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Trends in the incidence of cancer in the black population of Harare, Zimbabwe 1991–2010

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Incidence rates of different cancers have been calculated for the black population of Harare, Zimbabwe for a 20-year period (1991–2010) coinciding with continuing social and lifestyle changes, and the peak, and subsequent wane, of the HIV-AIDS epidemic. The overall risk of cancer increased during the period in both sexes, with rates of cervix and prostate cancers showing particularly dramatic increases (3.3% and 6.4% annually, respectively). By 2004, prostate cancer had become the most common cancer of men. The incidence of cancer of the esophagus, formerly the most common cancer of men, has remained relatively constant, whereas rates of breast and cervix cancers, the most common malignancies of women, have shown significant increases (4.9% and 3.3% annually, respectively). The incidence of Kaposi sarcoma increased to a maximum around 1998–2000 and then declined in all age groups, and in both sexes The incidence of squamous cell cancers of the conjunctiva is relatively high, with temporal trends similar to those of Kaposi sarcoma. Non-Hodgkin lymphoma, the fifth most common cancer of men and fourth of women, showed a steady increase in incidence throughout the period (6.7–6.9% annually), although rates in young adults (15–39) have decreased since 2001. Cancer control in Zimbabwe, as elsewhere in sub-Saharan Africa, involves meeting the challenge of emerging cancers associated with westernization of lifestyles (large bowel, breast and prostate), while the incidence of cancers associated with poverty and infection (liver, cervix and esophagus) shows little decline, and the residual burden of the AIDS-associated cancers remains significant.

The Zimbabwe National Cancer Registry (ZNCR) began operations in Harare in 1986. Acceptably complete coverage of the population of the city of Harare was achieved in 1990,[1] and the incidence rates for this population have been published in three successive volumes of "Cancer Incidence in Five Continents."[2–4] As a result, it is one of only two cancer registries in Africa able to document the evolution of cancer patterns over a substantial period of time (the other being the Kampala cancer registry in Uganda[5,6]). As in much of Africa, there have been marked social and lifestyle changes in the population in last 50 years. Progressive urbanization of the population has meant that Harare city has grown from a population of 1.18 million in 1992 to an estimated 1.53 million in 2010. Zimbabwe is one of the countries of Africa that have been severely affected by the epidemic of HIV/AIDS, with the prevalence of infection increasing to a maximum of 26.5% among adults (15–49) in 1997, before falling to 18.4% in 2005 and 13.1% in 2011.[7] These changes in HIV prevalence, as well as the increasing availability and use of antiretroviral therapy (ART) may be reflected in the trends of AIDS-related cancers.

In our article, we examine trends in incidence in the black population of Harare over a 20-year period, from 1991 to 2010. The cancer profile of the white population is very different,[8] and although a small proportion of the total (2.8% of the Harare population in 2002), it has been ageing much faster than the black population, so that time trends for the entire population are difficult to interpret.

Material and Methods

The Registry is situated in the Parirenyatwa Group of Hospitals complex, which provides most of the specialized cancer management services for the northern part of the country and is one of two teaching hospitals of the University of Zimbabwe College of Health Sciences. The ZNCR employs a combination of active and passive methods of case finding, with staff visiting all institutions within the healthcare delivery system of Harare that are involved in the management of cancer patients in order to register cases. The Registry also receives notifications from certain institutions on a voluntary basis.

The principal sources of information are the inpatient wards and oncology outpatient clinics of the two government

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What's new?

As in much of Africa, marked lifestyle changes have been observed in Zimbabwe since the latter part of the 20th century. During that time, Zimbabwe was also severely affected by HIV/AIDS. According to this study, these factors were coincident with changes in cancer risk and incidence in the black population of Harare, Zimbabwe. The findings reveal increased incidence for certain cancers typically associated with the Westernization of lifestyle, including cancers of the breast and prostate, as well as a rise and fall in incidence of Kaposi sarcoma, a pattern that mirrors the peak and subsequent wane of the HIV/AIDS epidemic.

referral hospitals (Harare Central Hospital and Parirenyatwa Group of Hospitals). In addition, the staff periodically collect information from: (*i*) medical records of discharged and deceased cancer patients, (*ii*) copies of histology reports of cancer patients from public and private histology laboratories, (*iii*) records of patients treated at the Radiotherapy Center which are registered through the medical records system of the Center, (*iv*) records of the three main private hospitals in

