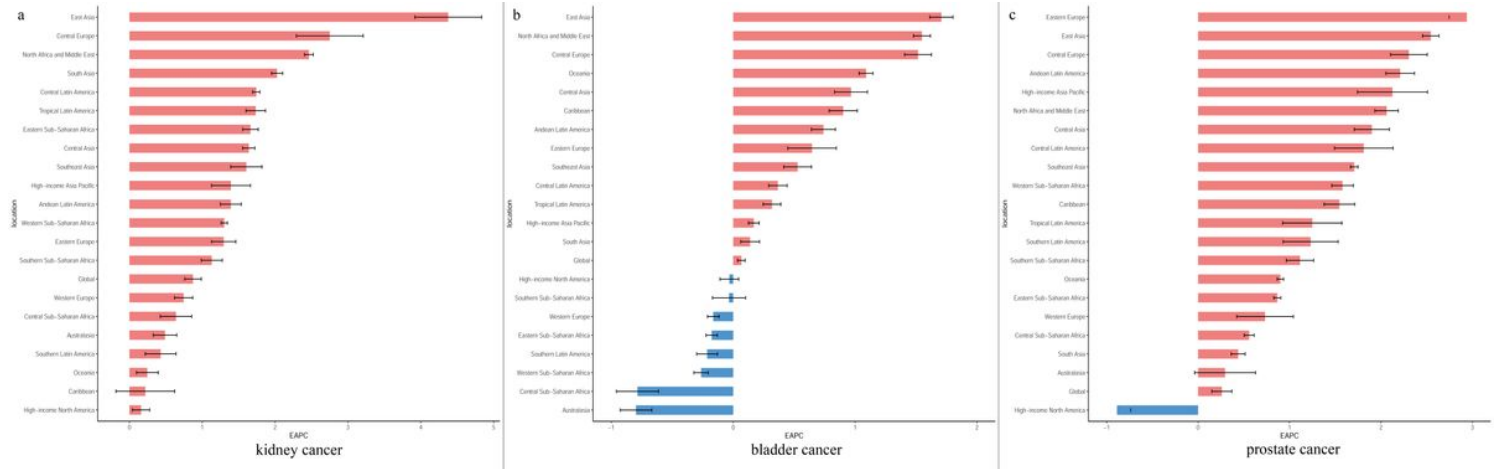


Figure 1

The EAPC of ASIR for genitourinary cancers in global and 21 regions. a, kidney cancer; b, bladder cancer; c, prostate cancer. ASIR, age-standardized incidence rate; EAPC, estimated annual percentage change.

