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Trends in cancer incidence in the Republic of Mauritius, 1991–2015

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ABSTRACT

Introduction: Mauritius, a small state, is among the few African countries where cancer registration is population based and nationwide. We reported trends in cancer incidence for twenty five years as well as the mortality to incidence ratio (MIR) as main quality indicator of the Mauritius National Cancer Registry (MNCR).

Materials and methods: We calculated age standardised incidence rates (ASRs) of cancers by sex and by 5 year age group for five successive year periods from 1991 to 2015. The average annual percentage change (AAPC) were determined by sex and cancer sites. MIRs were compared for the period 2001–2004 and 2012–2015.

Results: In males, the most common cancer sites (in terms of ASRs per 100,000) were those of the colon-rectum (17.0), prostate (16.5), trachea-bronchus-lung (13.0), stomach (8.4) and lip-oral cavity-pharynx (7.7). The AAPC were +3.9%, +4.2%, +0.5%, -0.1% and -1.3% respectively. In females, the most frequent sites were breast (53.7), colon-rectum (13.2), cervix uteri (11.2), corpus uteri (7.7) and ovary (5.7). The AAPC were +3.4%, +4.4%, -2%, +5.2% and -0.1% respectively. The most significant decrease in MIRs among males were liver (1.9 to 1.0), stomach (1.3 to 0.8) and lung (1.7 to 1.2) cancers while among females, they were pancreas (3.4 to 1.3), liver (1.8 to 1.2) and stomach (1.5 to 0.8) cancers.

Conclusion: The most common cancers were those associated with 'westernisation' of lifestyle. Our figures contrast with other Sub-Saharan Africa countries where infection related cancers are most predominant. The MNCR has also improved its data quality over time.

1. Introduction

Small states (with a population of less than 1.5 million) which make up 40% of the world's countries face a unique set of healthcare challenges. Yet there remains a dearth of literature relating to their cancer control challenges and solutions [1,2]. This lack of qualitative information on cancer registration is more obvious in regions with low or medium Human Development Index, most notably in sub-Saharan Africa and South Asia [3].

The Republic of Mauritius is unique as a small country state. It is among the few sub-Saharan African countries where cancer registration is population based and nationwide basis. The estimated resident population as at 31 December 2015 was 1,220,530 according to the last Health Statistics Report of the Ministry of Health and Quality of Life of Mauritius [4]. Life expectancy was 71 years for men and 77.8 years for women in 2015. In the same year, the Gross Domestic Product per capita was recorded at 9469.90 US dollars by the World Bank, which is equivalent to 78 percent of the world's average GDP [5].

Mauritius as an upper middle income country, has, in terms of cancer care facilities, one radiotherapy department and a centralised pathology service. Chemotherapy is currently available in the five main regional hospitals over the island. Medical imaging facilities such as

Abbreviations: AAPC, average annual percentage change; AFCRN, African Cancer Registry Network; ASCO, American Society of Clinical Oncology; ASR, age standardised incidence rate; DCI, Death Certificate Initiated; DCO, Death Certificate Only; HIV, Human Immunodeficiency Viruses; IACR, International Agency for Cancer Registry; ICD-10, International Statistical Classification of Diseases and Related Health Problems 10th version; MIR, mortality to incidence ratio; MNCR, Mauritius National Cancer Registry; NCD, non communicable diseases; WHO, World Health Organization

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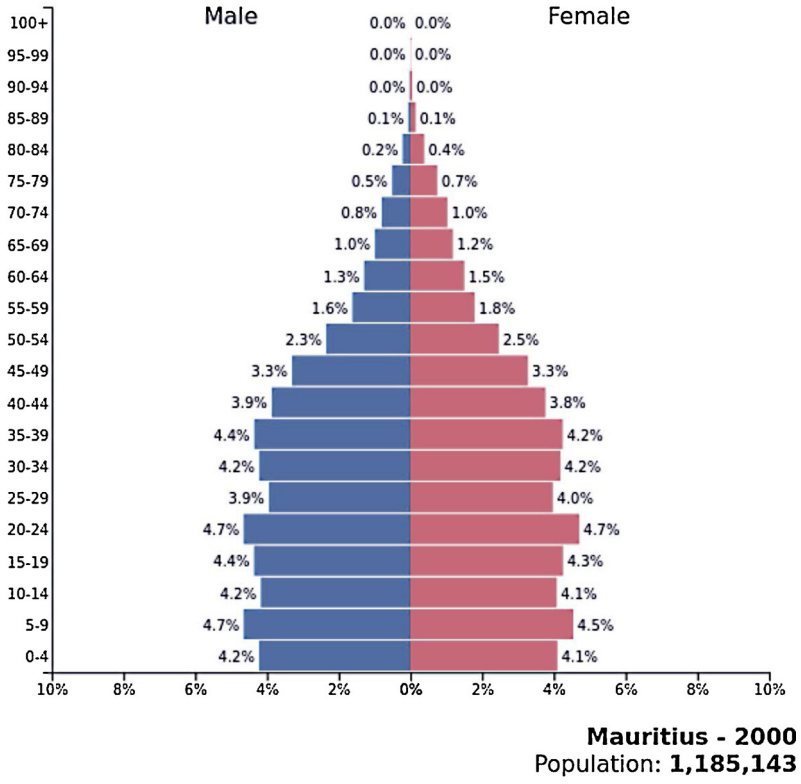

