Prostate cancer in Latin America and the Caribbean: mortality trends from 1997 to 2017 and predictions to 2030

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Torres-Roman JS, Valcarcel B, Arce-Huamani MA, Simbaña-Rivera K, Salvador-Carrillo JF, Poterico JA, Quispe-Vicuña C, Alvarez CS, McGlynn KA. Prostate cancer in Latin America and the Caribbean: mortality trends from 1997 to 2017 and predictions to 2030. Salud Publica Mex. 2024;66:226-235.
https://doi.org/10.21149/15463

Abstract
Objective. To evaluate the mortality rates of prostate cancer in Latin American and the Caribbean (LAC) countries and predict their mortality to 2030. **Materials and methods.** The data was retrieved from the World Health Organization mortality database. The age-standardized mortality rates for prostate cancer were estimated per 100 000 men between 1997 and 2017 for most LAC countries. The annual percent change was calculated by country and age group. The Nordpred was used to project prostate cancer mortality to 2030. **Results.** From 1997 to 2017, the countries with the highest mortality rates from prostate cancer were Trinidad and Tobago, Cuba, and Venezuela. For all ages, ten LAC countries presented significant decreases between -0.5 and -2.8%, whereas Brazil, Cuba, Guatemala, and Venezuela showed increases. Mortality by prostate cancer will increase in 2030 due to changes in the structure and size of the population. **Conclusions.** Despite the decline in

Torres-Roman JS, Valcarcel B, Arce-Huamani MA, Simbaña-Rivera K, Salvador-Carrillo JF, Poterico JA, Quispe-Vicuña C, Alvarez CS, McGlynn KA. Cáncer de próstata en América Latina y el Caribe: tendencias de mortalidad de 1997 a 2017 y predicciones a 2030. Salud Publica Mex. 2024;66:226-235.
https://doi.org/10.21149/15463

Resumen
Objetivo. Evaluar las tasas de mortalidad por cáncer de próstata en los países de América Latina y el Caribe (ALC) y predecir su mortalidad al año 2030. **Material y métodos.** Los datos se obtuvieron de la base de datos de mortalidad de la Organización Mundial de la Salud. Se estimaron las tasas de mortalidad estandarizadas por edad (TMES) por cáncer de próstata por 100 000 hombres entre 1997 y 2017 para la mayoría de los países de ALC. El cambio porcentual anual se calculó por país y grupo de edad. Se utilizó el *Nordpred* para proyectar la mortalidad por cáncer de próstata hasta 2030. **Resultados.** Entre 1997 y 2017, los países con las tasas más altas de mortalidad por cáncer de próstata fueron Trinidad y Tobago, Cuba y Venezuela. Para todas las edades, diez países de ALC presentaron disminuciones significativas entre -0,5 y -2,8%, mientras que Brasil, Cuba, Guatemala y Venezuela mostraron aumentos. La mortalidad global por cáncer de próstata aumentará en 2030 debido a los cambios

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Received on: November 20, 2023 • **Accepted on:** January 30, 2024 • **Published online:** March 22, 2024
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prostate cancer mortality rates over the last two decades in most countries in the region, some countries still have very high mortality rates. By 2030, most countries in the region will show overall increases in the number of deaths, mainly due to population size.

Keywords: prostatic neoplasms; mortality; forecasting; trends; Latin America

en la estructura y tamaño de la población. **Conclusiones.** A pesar del descenso de las tasas de mortalidad por cáncer de próstata en las dos últimas décadas en la mayoría de los países de la región, aún algunos de estos presentan tasas de mortalidad muy altas. Para el año 2030, la mayoría de los países de la región presentarán aumentos globales en el número de muertes, principalmente debido al tamaño de la población.