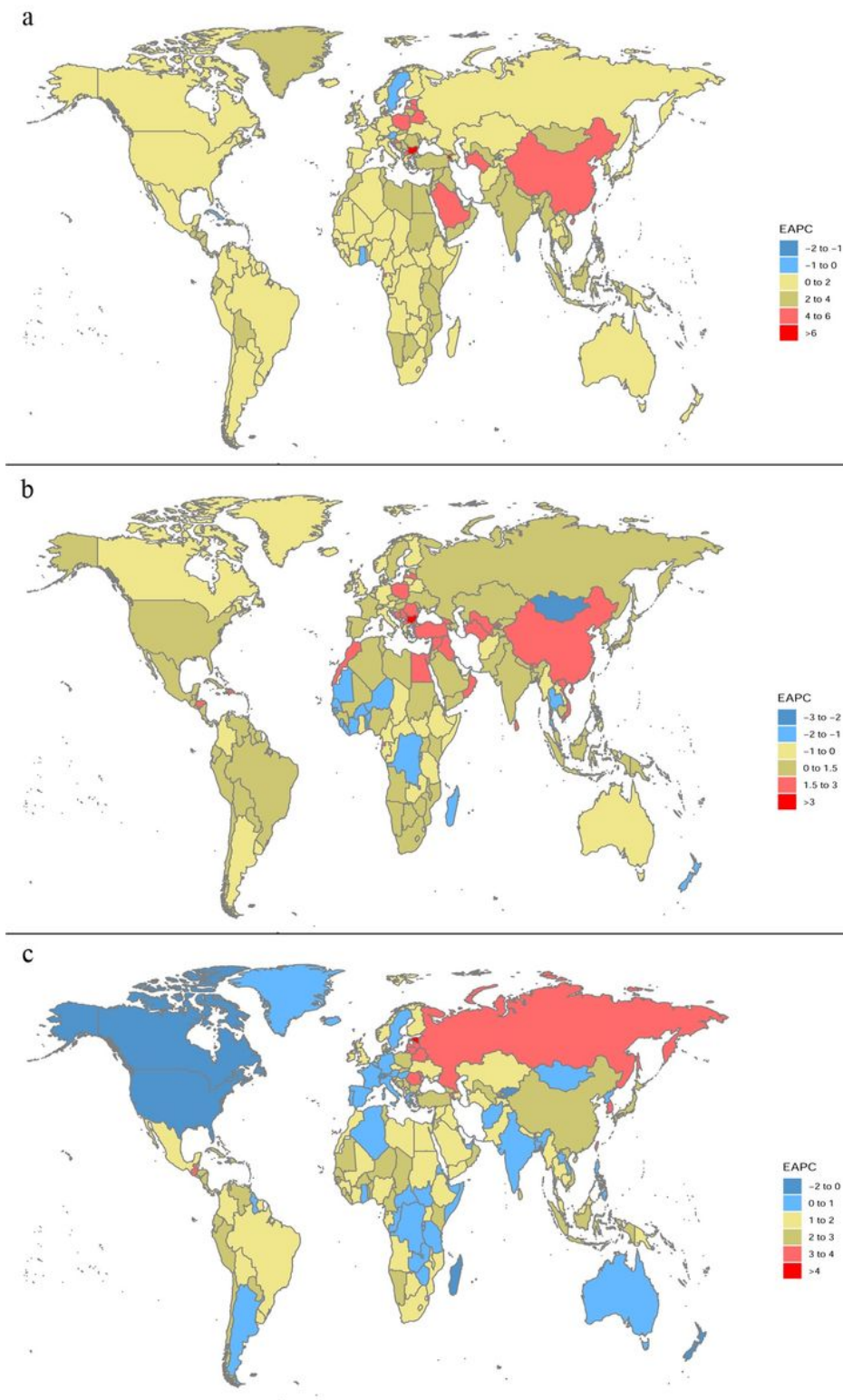


Figure 2

The EAPC of ASIR for genitourinary cancers in 204 countries and territories. a, kidney cancer; b, bladder cancer; c, prostate cancer. ASIR, age-standardized incidence rate; EAPC, estimated annual percentage change. Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of

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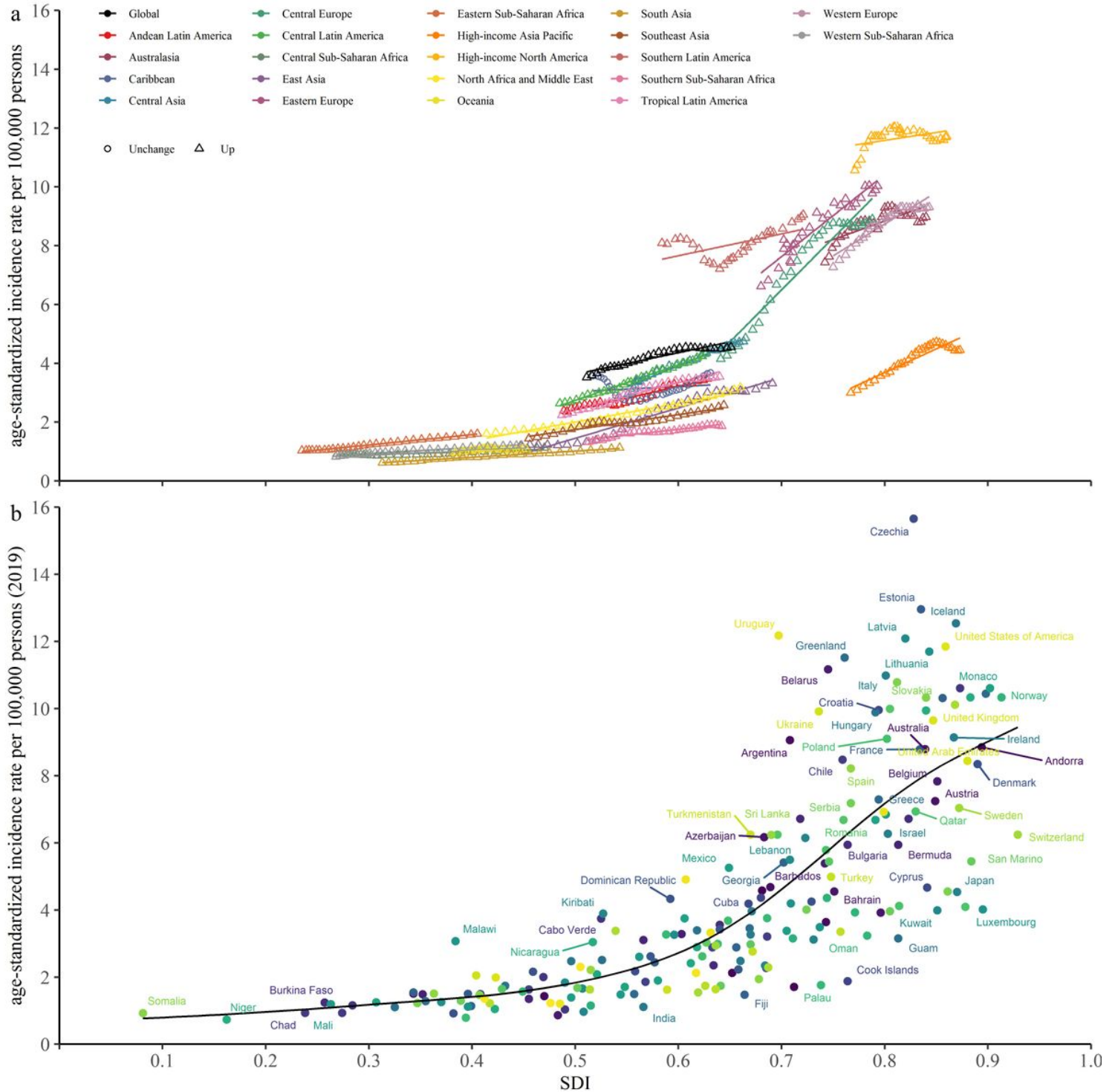


