

# Cancer Burden in Africa and Opportunities for Prevention

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Cancer is an emerging public health problem in Africa. About 715,000 new cancer cases and 542,000 cancer deaths occurred in 2008 on the continent, with these numbers expected to double in the next 20 years simply because of the aging and growth of the population. Furthermore, cancers such as lung, female breast, and prostate cancers are diagnosed at much higher frequencies than in the past because of changes in lifestyle factors and detection practices associated with urbanization and economic development. Breast cancer in women and prostate cancer in men have now become the most commonly diagnosed cancers in many Sub-Saharan African countries, replacing cervical and liver cancers. In most African countries, cancer control programs and the provision of early detection and treatment services are limited despite this increasing burden. This paper reviews the current patterns of cancer in Africa and the opportunities for reducing the burden through the application of resource level interventions, including implementation of vaccinations for liver and cervical cancers, tobacco control policies for smoking-related cancers, and low-tech early detection methods for cervical cancer, as well as pain relief at the palliative stage of cancer. *Cancer* 2012;118:4372-84. © 2012 American Cancer Society.

The burden of cancer is increasing in Africa because of the aging and growth of the population as well as increased prevalence of risk factors associated with economic transition, including smoking, obesity, physical inactivity, and reproductive behaviors.<sup>1,2</sup> According to United Nation's population estimates,<sup>2</sup> the population of Africa between 2010 and 2030 is projected to increase by 50% overall (from 1.03 billion to 1.52 billion) and by 90% for those aged  $\geq 60$  years (from 55 million to 105 million), the age at which cancer most frequently occurs.

Although current prevalence of adult cigarette smoking is low in Africa,<sup>3</sup> there is a concern that the prevalence will increase because of increased disposable income and adoption of Western lifestyles driven by images such as films that portray smoking as a stylish activity.<sup>4</sup> In most urban populations of African countries, there have also been changes in reproductive factors toward earlier menarche, delayed childbearing, and lower fertility; in dietary patterns toward high animal and hydrogenated fat intake; and in activity patterns toward reduced average energy expenditure.<sup>5</sup> There has already been some limited evidence for the rising burden of cancers associated with these risk factors. For example, breast cancer incidence rates in Uganda (Kampala) have nearly doubled over the past 20 years,<sup>6</sup> although the rates still remain less than half of those seen in black women in Western countries such as the United States.

Despite this growing cancer burden, cancer continues to receive a relatively low public health priority in Africa, largely because of limited resources and other pressing public health problems, including communicable diseases such as acquired immunodeficiency syndrome (AIDS)/human immunodeficiency virus (HIV) infection, malaria, and tuberculosis. It may also be in part because of a general lack of awareness among policy makers, the general public, and international private or public health agencies concerning the magnitude of the current and future cancer burden and its economic impact. Previous reviews of the cancer burden in Africa were based on an earlier version of GLOBOCAN estimates, and the cancer prevention and control aspects were presented in a separate paper.<sup>7,8</sup> In this paper, we review the current cancer burden for common cancers in Africa largely based on the updated data (GLOBOCAN 2008 estimates),<sup>9</sup> and discuss the opportunities for cancer prevention and control in the region.