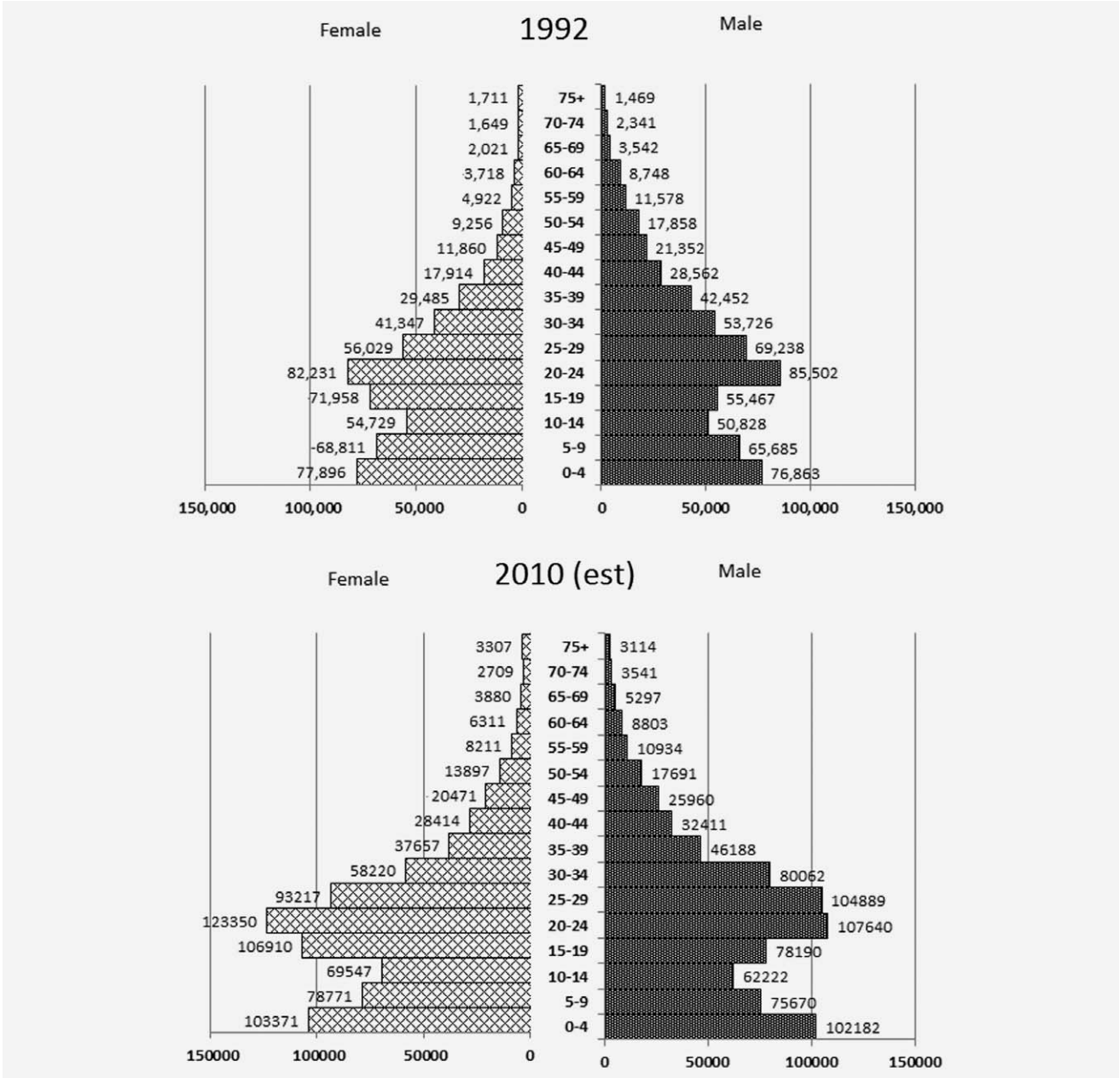

Figure 1. Black population of Harare, by age and sex, census of 1992 and 2010 estimate.

Epidemiology

Table 1. Cancer cases in black residents of Harare, 1991–2010,[1] by sex, site (ICD-10) and most valid basis of diagnosis

		Males					Females				
Cancer site	ICD-10	No. cases	(% total)	DCO[2]	Clinical	MV[3]	No. cases	(% total)	DCO[2]	Clinical	MV[3]
Oral cavity and pharynx	C00-C14	270	1.9	6%	18%	76%	175	1.3	5%	24%	71%
Esophagus	C15	873	6.0	13%	47%	40%	361	2.6	15%	47%	38%
Stomach	C16	511	3.5	18%	23%	58%	422	3.1	13%	31%	55%
Large bowel	C18-C21	525	3.6	9%	24%	67%	399	2.9	16%	18%	66%
Liver	C22	1,110	7.6	28%	56%	15%	499	3.6	34%	51%	14%
Pancreas	C25	206	1.4	25%	55%	20%	205	1.5	32%	46%	21%
Larynx	C32	204	1.4	9%	22%	69%	32	0.2	16%	22%	63%
Lung	C33-C34	548	3.8	17%	44%	39%	219	1.6	23%	31%	45%
Bone	C40-C41	163	1.1	5%	22%	73%	145	1.1	5%	18%	76%
Melanoma of skin	C43	82	0.6	6%	11%	83%	116	0.8	7%	5%	88%
Other skin	C44	222	1.5	1%	4%	96%	227	1.7	2%	2%	96%
Kaposi sarcoma	C46	5,047	34.6	11%	33%	56%	2,396	17.4	12%	38%	50%
Breast	C50	49	0.3	12%	16%	72%	1,435	10.4	10%	15%	76%
Cervix uteri	C53						3,377	24.6	7%	22%	71%
Corpus uteri	C54						247	1.8	5%	31%	64%
Ovary	C56						446	3.2	11%	35%	54%
Prostate	C61	1,560	10.7	18%	23%	59%					
Kidney	C64	139	1.0	11%	11%	78%	133	1.0	7%	6%	87%
Bladder	C67	359	2.5	16%	31%	52%	255	1.9	14%	34%	52%
Eye	C69	377	2.6	1%	3%	96%	385	2.8	1%	3%	96%
Brain, nervous system	C70-C72	190	1.3	21%	30%	49%	174	1.3	24%	28%	48%
Thyroid	C73	50	0.3	12%	20%	68%	171	1.2	9%	28%	63%
Hodgkin disease	C81	89	0.6	1%	0%	99%	59	0.4	7%	2%	92%
Non-Hodgkin lymphoma	C82-C85;C96	750	5.1	8%	5%	87%	618	4.5	9%	5%	86%
Myeloma	C90	124	0.9	10%	6%	83%	138	1.0	13%	1%	86%
Leukemia unspec.	C91-C95	296	2.0	9%	1%	90%	194	1.4	9%	1%	90%
All sites total	All	14,577	100	13%	29%	58%	13,742	100.0	11%	25%	64%