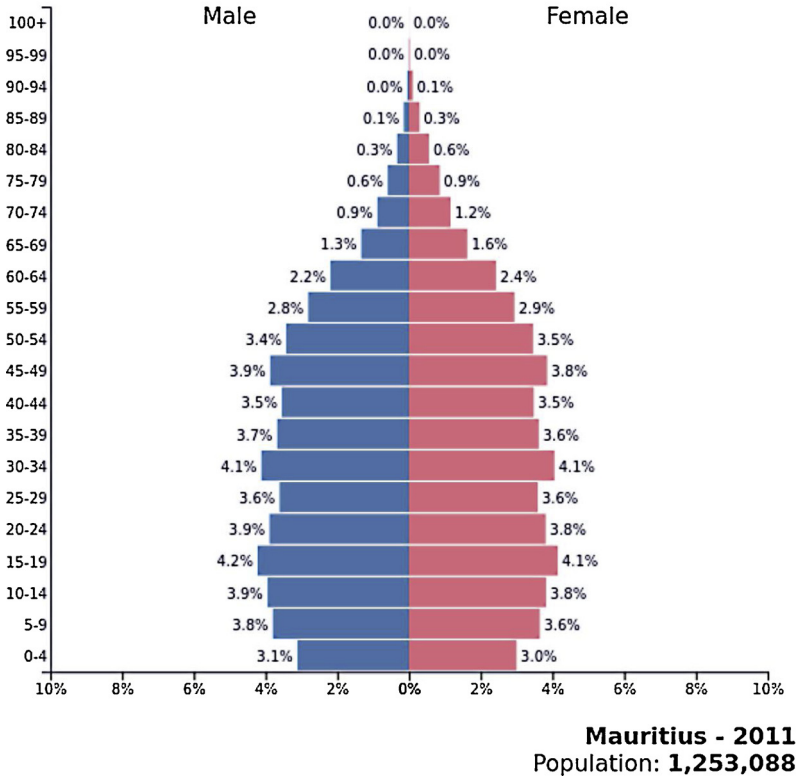

Fig. 1. Population of Mauritius by gender by gender and age groups in the censuses of 2000 and 2011.

Computed Tomography Scans, Magnetic Resonance Imaging, ultrasonography and mammography are available in both public and private health centres. There were 20.2 doctors per 10,000 inhabitants in 2015 [4]. Routine cancer screening programmes for any sites have not yet been introduced in the country.

The Mauritius National Cancer Registry (MNCR) was established in 1989 with French cooperation and subsequently with World Health Organization (WHO) assistance. Nearly thirty years later, the registry

has achieved the following: it obtained affiliation to the International Association of Cancer Registries (IACR) in 1997 and became a member of the African Cancer Registry Network (AFCRN) in 2013. The registry hosted the 33rd annual meeting of IARC in 2011 as well as the Multidisciplinary Cancer Management Course organised by the American Society of Clinical Oncology (ASCO) in 2016 at Balaclava. The MNCR has also participated in various international studies [6–8], publications [9–11] and to the first National Cancer Action Plan 2010–2014 [12].

With a swift economic transition from a monocrop based economy to a flourished diversified economy, fifty years after its independence, the lifestyle of the population has changed significantly to become more sedentary with a resulting increase in non-communicable diseases. Therefore, we expect to find an increase in cancer incidence over time. In this study, we reported the changes in cancer patterns over a twenty five year period, from 1991 to 2015 in the Republic of Mauritius using data from the MNCR. We also showed the evolution of the quality of the MNCR though different indicators.

2. Materials and methods

2.1. Setting

The study was performed at the MNCR, based at Victoria Hospital, one of the five regional hospitals of the country. The Registry covers the entire multi-racial population of the Republic of Mauritius including mainly the islands of Mauritius and Rodrigues. The sources of information are multiple and include; a unique radiotherapy unit patient register, regional health hospital records, pathology laboratory archives, the overseas treatment unit of the Ministry of Health and Quality of Life, private laboratories and clinics.

Data are collected on an annual basis retrospectively and semi-actively. For each cancer patient, the following variables are recorded accurately and consistently: surname, name, registration number, hospital, town and district of residence, age, sex, community, primary site of cancer, morphology, histological grading and basis of diagnosis.

2.2. Study design

Ethical clearance for a doctoral project on the topic "*Improving cancer surveillance for better cancer control in the Republic of Mauritius*" was granted from the National Ethics Committee of the Ministry of Health and Quality of Life, October 2, 2015.

Our analysis included all cancer patients registered in the Republic of Mauritius from January 1, 1991 to December 31, 2015. We converted data which were in different formats (*EpiInfo and CANREG4*) and merged them to a Microsoft Excel database. Patients living outside of the Republic of Mauritius were excluded. Cases were not included if there were recurrences or metastases from a cancer already registered in order to avoid duplication. Neither uncertain nor benign tumours were included in the registry, except for brain and the central nervous system.

We attributed a serial number unique to each case in the entire database. For each case, the variables: sex, age, community, topography, morphology and year of diagnosis were recorded. Topographical codes for cancer sites and morphological codes describing the characteristics of the tumour were updated using CanReg4 and ICD-10 coding [13]. Validity of data processed was checked at the time of computer data entry, using IARC check programs [14].

Ad hoc mistakes were corrected during subsequent checks. Patient records were anonymised and de-identified prior to analysis. Multiple primaries were sought and coded using IARC rules and regulations [15].