## Data Sources

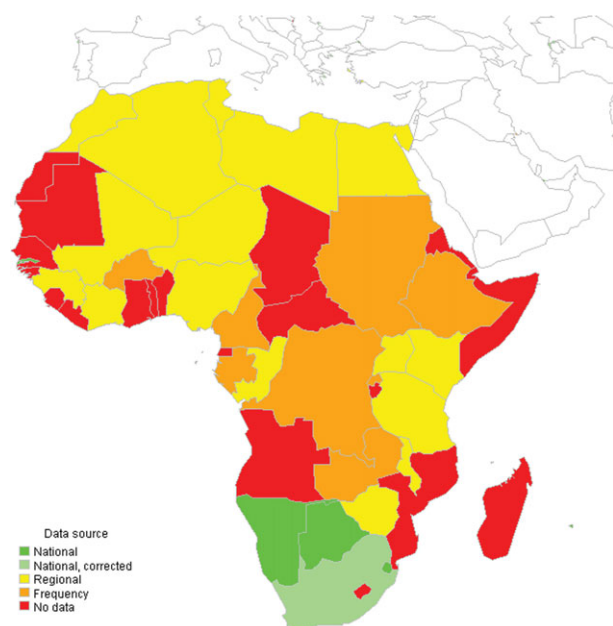
The numbers and rates presented here were extracted from the GLOBOCAN 2008<sup>9</sup> database of the International Agency for Research on Cancer (IARC), which presents the estimates of incidence of, and mortality from, 27 major cancers in 184 countries or territories worldwide for 2008. The country-specific cancer incidence and mortality rates were based on

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data reported by 5 national cancer registries and by some 50 local cancer registries covering 8% of the African population (Fig. 1). The local registries generally cover major cities and are predominantly urban, with 5 (covering around 1% of the African population) considered to be of sufficient quality to be included in the most recent volume of *Cancer Incidence in Five Continents*.<sup>10</sup> No reliable



**Figure 1.** Methods of estimation are shown for GLOBOCAN 2008 incidence data.

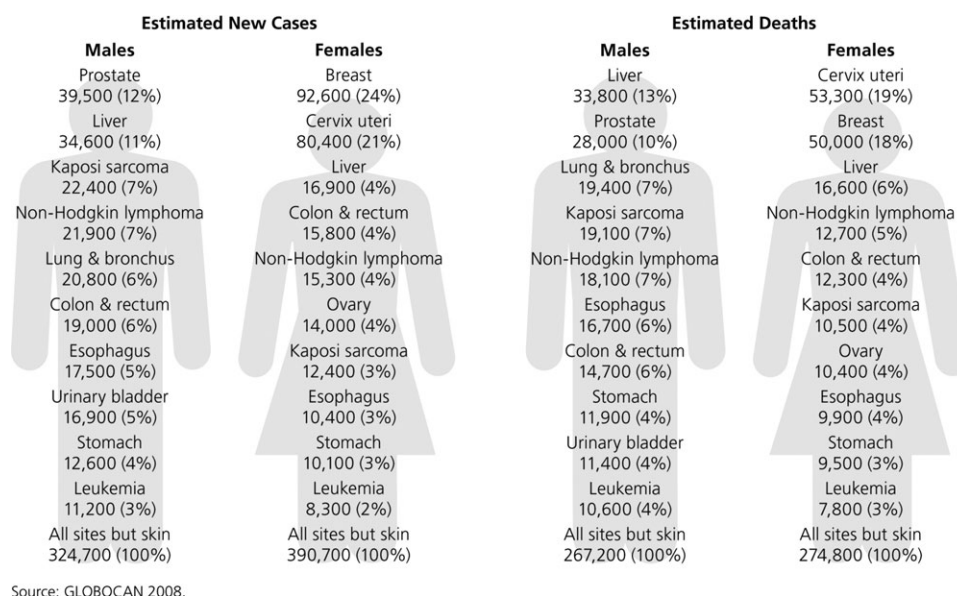
cancer-specific mortality statistics are available in any African countries (except Mauritius), and mortality in GLOBOCAN was estimated by combining corresponding estimates of cancer incidence with survival probabilities predicted from country-specific levels of gross domestic product. GLOBOCAN 2008 presents estimates of the incidence and mortality from Kaposi sarcoma (KS) in Sub-Saharan African countries only, given its relative rarity elsewhere.<sup>11</sup> For this paper, however, we computed an estimate of the incidence and mortality from KS in Northern Africa using the same methods.