[1]Excludes cases from 2007 to 2009.
[2]DCO: Cases registered on the basis of information contained on a death certificate only.
[3]MV: Cases for which diagnosis was based on cytology, hematology or histopathology.

Harare (Avenues Clinic, West End and St. Anne's Hospitals), (*v*) death certificates of cancer patients who die in the greater Harare area and (*vi*) records of specific cancer research studies including case series assembled by clinicians.

Death certificate notifications are followed up to obtain additional information on the diagnosis and management of the cancer, and if this proves fruitless, cases are registered on the basis of the death certificate only.

Cancer notification forms are filled in for each patient. Information collected includes patient demographic data (names, date of birth/age, sex, race and usual residential address), hospital and patient number, date of diagnosis, method of diagnosis, primary site, histological type as well as extent and stage of disease. Basic data on initial treatment and follow-up data are also collected, and HIV status is also recorded when it is available.

The abstract forms are matched manually and electronically with the records in the ZNCR database in order to prevent multiple registrations. The abstract forms are coded and entered into the computer using the CanReg4 cancer registration software provided by the IARC.

Tumor site and morphology are coded according to the third edition of the International Classification of Diseases (ICD) for Oncology.[9] For tabulation of results, these were converted to the 10th revision of the ICD.[10] Squamous cell carcinomas (SCC) of the conjunctiva were defined as tumors with ICD-O morphology codes M8010-M8082 of conjunctiva (ICD-O C69.0) or eye, unspecified (ICD-O C69.9).

Population

Population censuses were performed in 1992 and 2002, and for these years, the population of Harare was available by

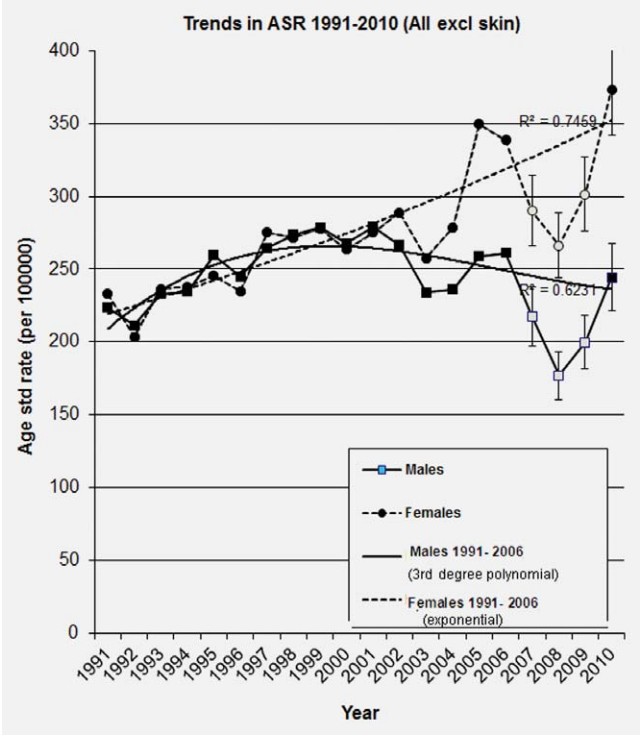

Figure 2. Annual age standardized incidence rates for all malignant neoplasms (excluding nonmelanoma skin cancer), by sex, 1991–2010 (with 95% confidence limits for the years 2007–2010). The best fitting trend lines for the period 1991–2006 ($y = 213.85e^{0.025x}$ for females, $y = 0.03x^3 + 1.41x^2 + 18.51x + 191.79$ for males) is also shown. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]

sex, ethnic group and 5-year age group. Annual intercensal estimates for 1993–2001 (and for 1991) were prepared, assuming a constant rate of growth within age groups between census counts. Projections for 2003–2010 (by sex and 5-year age group) were provided by the Central Statistical Office. They apparently assume a constant rate of growth annually, for both males and females, and that the age distribution of 2002 remains the same in each subsequent year. Figure 1 shows population pyramids for the black population at the beginning (1992 census) and end (2010 estimate) of the period studied.

Statistical methods

Incidence rates were calculated for the black population by 5-year age groups and sex, for each year (1991–2010), and for three 5-year time periods: 1991–1995, 1996–2000 and 2001–2005. Because of evident under-registration in the years 2007–2009 (see below), the fourth quinquennium was represented by the combined rate for the two years, 2006 and 2010.