2.3. Population

Censuses were carried out in 2000 and 2011, providing demographic information of the Republic of Mauritius, by sex and age groups for these years (Fig. 1). Inter census estimates were provided by the Health Statistics Unit of Mauritius, including the years 2012–2015. The population of the Republic of Mauritius was 1,233,000 in the last population census carried out in 2011, among which, 21% were less than 15 years while 8% were aged above 64. The last census that described the different communities that constituted the Mauritian society in 1972 mentioned that 51.8% were Hindus, 28.7% General population (mostly African descent, European descent or not categorised in the other three communities), 16.6% Muslim and 2.9% Sino-Mauritians. Data concerning the community group of each individual was determined according to their surnames in the MNCR.

2.4. Statistical methods

The rates of incidence of cancer were calculated by sex and by 5 year age group for five year periods: 1991–1995, 1996–2000, 2001–2005, 2006–2010 and 2011-2015. Age standardised incidence rates (ASRs) were thus determined using the world standard population [16]. The average annual percentage change (AAPC) and 95% confidence interval (95% CI) over the 25 year period were calculated for each sex and cancer sites using *Joinpoint Regression Programme, Version 4.5.0.1*. The AAPC was estimated on fitting a heteroscedasticity regression model to the natural logarithm of the counts offset for the logarithm of the person years, including the calendar period as a continuous variable to estimate the slope. *RStudio Version 1.0.136* was used for data analysis.

Indicators to assess the quality of the data from the MNCR were: age unknown, primary sites unknown, percentage of cases with a morphologically verified diagnosis and the mortality to incidence ratio (MIR). These indicators were compared between the periods 2001–2004 and 2012–2015.

3. Results

During the 25 years of cancer registration, 36 901 observations (21 224 females and 15 677 males) were recorded, after removal of 132 duplications. The overall male to female ratio over the study was 0.74.

The burden of cancer incidence for each community for the 25 year period among males was; Hindu 41.5%, (SD 3.4%), General population 40%, (SD 3.4%), Muslim 15%, (SD 1.8%) and Sino-Mauritian 3.5%, (SD 0.9%). Among females, the distribution of cancer incidence for each community over the study period was; Hindu 46.4%, (SD 2.3%), General Population 35.2%, (SD 2.1), Muslim 16.0%, (SD 1.3) and Sino-Mauritian 2.4%, (SD 0.7).

ASRs have increased for both sexes over the five year periods with an AAPC of +1.4% (95% CI: 0.8–2.0) among males and +1.4% (95% CI: -0.6 to 2.2) among females for the period 1991-2015. The ASRs for the 1991–1995 period which were 95.4 per 10^5 among males and 116.4 per 10^5 among females, increased to 132.8 per 10^5 among males and 151.2 per 10^5 among females 20 years later (2011–2015 period). Fig. 2A and B illustrate the trends in age incidence rate by gender and Fig. 2C and D, the trends among the five most common tumours in males and females.

In males, the most frequent cancers occurring in the last five years (in terms of ASRs per 100,000) were those of the colon-rectum (17.0), prostate (16.5), trachea-bronchus-lung (13.0), stomach (8.4) and lips, oral cavity, pharynx cancer (7.7) as described in Table 1. Thyroid cancer showed the most significant increase over the whole study with an AAPC of 8.6%; 95% CI: 1.4–16.3, followed by pancreas cancer (AAPC of 5.2%; 95% CI: 2.4–8.1), kidney cancer (AAPC of 4.9%; 95% CI: 2.2–7.8), prostate (AAPC of 4.2%; 95% CI:3.2–5.3), colon-rectum cancer (AAPC of 3.9%; 95% CI: 3.0–4.8) and Non-Hodgkin lymphoma