### Cancer Burden

Overall, 715,000 new cancer cases and 542,000 cancer deaths were estimated to have occurred in 2008 in Africa (Fig. 2). However, the incidence and mortality patterns vary remarkably across regions (Fig. 3, Tables 1 and 2), most likely because of substantial regional differences in the prevalence and distributions of social, cultural, and other environmental factors, including many of the major known risk factors for cancers, contrasting levels of economic development, and differences in access to health care and infrastructure that are not captured by economic development. We briefly describe the burden for select cancers with high burden, known preventive measures, or striking regional variations.

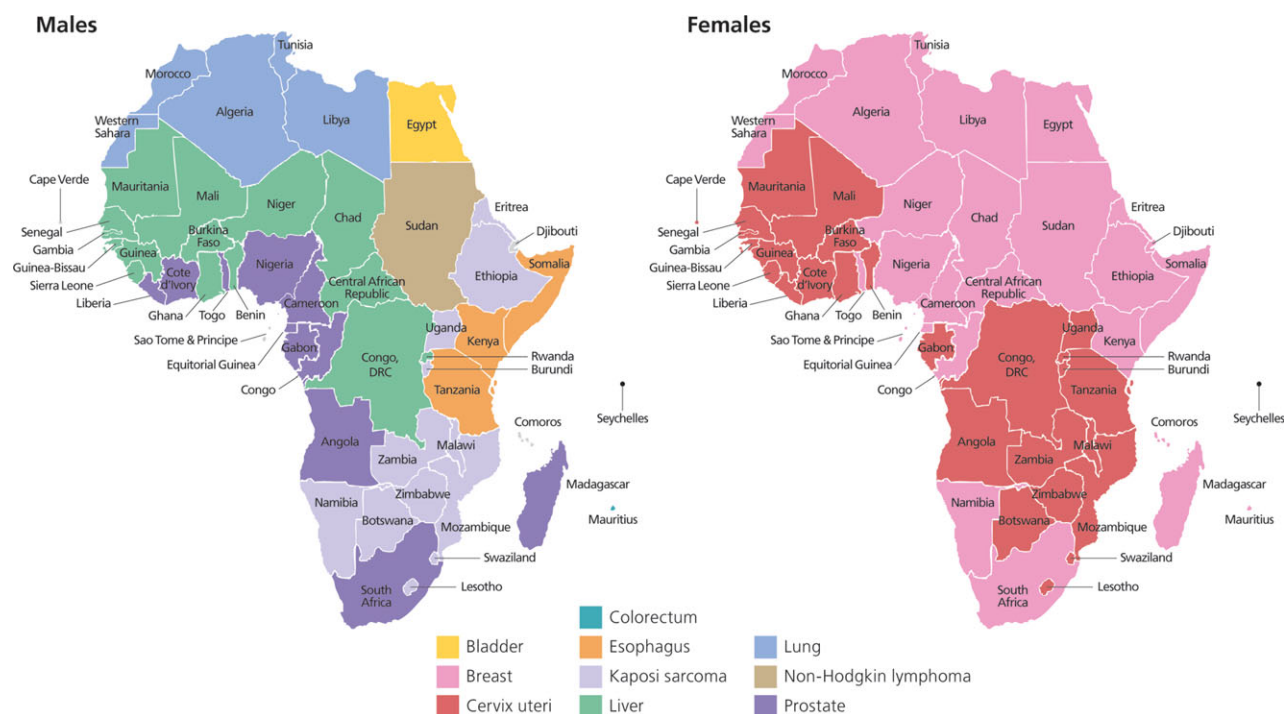
### Cervical cancer

Cervical cancer is the second most frequently diagnosed cancer (80,400; Fig. 2) and the leading cause of



Source: GLOBOCAN 2008.

**Figure 2.** Estimated numbers of new cases and deaths for leading cancer sites in Africa are shown for 2008. Source: GLOBOCAN 2008.