Age standardized rates (ASRs) were calculated using the World Standard population.[11] Average annual rates of change (and 95% confidence intervals) over the whole 20-year period (excluding 2007–2009) were calculated for each sex, for those cancer sites with at least one case registered in each year, assuming a constant rate of increase or decrease in the period considered.

Two widely used indicators of data quality[4]—the percentage of cases with morphological verification (histology or cytology) of diagnosis (MV%) and the percentage of cases registered solely on the basis of information on a death certificate only (DCO%) were calculated for each sex and the same periods.

Results

During the 20 years of registration considered (1991–2010), a total of 28,319 cases (14,577 male and 13,742 female) were registered among the black population of Harare (Table 1). The most common sites in males were Kaposi sarcoma (34.6%), prostate (10.7%), liver (7.6%) and esophagus (6.0%), whereas in women, cancer of the cervix was the most common (24.6% of cases) followed by Kaposi sarcoma (17.4%) and cancer of the breast (10.4%).

Overall, 58% of cases among men and 64% among women were diagnosed on the basis of histology or cytology and 12.4% on the basis of information on a death certificate alone. Basis of diagnosis varied markedly by cancer site (Table 1).

Figure 2 shows annual age standardized incidence rates for all cancers combined (excluding nonmelanoma skin cancer) in males and females. The best fitting trend line for the period 1991–2006 is also shown; this is a simple exponential curve for females, but a more complex polynomial[1] for males [because of the declining incidence of Kaposi sarcoma since 2000 (see below)]. In both sexes, the observed incidence rates in 2010 are within the expected (95% confidence interval of the rate) range based on these trends, but the rates for 2007–2009 are significantly low.

Table 2 shows the age standardized incidence rates for the main cancer sites in males and females in four time periods (1991–1995, 1996–2000, 2001–2005 and 2006/2010). Also shown are the percentage of cases MV% and based on DCO% for the same periods. MV% and DCO% were significantly different from the average in 2007–2009 (47% and 22% in males and 59% and 15% in females, respectively), reflecting problems in services for diagnosis and treatment of cancer in this 3-year period. The average annual percentage changes in incidence over the 20-year period with the 95% confidence intervals have, therefore, been calculated omitting the data for 2007–2009. For women, there was an overall increase in incidence of 2.7% (95% c.i. 2.0–3.4), whereas for men, the increase (0.6% per annum) was nonsignificant (95% c.i. −0.2 to 1.4).

Figure 3 shows trends in annual age standardized incidence rates for the main cancer sites: Figure 3*a* for cancers of the prostate, esophagus and Kaposi sarcoma in males, and Figure 3*b* for cancers of the cervix, breast and Kaposi sarcoma in females.

In males, there has been a significant increase in the incidence of prostate cancer [6.4% (95% c.i. 5.1–7.7%) annually]. Kaposi sarcoma rates show an initial increase, reaching a peak in the year 1998 (ASR of 76.2 per 10^5) before declining.

[1] $y = 0.03x^3 + 1.41x^2 + 18.51x + 191.79$.

Table 2. Age standardized incidence rates for the main cancer sites in black males and females in four time periods (1991–1995, 1996–2000, 2001–2005 and 2006/2010), and average annual percentage change (AAPC) in incidence over the 20-year period