Palabras clave: neoplasias prostáticas; mortalidad; predicción; tendencias; América Latina

Prostate cancer is a public health concern, being the second most common cancer and the fifth leading cause of cancer-related deaths in men worldwide.[1] In 2020, the Global Cancer Observatory (Globocan) reported approximately 1 415 000 new cases (14.1% of total) of prostate cancer and 375 000 deaths (6.8% of total),[1] representing an incidence rate of 30.7 per 100 000 and mortality rate of 7.7 per 100 000. Although the incidence of prostate cancer is increasing worldwide, mortality rates vary widely between regions.[2]

Prostate cancer remains the leading neoplasm in men from Latin America and Caribbean (LAC) countries, where some of the highest mortality rates worldwide are presented.[3] In the last decades, several LAC countries continue to report high mortality rates of prostate cancer.[4-6] For instance, in 2015, Cuba reported the highest mortality rates (23.2 per 100 000), followed by Venezuela (20/100 000) and Chile (15/100 000),[5] whereas Peru reported mortality rates ranging from 20.9 in 2005-2009 to 24.1 in 2010-2014 per 100 000.[6]

Considerable efforts are still required to significantly reduce the burden of prostate cancer in LAC countries. The paucity of information on prostate cancer mortality in LAC countries underscores the imperative need for epidemiological research to formulate and implement effective cancer control and treatment strategies. Therefore, the objective of this study was to determine prostate cancer mortality rates in LAC countries between 1997 and 2017 and predict their mortality up to 2030.

Materials and methods

Data source

Data on prostate cancer mortality were obtained from the World Health Organization (WHO) Mortality Database between 1997 and 2017.[7] The cause-of-death statistics are from country civil registration systems. When a death occurs, this event is registered at the local civil registry with information on the cause of death. The information is then compiled by the national authority and submitted to the WHO every year. We retreived information available from LAC countries: Argentina, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, El Salvador, Guatemala, Mexico, Nicaragua, Panama, Paraguay, Peru, Puerto Rico (1999-2017), Trinidad and Tobago (1997-2012), Uruguay, and Venezuela (1997-2016). We did not include countries that do not have complete information or countries that do not have information on prostate cancer deaths for more than five continuous years of the study period. For this reason, some countries such as Bolivia (2000-2003), Haiti, Honduras (2008-2013) were excluded. The study focused on deaths caused by prostate cancer (C61) in accordance with the International Classification of Diseases, 10th revision (ICD-10).[8] The United Nations World Population Prospects 2019 Revision provided population estimates for each country.[9]

Statistical analysis

Age-standardized mortality rates (ASMRs) for prostate cancer between 1997 and 2017 were calculated using the Segi world standard population.[10] Prostate cancer mortality trends between 1997 to 2017 were assessed for all age groups and for men from 30-59 and ≥ 60 years of age. Joinpoint regression analysis was performed to determine mortality trends using the Joinpoint Regression Program software (National Cancer Institute, Bethesda, Maryland, USA).[11] Moreover, we have averaged the mortality rates for the last few years (2012-2017) to provide a recent overview for each country (except Trinidad and Tobago, data only for 2012).

The method employed identified joinpoints based on the model with a maximum of four change points. The final model included an estimated annual percent change (APC) based on the trend of each segment and determined whether these values were statistically significant ($p<0.05$). In addition, for trends with two or more tie points, the average annual percentage change (AAPC) was calculated. The establishment of statistical significance thresholds was based on the use of the Monte Carlo permutation method, together with the calculation of the estimated APC of the proportion using the logarithm of the proportion.[12]

Of the statistical models for predictions, the age-period-cohort model of the Nordpred package in the software R studio was used to determine mortality for the year 2030, deriving the relevant parameters from the past observations and using them to estimate future rates. Here, the age, period and cohort function as pseudo indicators for factors that have influenced past trends, such as exposure to risk factors, treatment or screening affecting certain age groups, periods or cohorts. In addition, in this model we use Poisson regression in the standard exponential link function. The statistical model that is most commonly used in prediction,[13] and was expressed as follows:

$$R_{ap} = \exp(A_a + D \cdot p + P_p + C_c)$$

Where:
Rap= is the incidence rate in age group a in calendar period p;
D= is the average trend with time, denoted as the drift;
Aa= is the age component for age group a;
Pp= is the non-linear period component of period p;
Cc= is the non-linear cohort component of cohort c.