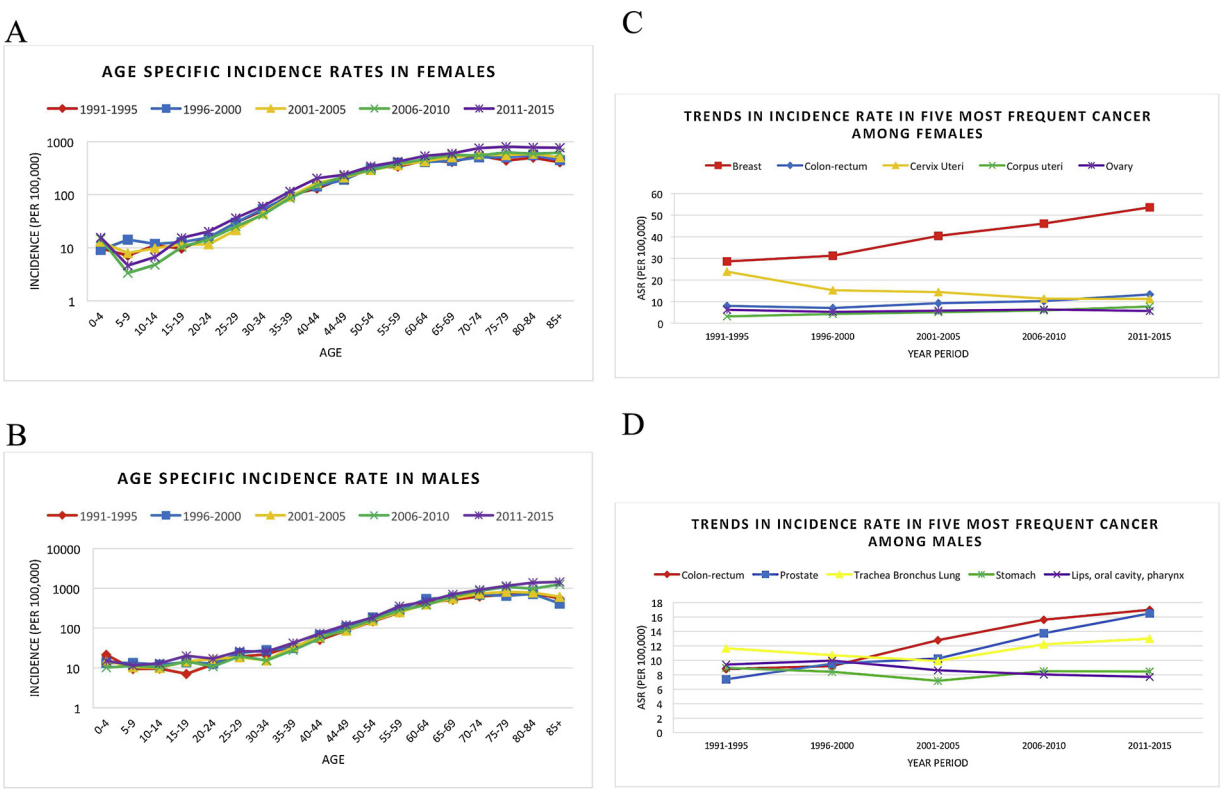

Fig. 2. A. - Age specific incidence rates in males. B. - Age specific incidence rates in females. C. - Trends in age standardised incidence rate in five most frequent cancer among males. D. - Trends in age standardised incidence rate in five most frequent cancer among females.

(AAPC of 2.8% %; 95% CI:0.5–5.1). Cancer of the lips-oral cavity-pharynx was the only site which has significantly decreased over the study period (AAPC of −1.3%; 95% CI: -2.4 to -0.3). Fig. 3A to 3E represent the distribution of incidence rates per age group for the five main cancer sites among males.

In females, the most frequent cancers for the last five years (in terms of ASRs per 100,000) were those of the breast (53.7), colon-rectum (13.2), cervix uteri (11.2), corpus uteri (7.7) and ovary (5.7) as described in Table 1. Kidney cancer showed the most significant increase over the whole study with an AAPC of 9.4%; CI: 0.7–18.8, followed by corpus uteri cancer (AAPC of 5.2%; 95% CI: 3.6–6.9), trachea-bronchus-lung cancer (AAPC of 4.7%; 95% CI: 2.6–6.9), colon-rectum cancer (AAPC of 4.4%; 95% CI: 0.4–8.4), pancreas cancer (AAPC of 4.1%; 95% CI: 0.8–7.5) and breast cancer (AAPC of 3.4%; 95% CI: 2.9–3.9). The sites which have shown a significant decrease over the study period were those of the cervix uteri (AAPC of -3.6%; 95% CI: −5.3 to −2.0) and bladder (AAPC of −2.0; 95% CI: −3.5 to −0.4). Fig. 4A to 4E represent the distribution of incidence rates per age group for the five main cancer sites among females.

Among children (0–14 years), 803 cases were registered during the 25 year period. Of the 803 paediatric tumours, 462 (57.5%) occurred in males and 341 (42.5%) in females. In the last fifteen years, the most common tumours were leukaemia (34%) and tumours of the brain-nervous system (11.4%). Among those suffering from leukaemia, 40.2% were acute myeloid leukaemia and 17.4% were lymphoid leukaemia. From 2001–2015, the AAPC for childhood leukaemia showed a non-significant increase of 5.2%; 95% CI: −12.6 to 26.5. The mean age of the children suffering from leukaemia was 6 years and those from brain-nervous system was 6.9 years.

Concerning the quality indicators of the cancer registry, for the period 2001–2004, the age unknown, primary sites unknown, percentage of cases with a morphologically verified diagnosis were 0.6%, 2.9% and 95.5% respectively, compared to 2.4%, 7.3% and 89.6% in the period 2012–2015. The Mortality to Incidence Ratios (MIRs) for the most common sites by gender are shown in Table 2. MIRs that significant decreased from periods 2001–2004 to 2012–2015 among males were liver (1.9 to 1.0), stomach (1.3 to 0.8) and lung (1.7 to 1.2) cancers while among females, they were pancreas (3.4 to 1.3), liver (1.8 to 1.2) and stomach (1.5 to 0.8) cancers. Lowest MIRs among males for the period 2012–2015 were seen for colon-rectum (0.5) and bladder (0.5) cancers while corpus uterus (0.2) and breast (0.3) cancers showed the lowest MIRs among females.

4. Discussion

This study is the first report on cancer incidence in a small African state. Moreover, the MNCR is among the few cancer registries in Sub Saharan African countries providing accurate and complete data on a national basis over a 25 year period. During this period, there has been a significant change in the socio economic status of the country as well as a change in the lifestyle of the population [17]. According to the Non Communicable Disease (NCD) Survey in 2015 [18], the prevalence of type 2 diabetes was 20.5% while that of overweight or obesity was 68.6%. Moreover, Mauritius is also facing a demographic transition with an increasingly ageing population and a low birth rate [4].