Figure 3

ASIR of kidney cancer for 21 regions and 204 countries and territories by SDI. a, 21 regions; b, 204 countries and territories. ASIR, age-standardized incidence rate; SDI: sociodemographic index.

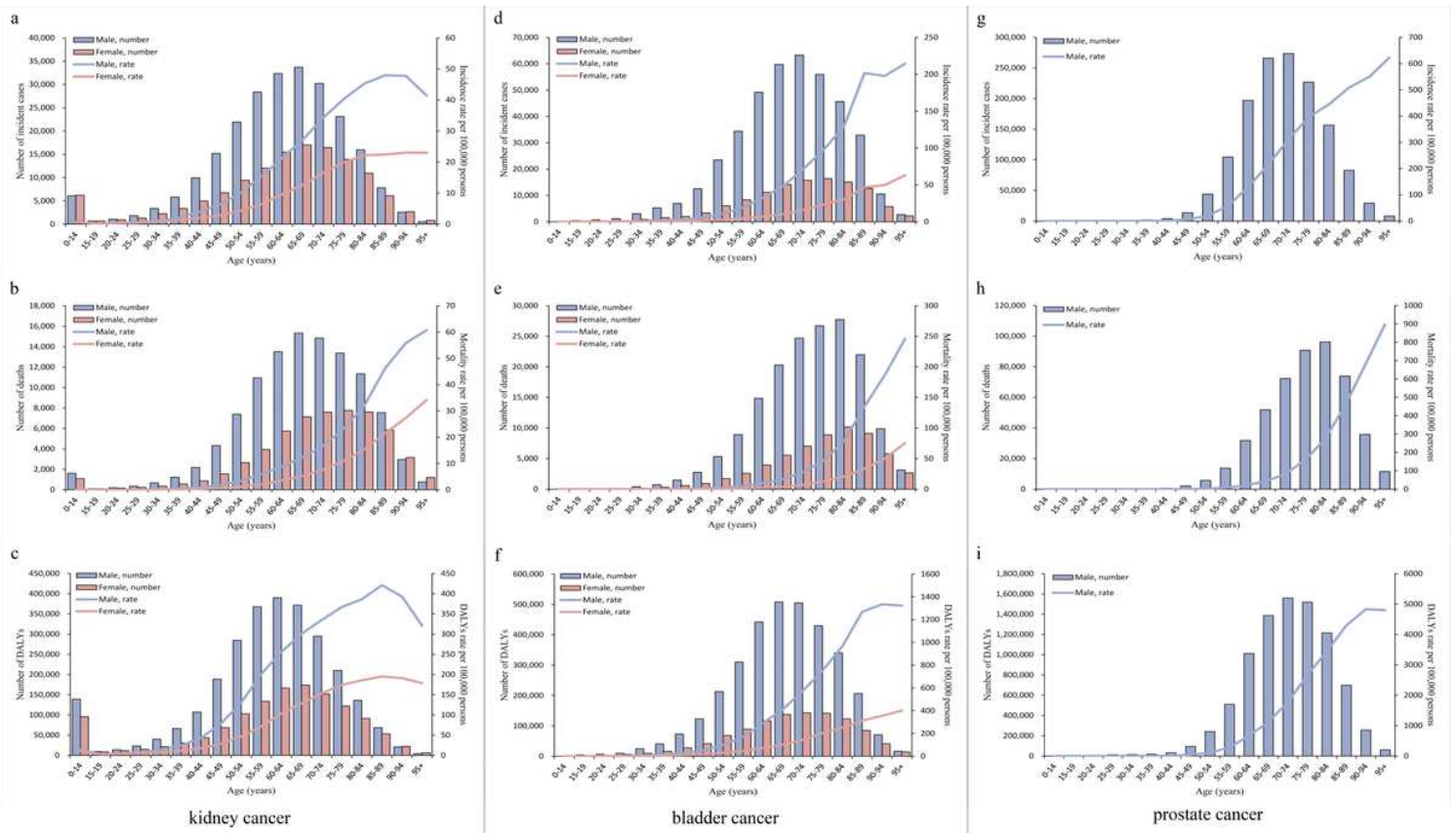


Figure 4

Global incidence, mortality, and DALYs of genitourinary cancers by age and sex in 2019. a, b, and c, incidence, mortality, and DALYs of kidney cancer; d, e, and f, incidence, mortality, and DALYs of bladder cancer; g, h, and i, incidence, mortality, and DALYs of prostate cancer. DALYs, disability-adjusted life-years.

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