The data were pooled over the last three five-year periods, and the cutoff age group considered for analysis was the first with more than 10 cases for the combined period, as described in previous studies.[14,15]

Predictions are presented for total observed and expected deaths in each country. For global comparisons, mortality rates were calculated from the Segi world population. The recent linear trend over the last 10 years was predicted and attenuated in the drift parameter by 25% in the second and 50% in the third prediction period.[16]

Changes between the last forecast period (2030) compared to the last observed period (2017) were calculated (except for Trinidad and Tobago, which had data available until 2012, and did not make predictions because it did not complete the last study period) according to changes in risk or due to changes in demographics (population size or structure).[17] The calculation was expressed as follows:

$$\Delta tot = \Delta risk + \Delta pop = (Nfff - Noff) + (Noff - Nooo)$$

Where:
Δtot= total change; Δrisk= change in function of risk; Δpop= change in function of the population; Nooo= number of observed cases; Nfff= number of projected cases; Noff= number of expected cases when the mortality rates increase during the observed period.

Results

Figure 1 shows the average mortality rates per 100 000 in LAC from 2012 to 2017. Trinidad and Tobago (29.9), Cuba (23.1), and Venezuela (21.2) reported the highest mortality rates; while Mexico (10.0), Nicaragua (9.9), Peru (9.8), and El Salvador (6.5) had the lowest mortality rates.

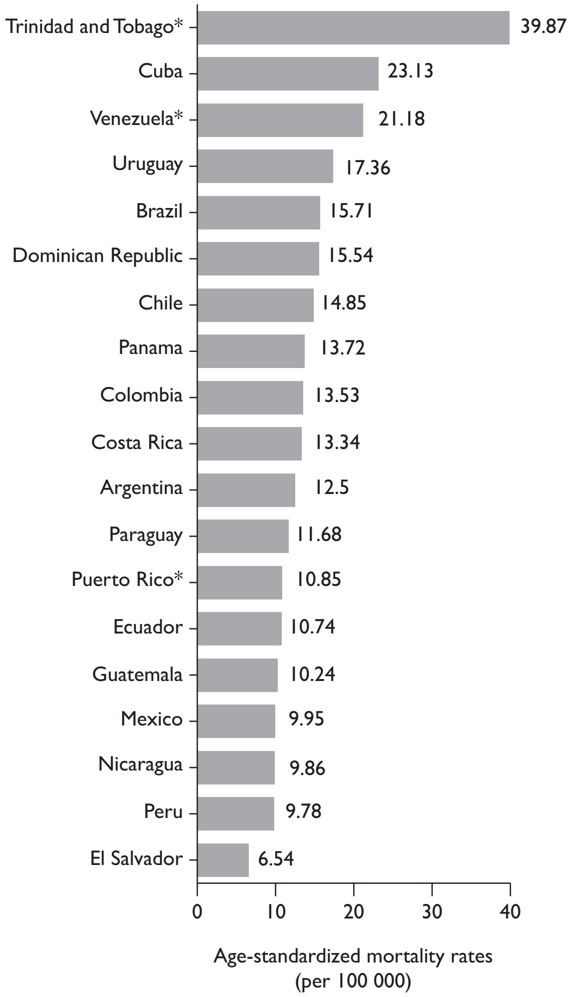
Trends for prostate cancer mortality for all ages between 1997 and 2017 are shown in table I. Ten countries reported significant decreases during the study period, the most remarkable being observed in Argentina (-1.8%), Chile (-2.1%), and El Salvador (-2.8%). In contrast, four countries showed upward trends: Brazil (1.1%), Cuba (0.7%), Guatemala (1.6%) and Venezuela (0.7%) (supplementary figure 1).[18]

Among men aged 30-59 years, the AAPC decreased in Argentina (-1.8%), Brazil (-0.6%), Colombia (-2.4%), Dominican Republic (-1.9%) Ecuador (-2.2%), and Mexico (-0.8%), but increased in Guatemala (2.8%) (table II and supplementary figure 2).[18] On the other hand, table III and (supplementary figure 2)[18] depicts the AAPC in men ≥60 years, with a decline in mortality rates in Argentina (-1.4%), Brazil (-0.5%), Costa Rica (-1.8%), El Salvador (-3.9%), Mexico (-0.5%), Panama (-1.5%), Puerto Rico (-2.6%), Trinidad and Tobago (-1.1%), and Uruguay (-0.8%), and an increase in these rates in Cuba (0.7%), Guatemala (2.4%), and Venezuela (1.3%).

Table IV shows the observed and projected ASMR for prostate cancer. According to the predictions for 2030, mortality rates in men of all ages will decrease in most LAC countries between 2017 and 2030. However, the positive change in population structure and size in all the countries resulted in an overall increase in most countries, mainly in Colombia (+99.3%), Venezuela (+83.5%), and Brazil (71.8%), while Puerto Rico (-6.1%) and Uruguay (-8.5%) had negative overall changes.