Breast cancer was the most common cancer among females during the whole study period with an increasing AAPC of 3.4% and an ASR of 53.7 per 10^5 from 2011 to 2015. Most cases occurred in post-menopausal women (Fig. 4A). Part of this increase might be related to the adoption of western habits, leading to a decline in fertility rates, reduced parity, late age at first childbirth, increase in alcohol consumption, obesity and type 2 diabetes. Moreover, women with breast cancer and diabetes face worse outcomes than those with breast cancer without diabetes [19]. Another cause that could explain this increasing rate is the use of hormonal pills for birth control [20,21], which is the preferred mode of contraception among Mauritian women [22].

Cancer of large bowel was the most common cancer among males, with a significant AAPC of 3.9% and an ASR of 17.0 per 10^5 from 2011

Table 1
ASR by period of five years over twenty five years and Average Annual Percentage Change (AAPC).

		MALE						FEMALE					
		Age standardised rate per 100,000					Annual percentage change (95% C)	Age standardised rate per 100,000					Annual percentage change (95% confidence interval)
Site	ICD10	1991-1995	1996-2000	2001-2005	2006-2010	2011-2015		1991-1995	1996-2000	2001-2005	2006-2010	2011-2015	
Lips, oral cavity, pharynx	C00-14	9.4	9.9	8.6	8.0	7.7	−1.3% (-2.4 to -0.3)*	3.3	3.5	3.3	2.7	3.4	−0.4% (-1.8 to 1)
Oesophagus	C15	3.7	4.2	2.8	2.8	3.8	4% (-1.8 to 10.1)	2.0	2.2	1.4	1.9	1.5	−0.1% (-9.5 to 10.2)
Stomach	C16	9.0	8.4	7.1	8.5	8.4	−0.1% (-1.3 to 1.2)	3.9	3.5	3.4	3.5	4.4	0.7% (-1 to 2.5)
Colon-rectum	C18-21	8.8	9.2	12.8	15.6	17.0	3.9% (3 to 4.8)*	8.0	7.0	9.3	10.3	13.2	4.4% (0.4 to 8.4)*
Liver	C22	2.7	3.4	2.1	2.3	3.4	0.1% (-1.9 to 2.2)	2.3	1.9	1.8	1.6	1.9	−0.7% (-2.8 to 1.6)
Pancreas	C25	1.2	1.3	1.7	2.9	3.2	5.2% (2.4 to 8.1)*	1.1	1.0	0.8	1.6	2.1	4.1 (0.8 to 7.5)*
Trachea Bronchus Lung	C33-34	11.6	10.7	9.9	12.2	13.0	0.5% (-0.8 to 1.9)	1.9	2.1	3.1	3.8	4.3	4.7% (2.6 to 6.9)*
Melanoma	C43	0.0**	0.0	0.4	0.3	0.3	−1.8% (-9.6 to 6.6)	0.0**	0.0	0.3	0.2	0.3	11% (-1.6 to 25.3)
Kaposi sarcoma	C46	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	
Other connective and soft tissue	C49	1.2	1.8	2.3	1.7	2.1	2.5 %(-0.2 to 5.3)	1.0	1.2	1.2	1.3	1.7	5.6% (-0.2 to 11.7)
Breast	C50	0.6	0.8	0.7	0.5	1.1	4.8 %(-0.7 to 10.6)	28.5	31.2	40.4	46.1	53.7	3.4% (2.9 to 3.9)*
Cervix Uteri	C53							23.8	15.2	14.4	11.3	11.2	−3.6% (-5.3 to -2)*
Corpus uteri	C54							3.1	4.3	5.1	6.0	7.7	5.2% (3.6 to 6.9)*
Ovary	C56							6.2	5.2	5.8	6.4	5.7	−0.1% (-1.4 to 1.1)
Penis	C60	0.9	0.8	0.6	0.7	0.4	−2.7% (-6.5 to 1.2)						
Prostate	C61	7.4	9.5	10.2	13.8	16.5	4.2% (3.2 to 5.3)*						
Kidney	C64	1.2	1.9	2.6	2.6	2.5	4.9% (2.2 to 7.8)*	0.7	1.5	0.9	1.5	1.4	9.4% (0.7 to 18.8)*
Bladder	C67	5.3	6.2	5.6	5.7	5.1	−0.2% (-1.7 to 1.3)	2.0	1.7	1.5	1.2	1.3	−2% (-3.5 to -0.4)*
Eye	C69	0.6	0.2	0.2	0.0	0.2	−8.6% (-17.6 to 1.4)	0.0	0.2	0.3	0.2	0.3	9.9% (-0.1 to 20.8)
Brain, nervous system	C70-72	0.0**	0.0**	2.4	2.5	3.1	3.5% (-0.8 to 8.1)	0.0**	0.0**	2.5	1.5	2.7	−3.6% (-15.2 to 9.6)
Thyroid	C73	0.2	0.5	0.8	0.4	1.1	8.6% (1.4 to 16.3)*	1.2	1.9	2.1	1.5	2.0	2.2% (-0.4 to 4.9)
Hodgkin's disease	C81	1.0	1.2	1.0	0.7	1.0	−0.4% (-2.9 to 2.2)	0.5	1.1	0.9	0.1	0.9	7.8% (-11 to 30.7)
Non-Hodgkin lymphoma	C82-85	2.1	3.5	3.3	3.1	3.6	2.8% (0.5 to 5.1)*	1.9	1.8	2.1	1.6	1.9	0% (-1.9 to 2)
Multiple Myeloma	C90	0.0**	0.0**	1.4	0.8	2.0	2.8% (-7.3 to 14)	0.0**	0.0**	1.0	0.9	1.3	4.7% (-1.6 to 11.5)
Leukemia	C91-95	0.0**	0.0**	3.9	4.2	4.6	2.6% (-0.3 to 5.6)	0.0**	0.0**	3.5	3.0	3.5	0.6% (-3.5 to 4.8)
Other	CX	28.7	35.0	19.2	22.1	32.8	1.2% (-4 to 6.6)	25.0	32.8	16.7	17.4	24.4	0.6% (–5.7to 7.4)

* Statistically significant at 95%.
** No observation for the time period.