		1991–2010	1991–1995	1996–2000	2001–2005	2006 and 2010	1991–2010[1]	
Site	**ICD-10**	**Cases[1]**	**ASR**	**ASR**	**ASR**	**ASR**	**AAPC[2]**	**95% conf. interval of AAPC**
Male								
Oral cavity	C00-C06	79	1.5	1.6	1.9	1.6	0.9%	−6.7% to 8.4%
Nasopharynx	C11	58	0.8	0.9	0.7	1.4	17.1%	−10.4% to 44.6%
Esophagus	C15	754	24.6	20.1	22.9	18.9	−1.2%	−2.6% to 0.3%
Stomach	C16	433	13.1	12.7	11.6	12.9	−0.4%	−3.0% to 2.2%
Large intestine	C18–21	430	8.1	8.7	11.2	14.9	**4.0%**	**2.0% to 6.1%**
Liver	C22	995	33.5	23.8	16	16.3	**−5.4%**	**−7.3% to −3.5%**
Pancreas	C25	185	5.7	4.6	5.5	4.4	−1.1%	−4.5% to 2.4%
Larynx	C32	170	4.8	5.5	4.9	4.4	−0.5%	−4.0% to 3.0%
Lung	C33-C34	493	18.7	13.3	10.5	13.3	**−3.5%**	**−6.3% to −0.8%**
Melanoma of skin	C43	72	2.4	1.8	1	2.1	−8.8%	−50.0% to 32.4%
Kaposi sarcoma	C46	4,655	42.2	66.8	48.6	28.5		
Penis	C60	**64**	1.9	1.7	1.2	0.8	−7.8%	−16.9% to 1.2%
Prostate	C61	**1,298**	30.1	46.4	58.5	73.3	**6.4%**	5.1% to 7.7%
Kidney	C64	**121**	1.2	1.8	2	2.1	4.5%	−1.2% to 10.2%
Bladder	C67	**318**	10.7	9.4	8.4	8.6	−2.3%	−4.8% to 0.2%
Eye	C69	**346**	1.4	3.9	5.7	4.3	**13.2%**	4.6% to 21.8%
Brain, nervous system	C70-C72	**170**	2.1	2.5	1.7	1.4	−0.9%	−5.6% to 3.8%
Hodgkin disease	C81	**79**	0.9	1.2	0.7	0.5	−1.5%	−7.8% to 4.9%
Non-Hodgkin lymphoma	C82–85;C96	**636**	5.1	8.3	9.9	12.7	**6.7%**	4.1% to 9.3%
Multiple myeloma	C90	**113**	3.2	3.3	2.7	1.7	−3.3%	−8.1% to 1.5%
Lymphoid leukemia	C91	**85**	1.6	1.7	0.8	0.9	**−5.6%**	−10.7% to −0.5%
Myeloid leukemia	C92-C94	**137**	1.7	1.7	1.6	1.0	−1.8%	−6.6% to 3.0%
All leukemia	C91-C95	**256**	3.6	4	2.8	3.4	−1.7%	−5.8% to 2.4%
All sites total	All	**12,900**	237.1	269.2	254.2	254.3	0.6%	−0.1% to 1.3%
All sites but C44	Not C44	**12,701**	233.7	265.1	249.8	250.8	0.6%	−0.2% to 1.4%
MV (%)	**12%**	**9%**	**12%**	**14%**	**14%**	**9%**		
DCO (%)	**60%**	**60%**	**59%**	**61%**	**56%**	**60%**		
Female								
Oral cavity	C00-C06	**47**	1.5	1.2	1.4	2.1	13.3%	−27.5% to 54.0%
Nasopharynx	C11	**34**	1.1	0.4	0.4	1.0	19.0%	−13.5% to 51.5%
Esophagus	C15	**287**	9.7	7.8	11.8	17.6	**4.1%**	0.8% to 7.4%
Stomach	C16	**346**	14.1	12.8	13.4	15.9	0.7%	−1.5% to 2.9%
Large intestine	C18–21	319	8.2	7.5	10.6	14.2	**3.8%**	1.9% to 5.7%
Liver	C22	**433**	14.4	15.6	15.2	12.2	−0.6%	−3.5% to 2.4%
Pancreas	C25	**159**	6.9	4.7	6.5	8.4	4.2%	−5.4% to 13.7%
Larynx	C32	**22**	1.5	1.1	0.6	0.7	−12.5%	−79.5% to 54.4%
Lung	C33-C34	**182**	7.6	6.5	6.9	6.3	−0.2%	−2.6% to 2.1%

Table 2. Age standardized incidence rates for the main cancer sites in black males and females in four time periods (1991–1995, 1996–2000, 2001–2005 and 2006/2010), and average annual percentage change (AAPC) in incidence over the 20-year period (Continued)

		1991–2010	1991–1995	1996–2000	2001–2005	2006 and 2010	1991–2010[1]	
Site	ICD-10	Cases[1]	ASR	ASR	ASR	ASR	AAPC[2]	95% conf. interval of AAPC
Melanoma of skin	C43	**99**	3.9	3.4	3.7	3.4	0.6%	−3.2% to 4.3%
Kaposi sarcoma	C46	**2,156**	15	32.5	27.5	19.2		
Breast	C50	**1,155**	20.9	26.9	30.3	46.8	**4.9%**	2.9% to 6.9%
Cervix uteri	C53	**2,733**	62.1	64.1	78.7	103.8	**3.3%**	2.0% to 4.6%
Corpus uteri	C54	**205**	5.5	7.6	7.7	12.7	**5.2%**	1.2% to 9.2%
Ovary	C56	**372**	6.8	9.8	9.6	13.8	**3.8%**	1.2% to 6.4%
Kidney	C64	**105**	1.4	2.2	1.7	1.4	8.5%	−0.3% to 17.3%
Bladder	C67	**226**	10	7.9	4.9	7.7	**−4.4%**	−7.6% to −1.2%
Eye	C69	**343**	1.7	4.7	6.3	4.9	**37.3%**	3.3% to 71.3%
Brain, nervous system	C70-C72	**153**	1	3.2	3.7	2.8	**9.8%**	5.5% to 14.1%
Thyroid	C73	**143**	4.1	4	5	5.9	2.4%	−1.8% to 6.6%
Hodgkin disease	C81	**51**	0.7	0.5	0.6	0.9	1.3%	−8.1% to 10.6%
Non-Hodgkin lymphoma	C82-C85;C96	**495**	4.6	8.5	9.2	12.4	**6.9%**	4.4% to 9.3%
Multiple myeloma	C90	**117**	4.6	4.8	4.6	4.3	−3.1%	−8.4% to 2.2%
Lymphoid leukemia	C91	**53**	1.7	1.4	0.6	0.9	−7.0%	−15.6% to 1.6%
Myeloid leukemia	C92-C94	**111**	1.8	2.2	1.8	1.1	−1.3%	−5.8% to 3.3%
All leukemia	C91-C95	175	3.6	4	2.6	2.0	−3.3%	−7.6% to 0.9%
All sites total	All	**11,518**	235.1	269.7	288.1	360.2	**2.7%**	2.0% to 3.4%
All sites but C44	Not C44	**11,319**	231.8	265.0	282.8	354.2	**2.7%**	2.0% to 3.4%
MV (%)		**10%**	**10%**	**10%**	**10%**	**9%**		
DCO (%)		**67%**	**70%**	**68%**	**63%**	**68%**		

[1]Excludes cases from 2007 to 2009.
[2]Bold text indicates statistically significant ($P < 0.05$) trend.