**Figure 3.** Most common cancer sites in Africa by sex and country are shown for 2008. Source: GLOBOCAN 2008.

cancer death (50,300) in African women. Rates vary substantially across regions, with the incidence and death rates in East Africa and West Africa 5× as high as the rates in North Africa (Tables 1 and 2). Notably, some countries in East Africa, including Zambia, Malawi, Mozambique, and Tanzania have among the highest cervical cancer rates (50 cases per 100,000) worldwide.<sup>9</sup> This is likely the result of lack of screening services for the prevention and early detection of the disease.<sup>12</sup> It is noteworthy that before the introduction and wide dissemination of Papanicolaou (Pap) testing in the 1960s in the United States, the rates of cervical cancer incidence (per 100,000 females) in 10 select metropolitan areas in 1947-1948 (40.1 in whites and 73.1 in nonwhites)<sup>13</sup> were the same order of magnitude as the highest rates found in Eastern Africa today.

### Breast cancer

Breast cancer was the most commonly diagnosed cancer and the second leading cause of cancer death among women in 2008 in Africa (92,600 cases, 50,000 deaths; Fig. 2). Southern African women have the highest breast cancer incidence rates of all African regions, in part because of a higher prevalence of reproductive risk factors for breast cancer, including early menarche and late childbearing among the more affluent predominantly white

population.<sup>14</sup> For example, the female breast cancer incidence rate in Harare (Zimbabwe) in 1990-1992 was 6× higher in whites (129.0) than in blacks (20.0).<sup>15</sup>

Notably, breast cancer has now become the most commonly diagnosed cancer in women (Fig. 3) in several Sub-Saharan African countries, a shift from previous decades in which cervical cancer was the most commonly diagnosed cancer in many of these countries.<sup>16</sup> The reasons for this shift are unknown but may include increases in the prevalence of risk factors for breast cancer such as early menarche, late childbearing, having fewer children, obesity, and increased awareness and detection, which are associated with urbanization and economic development. In the Ugandan (Kampala) and Algerian (Setif) cancer registries, breast cancer incidence rates have nearly doubled over the past 20 years, although the rates still remain much lower than those in black women in the United States and several Western countries.

It has been known for some time that breast cancer among black Americans is more likely to be early onset, higher grade, and estrogen receptor (ER) negative than is observed among white Americans,<sup>17</sup> and the same is true in the black population of the United Kingdom.<sup>18</sup> Early age at onset and aggressive clinical features have frequently been documented in clinical series from Africa, and case