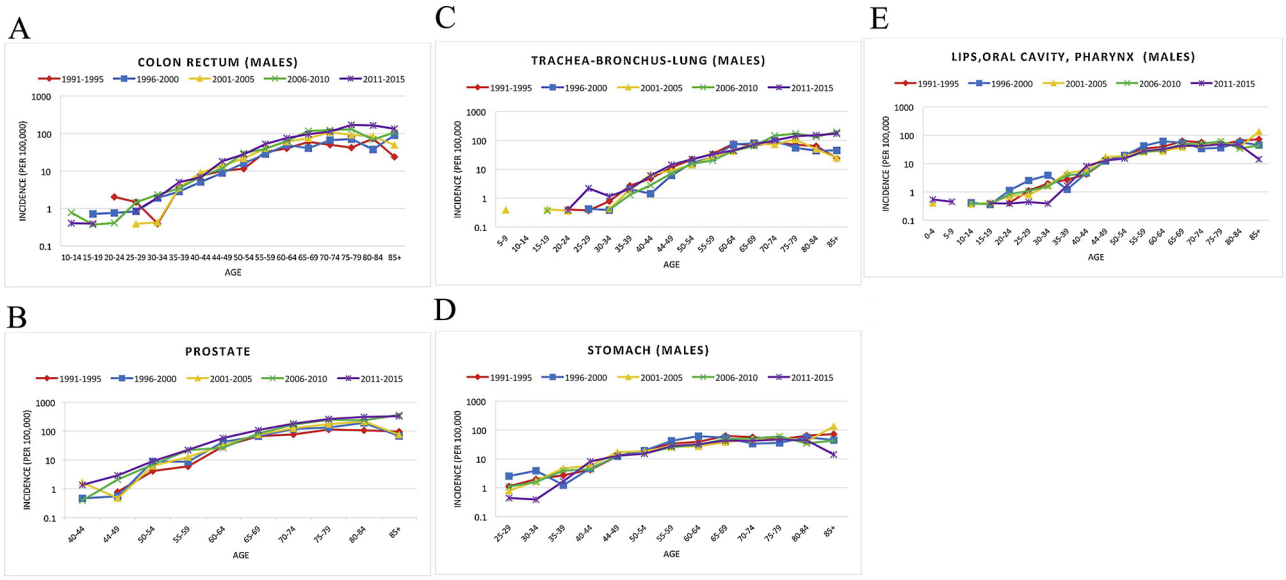

Fig. 3. A. - Age specific incidence rates for colon rectum cancer among males. B. - Age specific incidence rates for prostate cancer. C. - Age specific incidence rates for trachea, bronchus and lung cancer among males. D. - Age specific incidence rates stomach cancer among males. E. - Age specific incidence rates lips, oral cavity and pharynx cancer among males.

to 2015. Among females, it was the second most common cancer with an AAPC of 4.4% and an ASR of 13.2 per 10^5 from 2011 to 2015. Colorectal cancer is known to be highest in the Afro-American community in both males and females [23]. However, cancer of large bowel is not among the most common cancer sites in Africa [24]. This suggests the strong association of lifestyle and cancer of large bowel in the Mauritian context.

Prostate cancer was the second most common cancer site among males with an AAPC of 4.2% and an ASR of 16.5 per 10^5 from 2011 to 2015. Most of the increase occurred in the elderly men aged 70 and above. This increase might be due to age, obesity [25], increasing awareness, availability of PSA testing in most laboratories, a greater readiness to perform prostatectomy for urinary symptoms in elderly men and histological examination of operative biopsies. However, type 2 diabetes was also found to be significantly inversely associated with risk of developing prostate cancer [26].

Cancer of the corpus uteri showed a significant increase in incidence rate of 5.2% and an ASR of 7.7 per 10^5 from 2011 to 2015. Most cases occurred in post-menopausal women with a mean age of 60 years. Obese and overweight women are two to four times more likely to develop corpus uteri cancer while extremely obese women are about seven times more likely to develop this same cancer compared to normal-weight women [27]. The risk of endometrial cancer increases with increasing weight gain in adulthood, particularly among women who have never used hormone replacement therapy [28].