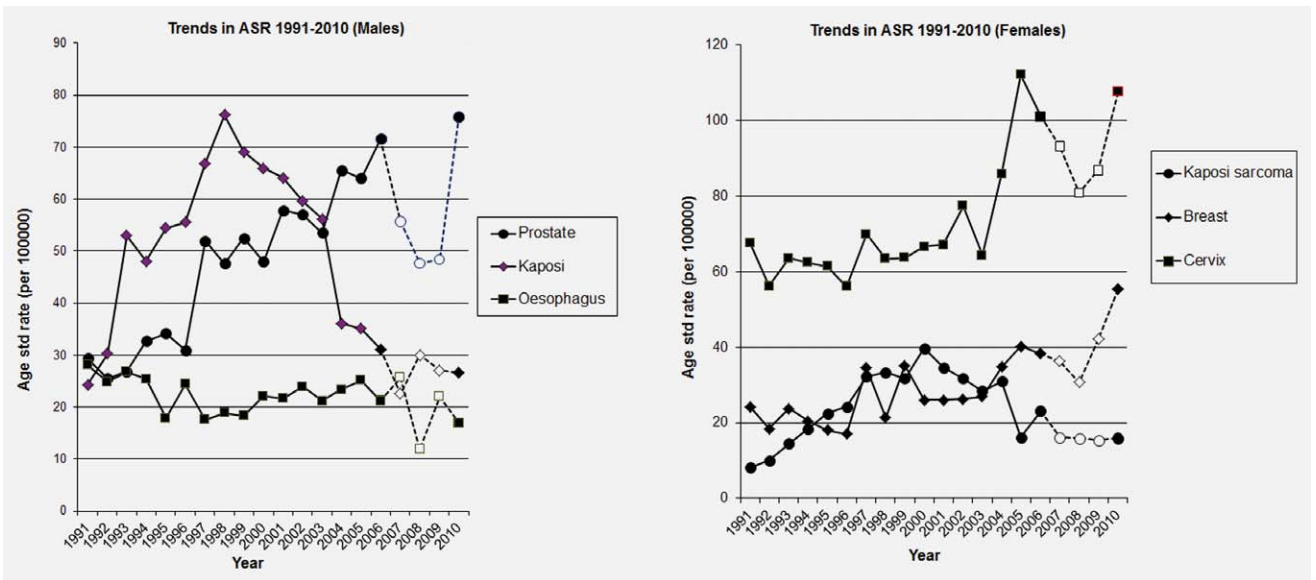

Figure 3. Trends in age standardized incidence rates of the main cancers of (*a*) males and (*b*) females, 1991–2010. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]

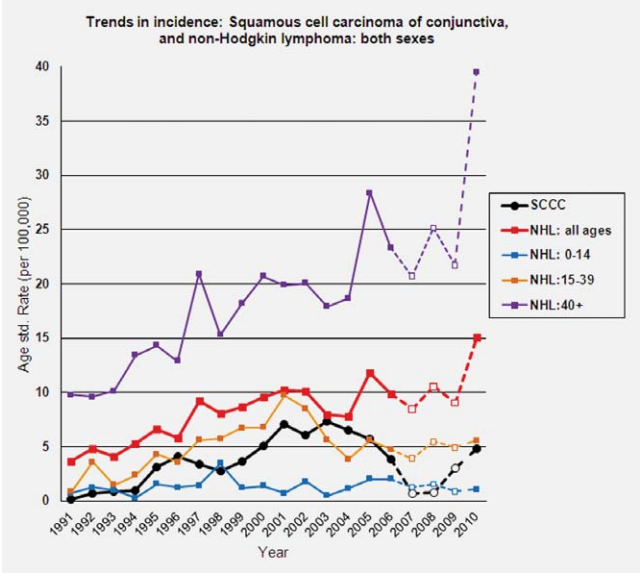

Figure 4. Trends in age standardized incidence rates of squamous cell carcinoma of conjunctiva and non-Hodgkin lymphoma (all ages and three age groups) in both sexes combined, 1991–2010.

The small decline in the incidence of cancer of the esophagus was nonsignificant (Table 2). Among the other sites with lower rates of incidence, significant increases are evident for cancers of the eye (13.2% annually), non-Hodgkin lymphomas (NHLs) (6.7% per year) and large bowel (4% per year), whereas cancers of the lung and liver have shown significant declines (−3.5% and −5.4%, respectively).

In females, the most frequent cancer over the whole period was cancer of the cervix uteri. Rates have been increasing markedly over the 20-year period 1990–2004 (average annual change 3.3% (95% c.i. 2.0–4.6%) so that the ASR in 2006/2010 was 103.8 per 10^5 (Table 2). The incidence of breast cancer is about half that of cervix cancer, but the rate of increase is even greater: 4.9% (95% c.i. 2.9–6.9%) annually. As for men, rates of Kaposi sarcoma show an initial increase to a peak (in 2000) before declining, although the peak incidence was about half that in males (39.8 per 10^5 in 2000, compared to 76.2 in males in 1998). There have been significant increases in the incidence of cancers of the eye (37.3% annually), NHLs (6.9% per year) and cancers of the large bowel (3.8% per year).