Discussion

Prostate cancer is the main malignancy among men worldwide, with geographically variable rates,[19] and a disproportionate mortality in some countries of the Caribbean (Barbados, Trinidad and Tobago, and Cuba), Africa, and Latin America.[2,3] In the present study, we found that Trinidad and Tobago, Cuba and Venezuela had the highest mortality rates in LAC, similar to previous reports.[3,20-22] Moreover, our findings reported that mortality rates decreased in most LAC countries during the 20-year study period from 1997 to 2017, while by



* Trinidad and Tobago (last year 2012), Puerto Rico (first year 1999), and Venezuela (last year 2016)

Figure 1. Average age-standardized (Segi world standard population) prostate cancer mortality rates per 100 000 in Latin America and the Caribbean from 1997 to 2017

the year 2030, the global death toll will increase mainly due to the structure and size of the population in the countries of the region.

In our study, eight countries had mortality rates higher than 13 deaths per 100 000 in the last study period (Trinidad and Tobago in 2012). In fact, in 2018, one study reported Latin America and Caribbean with a rate around 14 deaths per 100 000. Whereas the highest mortality rates (> 19.4 per 100 000) for prostate cancer were founded in countries with predominantly African descent population, including the Caribbean and Southern and Middle Africa,[3] while some European countries, such as France, Germany, Spain, and Italy, reported rates of less than 10 deaths per 100 000.[3] The LAC countries with the highest mortality rates in our study align with those previously reported by Chatenoud and colleagues,[21] and are in line with forecasts for the next decade. Indeed, the mortality rates observed in these LAC countries are expected to continue increasing at a consistent rate, with the exception of Puerto Rico, and Uruguay. However, our findings differ from those reported by Sierra and colleagues,[20] who analyzed ASMRs between 2003 and 2007. In their study, Belize, Uruguay, and Cuba were identified as having the highest ASMRs (24.1-28.9), whereas Peru, Nicaragua, and El Salvador had the lowest estimates, ranging from 6.8 to 9.7 per 100 000.[20] Some reports from countries in the region show results similar to those found in our study. For example, Brazil reported an average rate of around 15 deaths per 100 000, however, despite starting with upward trends, in the last 10 years these mortality rates began to decrease by 1% annually. Another study in Brazil[23] reported decreases in mortality in different age groups. Whereas Mexico reported around 10 deaths per 100 000; and significant decreases between 0.5 to 1% annually over the last 21 years. A similar study in men over 40 years of age reported between 2000 and 2010 a significant decrease of 0.1% annually;[24] on the contrary, another study[25] using the global burden disease database from 2000 to 2019 reported decreases in the first period (2000-2010), however, in the second period (2010-2019) there were no significant reductions.[25] It is important to mention that the differences in prostate cancer mortality rates in the region may also be due to the poor quality of data recording in some countries.[26] For example, since 2000, some developing countries such as Chile, Mexico and Cuba have reported stable death registration systems and low percentages of garbage codes, while countries such as Peru report a high prevalence of garbage codes.[27]

By 2030, our study reported increases in prostate cancer mortality for all countries in Latin America and the Caribbean, mainly due to changes in the size and structure of the population in each country. However, in our study, we also report that ten countries have significantly decreased their mortality rates in the last years, studies in other countries also report similar results.[28,29] For example, a study[28] reported that about 20 countries decreased in recent years the mortality rates for prostate cancer, mainly being developed countries and after the introduction of prostate specific antigen (PSA), while countries such as Chile and Cuba showed increasing trends, as our study shows. Another study[29] also reported declines in mortality rates in 45 out of 89 countries, mainly in European and North American countries. For this rea-

Table I

Mortality trends for prostate cancer in men of all ages in Latin America and the Caribbean, 1997-2017