Other obesity associated cancers with high standardised incidence rates were ovary and stomach. Thyroid, kidney and pancreas cancers had the most significant AAPC. The ASR of ovarian cancer was 5.7 per 10^5 from 2011 to 2015 and the mean age was 53 years. Stomach cancer among males was the fourth most common cancer site with an ASR of 8.4 per 10^5 from 2011 to 2015. The mean age was 65 years. Thyroid cancer among males had one of the highest AAPC (8.6%) in the study

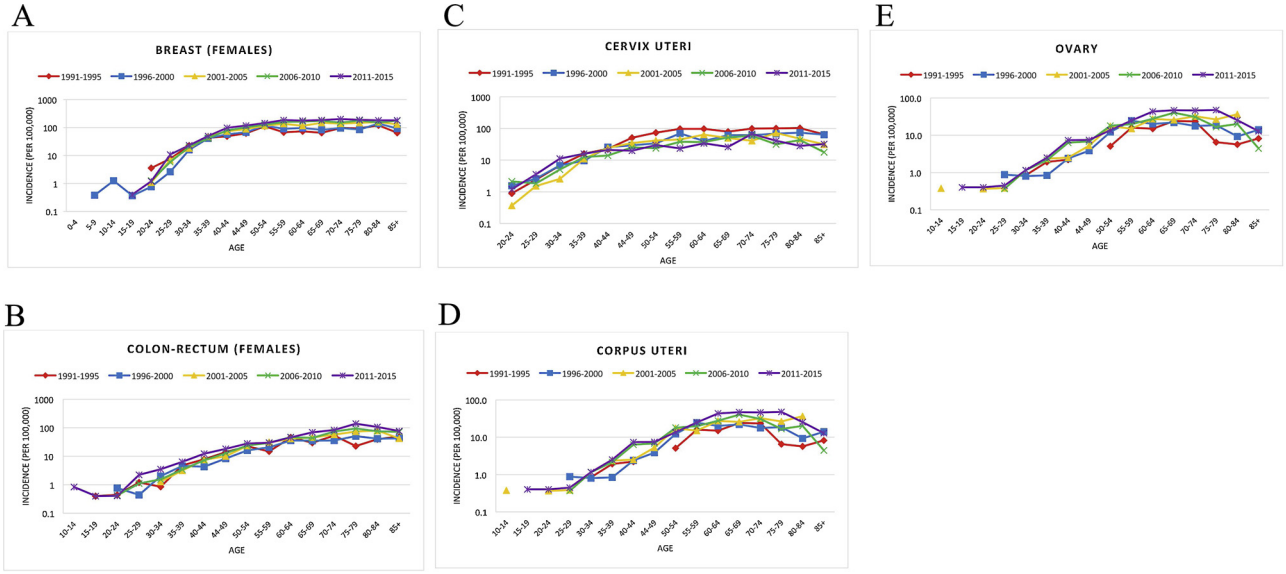

Fig. 4. A. - Age specific incidence rates in females for breast cancer. B. - Age specific incidence rates in females for colon rectum cancer. C. - Age specific incidence rates for cervix uteri cancer. D. - Age specific incidence rates for corpus uteri cancer. E. - Age specific incidence rates for ovary cancer.

Table 2
Mortality to Incidence ratio by gender in the most common sites.

Site	ICD10	Male		Female	
		2001–2004	2012–2015	2001–2004	2012–2015
Lips, oral cavity, pharynx	C00-14	0.6	0.8	0.5	0.5
Oesophagus	C15	0.8	0.8	1.1	0.6
Stomach	C16	1.3	0.8	1.5	0.8
Colon-rectum	C18-21	0.5	0.5	0.5	0.5
Liver	C22	1.9	1.0	1.8	1.2
Pancreas	C25	1.9	1.6	3.4	1.3
Trachea Bronchus Lung	C33-34	1.7	1.2	1.7	1.1
Breast	C50			0.3	0.3
Cervix Uteri	C53			0.5	0.5
Corpus uteri	C54			0.3	0.2
Ovary	C56			0.6	0.9
Prostate	C61	0.8	0.6		
Bladder	C67	0.4	0.5	0.5	0.6
Leukemia	C91-95	0.9	0.7	0.7	0.7
Other	CX	0.8	0.3	1.3	0.3

although the ASR was relatively low (1.1 per 10^5 from 2011 to 2015). The mean age of diagnosis of thyroid cancer was 47 years. In kidney cancer, the increase in AAPC was significant among both males (4.9%) and females (9.4%). The ASR was 2.5 per 10^5 in males and 2.4 per 10^5 in females from 2011 to 2015. The AAPC of pancreas cancer among males was 5.2% and 4.1% among females. The mean age in males was 63 years old and 59 years among females.

Lips-oral cavity-pharynx and trachea-bronchus and lung were among the most common cancer sites among men. There was a significant annual decrease of 1.3% in the incidence of lip, oral cavity and pharynx cancer in the male population while trachea-bronchus and lung cancer showed a non-significant increase. The ASRs were 7.7 per 10^5 and 13.0 per 10^5 respectively from 2011 to 2015. In 2015, the prevalence of current smoking was 19.3% in Mauritius: 38.0% in men and 3.9% in women [18]. Among females, cancer of the lower respiratory tract increased significantly by 4.7% with an ASR of 4.3 per 10^5 from 2011 to 2015. The mean age of cancer incidence (61 years) among females was also lower than that of the males counterpart (65 years). This trend is comparable to a lesser extent to that in western countries [29] where tobacco smoking among women became very popular after World War II while its consumption was decreased among males.