For cancer of the breast, the increases in incidence are more evident at older age groups (after age 50) than among the young (Supporting Information Fig. 1); this is less evident for cancer of the cervix.

For Kaposi sarcoma, incidence rates peak around ages 35–44 in men, and rather earlier in women (30–39), and there are small peaks in childhood (ages 5–9) and in older men (ages 65–74) (Supporting Information Fig. 2). The decrease in incidence in the most recent period (2006/2010) seems to be most marked in young adults. Mean age at diagnosis has progressively increased, from 36.6 in 1991–1995 to 41.1 in 2006/2010 in men, and from 32.8 in 1991–1995 to 35.7 in 2006/2010 in women.

Figure 4 shows the trends in age standardized incidence rates of squamous cell carcinomas of the conjunctiva (SCCC) and NHL in both sexes combined. For SCCC, incidence rates rise to a maximum in 2001, and then decline, whereas for NHL, ASRs appear to continually increase, up to 2010. However, examining NHL trends in different age groups, while the increase in older adults (40+) may well be continuous, for young adults (aged 15–39), the trend more resembles that of SCCC (or Kaposi sarcoma) with a peak incidence around 2001, and a decline thereafter. There is relatively little change in the incidence of childhood NHL.

Discussion

To study time trends, it is important that the degree of completeness of registration of incident cancer cases should be similar throughout the period under consideration. Results from the registry have been published in Cancer Incidence in Five Continents (CI5) volumes VII (1990–1992), VIII (1993–1997) and IX (1998–2002) [2–4]; these volumes "present incidence data from populations all over the world for which good quality data are available."[4] The indicators of data quality used for Harare in CI5 (MV% and DCO%) remain constant until 2006. However, the period 2007–2009 was very difficult politically, economically and socially for Zimbabwe. The severe economic challenges experienced in the country adversely affected the healthcare delivery system leading to the near collapse of the public sector component in 2008. Most departments of government central referral hospitals operated below capacity and some of them closed altogether. One of the key information sources—the private Clinical Laboratories, lost its entire histological database for 2007 and 2008 due to computer system failure. It is not, therefore, surprising that the calculated incidence rates, and indicators of data quality, show that registration was incomplete during this period. However, rates for 2010 are within the expected range, given pre-existing trends (in 1991–2006), as are the indicators of data quality, so we have included this year in the analysis of time trends.

In addition to completeness of ascertainment, a valid estimation of incidence rates requires that accurate population denominators are available. For Harare, census counts (by age group, sex and race) of the population were available for 1992 and 2002, and we made use of interpolations and projections for the other years. There must be some question as to the accuracy of the person-years at risk estimates, especially for more recent years (and particularly with respect to the age distributions), although no better data are, of course, available.

In common with much of urban Africa, lifestyles in Harare are changing rapidly, as the population changes from one comprising relatively recent immigrants from village life, to one of second or third-generation inhabitants, engaged in wage-earning or the informal economy as well as purchasing foodstuffs and other necessities, rather than producing them themselves. This demographic transition is accompanied by familiar trends in patterns of health and illness, with a

decrease in maternal and infant mortality, fertility and a rise in the importance of noncommunicable diseases.[12] It is, therefore, not surprising to note a steady increase in the incidence of cancer in both sexes. One might reasonably expect the changes to relate to an increase in the cancers that are particularly common in "western" populations (Europe and North America)—lung, prostate, large bowel and breast, and a decrease in those more familiar in the so-called developing world (cancers of the stomach, esophagus, liver and cervix uteri), but these preconceptions are not always borne out.

Cancer of the prostate became the most common cancer of men (in terms of age standardized incidence) in 2004, and there has been a major increase in incidence 6.4% annually on average over the 20-year period, and by 2006/2010, the age standardized incidence rate (73.3 per 10^5) was the highest observed in Africa.[13] Most of this increase is in elderly men—aged 65 or over. The increase is certainly not due to screening, although it is quite likely that increased awareness, a greater readiness to perform prostatectomy for urinary symptoms in elderly men, and histological examination of operative biopsies have played a role.

The incidence of breast cancer in women has been increasing at a similar rate (4.9% annually), although the absolute incidence rate (ASR of 46.8 per 10^5 in 2006/2010) remains relatively low by world standards.[13] Most of the change has been in postmenopausal women (Supporting Information Fig. 1). It is possible that some of the increase is related to declines in fertility; according to successive demographic surveys since 1988, fertility has fallen among women over age 20 over the past two decades and analysis of trends in age at first birth reveals a decline in early childbearing. In addition, 43% of women resident in Harare were overweight or obese in 2010/2011 (compared to 26% of rural Zimbabwean women). The proportion of women, who are overweight or obese, has increased by 6 percentage points since 2005–2006.[14]

Tumors of the large bowel are relatively uncommon, although the rates are increasing in both sexes, especially among women. Likewise, cancers of the lung remain relatively rare, and although incidence is increasing in women, there appears to have been a modest decline in incidence rates in males. Tobacco use (mostly cigarette smoking) is not very prevalent in Zimbabwe (22% of men and 1% of women) and is more common in rural than urban settings and decreases with increasing wealth and education.[14]