Countries	*1997*	*2017*	*Trend 1 Years*	*EAPC*	*Trend 2 Years*	*EAPC*	*Trend 3 Years*	*EAPC*	*AAPC (95%CI)*
Argentina	16.52	11.89	1997-2006	-1.2*(-1.8,-0.6)	2006-2017	-2.3*(-2.7,-1.9)			-1.8*(-2.1,-1.5)
Brazil	12.54	15.37	1997-2008	2.9*(2.5,3.2)	2008-2017	-1.0*(-1.4,-0.7)			1.1*(0.9,1.3)
Chile	21.45	14.05	1997-2007	-2.6*(-3.3,-1.9)	2007-2017	-1.5*(-2.1,-1.0)			-2.1*(-2.5,-1.7)
Colombia	16.40	13.13	1997-2001	4.3 (-0.1,8.8)	2001-2017	-2.6*(-3.0,-2.2)			-1.3*(-2.1,-0.4)
Costa Rica	13.88	10.90	1997-2011	-0.3 (-1.6,0.9)	2011-2017	-4.8*(-8.5,-1.0)			-1.7*(-3.0,-0.4)
Cuba	21.18	23.53	1997-2017	0.7*(0.2,1.2)					0.7*(0.2,1.2)
Dominican Republic	15.50	14.34	1997-2017	-0.4 (-1.0,0.2)					-0.4 (-1.0,0.2)
Ecuador	10.09	10.04	1997-2010	0.8 (-0.3,2.0)	2010-2017	-2.0 (-4.8,0.9)			-0.2 (-1.3,1.0)
El Salvador	10.42	5.39	1997-2002	-2.8*(-4.0,-1.5)					-2.8*(-4.0,-1.5)
Guatemala	5.83	9.36	1997-2017	1.6*(0.6,2.6)					1.6*(0.6,2.6)
Mexico	10.71	9.50	1997-2003	1.0 (-0.3,2.2)	2003-2017	-1.2*(-1.5,-0.8)			-0.5*(-0.9,-0.1)
Nicaragua	10.34	8.24	1997-2017	-0.3(-1.2,0.5)					-0.3 (-1.2,0.5)
Panama	15.79	12.11	1997-2017	-1.5*(-2.1,-0.8)					-1.5*(-2.1,-0.8)
Paraguay	9.80	12.42	1997-2005	3.1*(0.4,5.9)	2005-2017	-0.9 (-2.3,0.5)			0.7 (-0.6,1.9)
Peru	9.80	8.76	1999-2002	-2.0 (-6.1,2.3)	2002-2008	3.6 (-0.7,8.2)	2008-2017	-3.0*(-4.7,-1.3)	-0.8 (-2.5,0.9)
Puerto Rico	15.53	9.74	1999-2017	-2.5*(-3.0,-2.0)					-2.5*(-3.0,-2.0)
Trinidad and Tobago	47.85	39.87	1997-2012	-1.0*(-2.0,-0.1)					-1.0*(-2.0,-0.1)
Uruguay	19.11	16.03	1997-2004	1.9 (-0.1,3.8)	2004-2017	-2.1*(-2.8,-1.4)			-0.7*(-1.5,0.0)
Venezuela	18.53	21.70	1997-2016	0.7*(0.4,1.0)					0.7*(0.4,1.0)

CI: confidence interval; EAPC: estimated annual percent change; AAPC: average annual percent change.
* p <0.05.

son, our study explains that mortality rates are declining not only in most countries in LAC, but that these patterns are also occurring in other regions of the world.

The decreasing rates that Puerto Rico has presented throughout the years evaluated as well as its decreasing projection for 2030 could be due to factors associated with its proximity to high resource countries such as the USA, as opposed to the rest of the LATAM countries. It has previously been reported that Hispanics living in the US are less likely than whites to be diagnosed with prostate cancer (11.1 vs. 12%, respectively) and instead have a higher frequency of cancers that are more common in Latin America.[30] The explanation for this may be the fact that in high-income countries, prostate cancer mortality rates have declined since the 1990s,[2] which would also affect related countries such as Puerto Rico as they are more likely to have access to early diagnosis strategies and better treatment.[31]

Factors contributing to the heterogeneity of our results concerning mortality in LAC countries could be related to inadequate and unequal access to diagnostic and treatment toolkits, slow updating and translation of new biomarkers and therapeutic agents to oncologic patients, political ambiguity with low investment in prostate cancer control and prevention, centralization, lack of urologists, and precarious data collection of new cases and mortality related to prostate cancer. All of these factors can affect the registration and updating of epidemiological data for developing public health policies.[32,33]