Cervix cancer was the third most common cancer among women with an ASR of 11.2 per 10^5 from 2011 to 2015 and had a significant decrease of incidence rate of 3.6%. The mean age of diagnosis was 56 years. These figures contrast with the high rates, increasing trends and younger age of cervix cancer in Sub-Saharan Africa [30–32]. Social disruption in these countries may have favoured the spread of Human Papilloma Virus (HPV) infection as well as other sexually transmitted diseases leading to an increased risk of cancer of the uterine cervix. In contrast, Mauritius has enjoyed social stability since its independence in 1968. A good family planning system with the use of condoms, improvement in hygiene and later age of first sexual relationship have also helped to decrease the risk of HPV transmission. HPV vaccine, which protects girls against four strands of HPV, including types 16 and 18 that are most commonly associated with cervical cancer, has been introduced in August 2016 according to World Health Organization recommendations [33]. We expect the trend to further decrease in the coming years.

HIV related cancer incidence (Kaposi Sarcoma and Squamous Cell Carcinoma of Conjunctiva) was generally very low compared to that in Africa [34]. The first cases of HIV were detected in Mauritius in 1987. The rising incidence as from year 2000 was driven by injecting drug users acting as the main mode of transmission [4]. In order to decrease the spread of the infection, the Government provided universal access to anti-retroviral drugs and financial incentives for infected persons to continue their follow-up treatments. With the collaboration of NGOs, the needle exchange program has been introduced in 2006 among injecting drug users. The mode of transmission of the virus is predominantly heterosexual at present. Thanks to antenatal screening, mother to child transmission represented only 0.9% of the newly detected cases from the period 1987-2015. The incidence of HIV/AIDS cases among Mauritians in 2015 was 262 compared to 322 in 2014 and 568 in 2010 [4].

Liver cancer has a relatively low ASR (3.4 per 10^5 in males and 1.9 per10^5 in females from 2011 to 2015) over the study period. The average annual change was also not significant. These figures diverge from those in Sub-Saharan African countries where liver cancer have higher rates [24]. The introduction of compulsory and free Hepatitis B vaccination since two decades and the 97% estimated coverage of the population [35] might explain this difference.

Among children, the most common cancer sites were leukaemia and brain tumours in Mauritius, in contrast to those in Sub Saharan Africa where Kaposi Sarcoma and Non-Hodgkin lymphoma are most common [24].

Over the years, the MNCR has levelled up its standards. Key indicators to assess the completeness and accuracy of the registry have been determined. The MIRs for most sites have improved from the period 2001–2004 to 2012–2015. This is mainly due to the introduction of Death Certificates Initiated cases (DCIs) in 2013. The MIRs that are above 1 are cancers where there are more registered deaths than incident cases. These are cancers usually associated with poor prognosis and/or are difficult to biopsy for diagnostic purposes (oesophagus, stomach, liver, pancreas and lung). The percentage of morphologically verified diagnosis has decreased from 2001 to 2004 to 2012–2015, indicating that the registry is depending less on the pathology department to find cancer cases in favour of clinical services and Death Certificates Only (DCOs).

In order to verify the generalisability of our results, we compared cancer incidence rates between western countries, small states, Mauritius and Sub-Saharan African countries using the *Globocan 2018* database as shown in Table 3. Cancers associated to lifestyle are prostate, colon-rectum lung and breast while that to infectious disease is cervix. Small states including Mauritius have a higher incidence rate of cancers associated to lifestyle than Sub-Saharan African countries but have a relatively lower incidence rate of the same types of cancers compared to western countries. The prevalence of common risk factors for NCDs in small states, such as obesity, physical inactivity, poor diet and tobacco and alcohol consumption, is high [36]. However, infectious disease related cancers which are less of a burden in small

Table 3
Comparison of ASR (per 100,000) between western countries, small nations, Mauritius and Sub-Saharan African countries using *Globocan 2018* database.

Country	Male			Female		
	Prostate	Colon-rectum	Lung	Breast	Colon-rectum	Cervix
USA	75.7	28.8	40.1	141.9	45.0	6.5
France	99.0	36.9	51.3	99.1	24.8	6.7
UK	80.7	37.8	35.5	93.6	27.0	8.4
Samoa	51.5	30.6	44.0	80.1	14.8	12.6
Trinidad and Tobago	68.1	21.5	21.8	68.1	17.5	15.2
Reunion Island	63.7	29.2	34.6	59.1	21.6	10.5
Mauritius	19.9	17.4	17.7	69.6	12.6	12.4
Uganda	34.5	8.3	4.3	21.3	7.9	54.8
Botswana	13.7	4.9	6.4	17.5	1.6	31.6
Mozambique	27.1	3.7	1.9	14.5	3.0	42.8

states compared to sub-Saharan African countries (Table 3) are still higher than in western countries.

5. Conclusions

Despite the diversity in size, development and geographic location, small states share common challenges associated with the size of their economies, remoteness and the dual burden of communicable diseases and non-communicable diseases.

As a result of the ongoing cancer surveillance by the National Cancer Registry, we have portrayed the trends of cancer in the Republic of Mauritius. Cancers related to the 'westernisation' of lifestyle are the most common sites and feature the most dramatic increase. Our findings contrast with other Sub-Saharan African countries where HIV, Hepatitis B, HPV and other infection related cancers are more predominant. This is mainly due to a high adherence among the population to the compulsory and free vaccination programmes. Public health interventions could be designed to target lifestyle associated to these cancers such as: tobacco and alcohol control, better nutrition and weight control. However, not all cancers can be prevented; so timely and universal access to quality care, diagnostics, and affordable, proven treatments are also necessary.

Declaration of Competing Interest

None.

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