The increase in incidence of cancers associated with a "western" lifestyle (breast, prostate, large bowl and lung) is not, however, being accompanied by major declines in the cancers traditionally associated with Eastern and Southern Africa. Oesophageal cancer rates appear to have changed little in the last 20 years in males, and shown something of an increase in the most recent period (2006/2010) in females. Likewise, stomach cancer has not shown the declines in incidence observed in western countries. On the other hand, the incidence of liver cancer, which was the most common cancer of men in 1990–1992,[1] has declined in males (although less markedly in females). Most liver cancer cases in Harare are related to infection with Hepatitis B, with a lower percentage associated with Hepatitis C (or both).[15]

Cancer of the cervix uteri has been the most common cancer of women ever since the inception of the registry[1,16] and so it remains. The rates are still increasing at an average of 3.3% a year and are now very high (ASR 103.8 per 10^5 in 2006/2010). This trend is quite the opposite of the decrease in incidence of cervix cancer in Zimbabwe over the period 1980–2010 estimated by the Institute for Health Metrics and Evaluation.[17] The reasons for this trend and the resulting very high rates of disease are not immediately clear. The possible link to the epidemic of HIV/AIDS is complex. Cervix cancer is considered to be an AIDS-defining condition in the United States, an association due to the high risk for human papillomavirus (HPV) infection, HPV DNA persistency and progression of HPV lesions to cervical cancer in women infected with HIV.[18] The prevalence of HIV infection in Zimbabwe has been decreasing since the peak of about 29% in 1997, and there is no clear evidence that treatment with ART—which has increased markedly since 2004[7]—results in a decreased risk of invasive cervix cancer.[19] While the availability of ART means that HIV-infected individuals who live longer may be at increased risk of persistent HPV infection and precancerous CIN progressing to cervical cancer, the prevalence of survivors with HIV/AIDs is estimated to be declining (as new infections decrease), and the increase in incidence of cervix cancer is certainly not especially marked in younger women, who are the more likely to be infected with HIV.[14] Changes in family structures and social mores may have favored the spread of HPV (like other sexually transmitted diseases), resulting in increasing risk of cervical cancer. Although there have been several projects to investigate appropriate screening modalities,[20] these have been limited in scope, and screening is confined to a very limited number of opportunistic examinations.

The most dramatic changes in incidence concern those cancers related to infection with HIV, particularly Kaposi sarcoma, SCC of the conjunctiva and NHL. Before the epidemic of HIV-AIDS, Kaposi sarcoma in Africa was of the typical "endemic" pattern, involving the skin, particularly the legs, and affecting principally males, with the risk rising progressively with age. There has been an enormous increase in incidence of Kaposi sarcoma since the first report on cancer in Harare (for the years 1986–1989[16]). These changes are the result of the evolution of the epidemic of HIV-AIDS in Zimbabwe, and the age-specific incidence of Kaposi sarcoma was noted to correspond closely to the age-specific reporting rates for AIDS.[21] HIV prevalence has been declining in Zimbabwe since 1997,[7] and these declines, resulting from either the natural dynamics of HIV epidemics or the impact of interventions, have been most marked in the younger age-groups where most individuals have had little previous exposure to infection and HIV prevalence reflects recent incidence. In older age-groups, ageing of persons infected at younger ages into these age-groups tends to offset the effects of mortality and reduced HIV incidence.[22] The fall in incidence of Kaposi sarcoma in males since 1998 and in women since 2000 has similarly been more marked in the younger age groups, resulting in an increase in the mean age at onset of Kaposi

sarcoma. The fall has almost certainly been accelerated by the increasing availability of ART, which suppresses manifestations of AIDS (particularly Kaposi sarcoma) in HIV positive subjects.[23,24] The ART program was launched by the Ministry of Health and Child Welfare in 2004, and by 2011, it was estimated that 80% of eligible HIV-AIDS subjects (CD4 < 350) were receiving therapy.[7]

SCC of the conjunctiva has been shown to be associated with HIV infection in African populations,[25] with rises in incidence in many populations[26]; the incidence in the Harare population increased 10-fold between 1991 and 2004. Because of the inadequacy of the registry data in 2007–2009, the evolution in recent years is uncertain, but it seems quite possible that a decline in incidence has occurred since then.

The incidence of NHLs has also increased markedly during the period studied, although among younger adults, the trend has been reversed in recent years, so that the incidence at ages 15–39 has decreased since 2001. This may also be associated with increasing access to ART—in the USA, there has been a decrease in the incidence of systemic and CNS NHL among patients with AIDS following the introduction of ART.[27]

Conclusions

The ongoing surveillance system provided by the registry in this predominantly urban population provides a picture of the evolution of the problem of cancer in modern sub-Saharan Africa. The increase and subsequent waning of the epidemic of HIV-AIDS is mirrored by the trends in AIDS-related cancers, whereas cancers associated with westernization of lifestyles (breast, prostate and large bowel cancers) continue to increase. At the same time, there has been no decline, and even some increase, in the incidence rates of the major cancers of this region—cervix, liver and esophagus, although so far there is little evidence for the onset of the epidemic of tobacco-related cancer that has been such an important feature of the cancer profile in economically developed countries. However, while economic hardship may limit tobacco consumption and its health consequences, it will also restrict the capacity to mount effective programs of cancer control.

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