The variations in incidence and mortality rates of prostate cancer among LAC countries can be attributed to the diverse stages of nutrition and epidemiological transition within these countries. One potential explanatory factor is the increasing prevalence of obesity, which is a modifiable factor that has been on the rise in LAC populations over the last few decades[34-36] and has the potential to influence both the occurrence and survival rates of individuals diagnosed with this cancer.[37,38]

The education level of individuals may be another modifiable factor that impacts mortality by prostate can-

Table II
MORTALITY TRENDS FOR PROSTATE CANCER IN MEN FROM 30-59 YEARS OF AGE IN LATIN AMERICA AND THE CARIBBEAN, 1997-2017

Countries	*1997*	*2017*	*Trend 1 Years*	*EAPC*	*AAPC (95%CI)*
Argentina	2.70	1.94	1997-2017	-1.8*(-2.2,-1.4)	-1.8*(-2.2,-1.4)
Brazil	2.02	1.78	1997-2017	-0.6*(-0.8,-0.3)	-0.6*(-0.8,-0.3)
Chile	1.40	1.68	1997-2017	-0.3 (-1.3,0.7)	-0.3 (-1.3,0.7)
Colombia	1.75	1.41	1997-2017	-2.4*(-3.1,-1.6)	-2.4*(-3.1,-1.6)
Costa Rica	0.60	1.42	1997-2017	3.1 (-1.8,8.3)	3.1 (-1.8,8.3)
Cuba	3.24	3.09	1997-2017	0.2 (-0.9,1.4)	0.2 (-0.9,1.4)
Dominican Republic	3.65	2.99	1997-2017	-1.9*(-3.1,-0.8)	-1.9*(-3.1,-0.8)
Ecuador	1.48	1.22	1997-2017	-2.2*(-4.0,-0.4)	-2.2*(-4.0,-0.4)
El Salvador	0.63	0.75	1997-2017	-1.5 (-3.7,0.7)	-1.5 (-3.7,0.7)
Guatemala	0.45	2.15	1997-2017	2.8*(0.1,5.5)	2.8*(0.1,5.5)
Mexico	1.98	1.40	1997-2017	-0.8*(-1.3,-0.3)	-0.8*(-1.3,-0.3)
Nicaragua	0.94	0.84	1997-2017	0.1 (-2.0,2.3)	0.1 (-2.0,2.3)
Panama	3.39	0.73	1997-2017	-2.3 (-5.1,0.5)	-2.3 (-5.1,0.5)
Paraguay	1.63	2.08	1997-2017	1.0 (-1.3,3.3)	1.0 (-1.3,3.3)
Peru	1.19	0.93	1999-2017	-1.1 (-2.5,0.3)	-1.1 (-2.5,0.3)
Puerto Rico	1.49	1.77	1999-2017	-0.6(-2.8,1.6)	-0.6 (-2.8,1.6)
Trinidad and Tobago	3.78	6.49	1997-2012	1.3 (-2.2,4.8)	1.3 (-2.2,4.8)
Uruguay	2.37	1.21	1997-2017	-1.9 (-4.3,0.5)	-1.9 (-4.3,0.5)
Venezuela	2.76	3.21	1997-2016	0.3 (-0.5,1.1)	0.3 (-0.5,1.1)

CI: confidence interval; EAPC: estimated annual percent change; AAPC: average annual percent change.
* Significantly different from 0 (*p* <0.05).

cer. It has been described that men from LAC countries with a lower level of education tend to exhibit higher mortality rates associated with this disease.[39] Education may affect the perception of screening evaluations for prostate cancer and adherence to follow-up programs.[40] Furthermore, culture may also impact access to health care, and thus, lack of perception of risk and the need for early diagnosis of prostate cancer in men from LAC[41,42] reduces their odds of curative treatment.

In addition to potentially modifiable risk factors for prostate cancer, there has been a rise in studies on non-modifiable risk factors in recent years. We believe that ancestry, genetic background, and ageing populations, together with modifiable, socioeconomic, and behavioral factors, may contribute to the heterogenous ASMR of prostate cancer in men in LAC[43-45] and may also explain why men with prostate cancer in LAC are diagnosed at later stages. Despite the lack of proper registries, selected cohorts from Brazil, Mexico, and Colombia described three- to five-fold increases in the rate of men diagnosed with prostate cancer compared to males in the United States.[45-49]

Historically, it has been acknowledged that individuals of African ancestry have a higher risk of developing prostate cancer compared to those of European or Asian ethnicities.[50,51] In agreement with these findings, our study showed that the highest mortality rates were observed in individuals from certain Caribbean countries where a significant proportion of the population is of African ethnicity.[22] However, LAC populations present complex genomic admixtures, which complicate the assessment of the impact of ethnicity on the incidence and mortality of prostate cancer.[22,52-54]

One potential approach to address this complexity is the incorporation of polygenic risk scores alongside conventional predictive and prognostic biomarkers such as age and prostate-specific antigen levels.[51-54] However, before their clinical use and interpretation in populations different from those included in the original studies (predominantly Caucasians), it is crucial to calibrate polygenic risk scores.[55,56] This is particularly important because the majority (over 90%) of cancer genomics databases are derived from individuals of European

Table III
MORTALITY TRENDS FOR PROSTATE CANCER IN MEN ≥ 60 YEARS OF AGE IN LATIN AMERICA AND THE CARIBBEAN, 1997-2017

Countries	*1997*	*2017*	*Trend 1 Years*	*EAPC*	*Trend 2 Years*	*EAPC*	*Trend 3 Years*	*EAPC*	*AAPC (95% CI)*
Argentina	132.63	102.52	1997-2017	-1.4*(-1.7,-1.0)					-1.4*(-1.7,-1.0)
Brazil	134.18	117.53	1997-2017	-0.5*(-1.0,0)					-0.5*(-1.0,0)
Chile	142.79	130.89	1997-2004	0.8 (-0.5,2.2)	2004-2017	-1.1*(-1.6,-0.6)			-0.4 (-1.0,0.1)
Colombia	119.59	105.55	1997-2001	4.2*(0.0,8.5)	2001-2017	-1.7*(-2.2,-1.2)			-0.6 (-1.4,0.3)
Costa Rica	128.84	87.29	1997-2017	-1.8*(-2.6,-1.0)					-1.8*(-2.6,-1.0)
Cuba	182.70	204.69	1997-2017	0.7*(0.2,1.2)					0.7*(0.2,1.2)
Dominican Republic	129.73	120.91	1997-2013	-0.3 (-1.0,0.3)					-0.3 (-1.0,0.3)
Ecuador	87.18	87.66	1997-2017	0.1 (-0.5,0.7)					0.1 (-0.5,0.7)
El Salvador	92.45	46.75	1997-2002	-11.4*(-20.1,-1.8)	2002-2017	-1.2(-2.9,0.5)			-3.9*(-6.4,-1.3)
Guatemala	51.27	78.66	1997-1999	18.8 (-2.0,44.2)	1999-2007	3.6*(0.9,6.3)	2007-2017	-1.4 (-2.9,0.1)	2.4*(0.3,4.6)
Mexico	93.76	83.91	1997-2003	1.1 (-0.2,2.3)	2003-2017	-1.2*(-1.5,-0.8)			-0.5*(-0.9,-0.1)
Nicaragua	91.15	72.37	1997-2017	-0.4(-1.2,0.5)					-0.4 (-1.2,0.5)
Panama	133.43	107.02	1997-2017	-1.5*(-2.1,-0.8)					-1.5*(-2.1,-0.8)
Paraguay	84.25	106.44	1997-2005	3.1*(0.3,5.9)	2005-2017	-1.0 (-2.4,0.5)			0.6 (-0.6,1.9)
Peru	85.57	76.76	1999-2012	0.8 (-0.1,1.7)	2012-2017	-4.8*(-9.3,-0.1)			-0.6 (-1.9,0.7)
Puerto Rico	136.70	83.22	1999-2017	-2.6*(-3.1,-2.1)					-2.6*(-3.1,-2.1)
Trinidad and Tobago	423.69	342.97	1997-2012	-1.1*(-2.1,-0.1)					-1.1*(-2.1,-0.1)
Uruguay	166.61	142.13	1997-2004	1.9*(0.2,3.6)	2004-2017	-2.1*(-2.7,-1.4)			-0.8*(-1.4,0)
Venezuela	162.89	217.28	1997-2016	1.3*(1.1,1.6)					1.3*(1.1,1.6)

CI: confidence interval; EAPC: estimated annual percent change; AAPC: average annual percent change.
* Significantly different from 0 (p <0.05).

descent,[56] thereby introducing potential biases in tumor information available in The Cancer Genome Atlas. This limitation may hinder the discovery of novel biomarkers specific to populations and impede the translation of genomic technologies into clinical practice.[44]

Furthermore, the identification of specific high-risk groups in terms of incidence and mortality can be facilitated through genomic services, allowing for adequate follow-up of individuals carrying germline pathogenic variants (e.g., *BRCA1/2*, *TP53*, *HOXB13*). This approach not only optimizes health care system investments but may also potentially reduce mortality rates in LAC nations. However, it is essential to invest further efforts in these countries to develop sustainable genomic examinations, establish appropriate clinical genetic programs, and provide genetic counseling.[57,58]

Limitations

The present study has certain limitations. We could include only eighteen LAC countries in this study because databases from other countries were not available (for instance, Bolivia, Honduras and Haiti). In addition, three included nations had incomplete data regarding to study period (Puerto Rico, Trinidad and Tobago, and Venezuela). We did not have access to any additional demographic, clinical, or staging information other than age from males who died from prostate cancer. On the other hand, the strength of this study is that it provides an update of death figures in LAC and projections up to 2030, which may be used to further health policies. The implementation of official prostate cancer screening programs and effective treatments with access to care are crucial to guarantee quality life in LAC population,

Table IV

Number of prostate cancer deaths, age-standardized mortality rates, and percentage change in cases due to population growth and risk among Latin American and the Caribbean males, 2017 and predicted 2030

Country	*Male population (annual million)*		*Number of deaths*		*Age-standarized mortality rate*		*Total change (%)*	*Change due to population (%)*	*Change due to risk (%)*
	2017	*2030*	*2017*	*2030*	*2017*	*2030*			
Argentina	21.2	24	3 802	4 025	11.89	9.9	7.1	34.5	-27.4
Brazil	102	109.6	14 480	24 982	15.37	12.1	71.8	102.3	-30.5
Chile	8.9	9.6	2 097	3 132	14.05	12.74	49.4	78.1	-28.8
Colombia	23.7	26.2	2 888	5 743	13.13	10.87	99.3	130.5	-31.2
Costa Rica	2.4	2.7	388	587	10.90	9.5	50.1	98.6	-48.4
Cuba	5.7	5.5	2 954	4 087	23.53	22.24	38.4	42.6	-4.2
Dominican Republic	5.4	5.9	722	1 271	14.34	14.31	66.5	81.9	-15.4
Ecuador	8.1	9.9	931	1 175	10.04	7.5	30.9	80.6	-49.7
El Salvador	2.9	3.2	177	233	5.39	4.87	16.6	55.4	-38.8
Guatemala	8	10.5	588	956	9.36	10.09	65.3	67.1	-1.8
Mexico	63.2	68.9	6 307	9 852	9.50	9.9	56.4	60.3	-3.9
Nicaragua	3	3.6	217	334	8.24	9.07	52.9	59.5	-6.6
Panama	1.9	2.5	333	419	12.11	9.33	31.8	81.9	-50.2
Paraguay	3.3	4	355	488	12.42	9.67	41.8	68.9	-27.1
Peru	15.7	18	1 498	2 162	8.76	6.81	47.6	103	-55.4
Puerto Rico	1.6	1.4	472	453	9.74	7.92	-6.1	28.7	-34.8
Uruguay	1.6	1.7	546	506	16.03	12.11	-8.5	26.3	-34.8
Venezuela	15.2	16.6	2 874	4 930	21.70	23.2	83.5	90.6	-7.1

especially in the countries with the highest mortality rates for this disease.[33] A previous study showed that healthcare policies can affect significantly the prostate cancer burden in the region.[59]

Conclusions

Overall, we found downward trends in mortality by prostate cancer among men of all ages in most of the LAC countries. Of note, however, was the significant upward trend in mortality in Guatemala, and Venezuela. Mortality is projected to increase in most LAC up to 2030 due to changes in population structure and size. It is suggested that the impact of specific public health interventions for the reduction of prostate cancer mortality in the countries of the region could be investigated.

Declaration of conflict of interests. The authors declare that they have no conflict of interests.

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