**Table 1.** Age-Adjusted Incidence Rates<sup>a</sup> for the Most Common Cancers in Males and Females in Africa, 2008

Site	Africa		Sub-Saharan Africa		Southern Africa		Eastern Africa		Middle Africa		Northern Africa		Western Africa	
	Rank	Rate	Rank	Rate	Rank	Rate	Rank	Rate	Rank	Rate	Rank	Rate	Rank	Rate
<b>Males</b>														
All sites <sup>b</sup>		114.1		115.9		235.9		121.3		88.1		109.2		92.0
Prostate	1	17.5	1	21.2	1	53.9	3	14.5	2	16.4	4	8.1	1	22.2
Liver	2	11.7	2	13.1	5	13.9	4	7.2	1	18.9	5	7.5	2	16.5
Lung	3	8.4	6	5.9	2	29.0	9	4.1	7	2.8	1	14.9	7	3.1
Colorectal	4	6.9	5	6.8	4	20.4	6	5.8	5	4.3	6	7.0	3	5.6
Esophagus	5	6.7	3	8.5	3	22.3	1	14.9		1.5		2.0		1.4
Urinary bladder	6	6.7	9	3.7	8	7.3	10	3.4		1.5	2	14.5	6	3.9
Non-Hodgkin lymphoma	7	6.3	7	5.5	9	5.7	5	6.2	3	5.4	3	8.4	4	4.8
Kaposi sarcoma	8	6.0	4	8.1	6	11.5	1	14.9	6	4.1		0.4		1.9
Stomach	9	4.7	8	5.0		4.1	7	5.6	4	5.3	9	3.9	5	4.5
Leukemia	10	3.2		2.8		3.9		3.0	8	2.8	7	4.4	9	2.5
<b>Females</b>														
All sites <sup>b</sup>		118.1		124.7		161.1		125.3		96.7		98.9		123.5
Breast	1	28.0	2	26.3	1	38.1	2	19.3	2	21.3	1	32.7	2	31.8
Cervix uteri	2	25.2	1	31.7	2	26.8	1	34.5	1	23.0	2	6.6	1	33.7
Liver	3	5.3	3	6.3	7	5.1	9	3.6	3	9.6	8	2.5	3	8.1
Colorectal	4	5.0	4	4.7	4	8.2	5	4.7	7	3.3	3	5.8	4	4.3
Ovary	5	4.2	6	4.0		3.8	6	4.0	6	4.3	5	4.8	5	3.8
Non-Hodgkin lymphoma	6	4.1	7	3.8	9	4.3	8	3.7	4	4.8	4	5.0	7	3.2
Esophagus	7	3.5	5	4.2	3	11.7	4	6.4		0.8		1.6		1.0
Stomach	8	3.3	8	3.7		2.2	6	4.0	5	4.7	9	2.4	6	3.3
Kaposi sarcoma	9	2.8	9	3.6	8	5.1	3	6.8		0.6		0.1		1.2
Corpus uteri	10	2.5	10	2.6	6	6.9		2.4	9	1.9		2.2	10	1.9

Source: GLOBOCAN 2008. Data for Kaposi sarcoma in Northern Africa were estimated separately (see data sources).

<sup>a</sup> Rates are per 100,000 and age-standardized to the world population.

<sup>b</sup> Excluding nonmelanoma skin cancer.

series from several centers in Africa have reported that hormone receptor-negative cases are predominant<sup>19-21</sup>; for example, only 25% of cases in a large multicenter series of patients from West Africa were ER positive, less than half that observed in the US black population.<sup>19</sup> However, these findings were based on archival materials, and the role of antigen degradation and false-negative results could not be ruled out.<sup>22</sup>

## KS

An estimated 22,400 KS cases in males and 12,400 cases in females were diagnosed in Africa in 2008. More than 70% (25,000 of 34,900) of these cases were in East Africa,<sup>9,23</sup> where it is the most common cancer in males and the third most common cancer in females (Table 1). The incidence rates for KS rose several fold in East Africa and other parts Sub-Saharan Africa during the 1990s, consistent with the HIV/AIDS epidemic in these regions.<sup>24</sup> KS is an HIV-associated cancer caused by human herpes virus-8.<sup>25,26</sup> Although KS continues to be a leading cause of cancer death in most parts of Eastern

Africa, rates are declining because of reduction in prevalence of HIV and wider availability of highly active antiretroviral therapy.<sup>6,27</sup> In contrast to Sub-Saharan Africa, KS is less common in Northern Africa, with only 1% of the total cases (350 of 34,900) in Africa.

## Liver cancer

Liver cancer is the second most commonly diagnosed cancer and the leading cause of cancer death in men and the third most common cancer and the third leading cause of cancer death in women in Africa (Fig. 2). The incidence and mortality rates were highest in Middle Africa followed by Western Africa (Tables 1 and 2). Chronic infections with hepatitis B virus (HBV) in Sub-Saharan Africa regions and hepatitis C virus (HCV) in Northern Africa are the major causes of liver cancer,<sup>28,29</sup> accounting for as much as 90% of the total cases.<sup>30-32</sup> The high burden of HCV-associated liver cancer in Egypt was largely because of the extensive spread of the virus through contaminated injection equipment during mass treatment campaigns against *Schistosoma hematobium*, a parasitic

**Table 2.** Age-Adjusted Death Rates<sup>a</sup> for the Most Common Cancers in Males and Females in Africa, 2008

Site	All Africa		Sub-Saharan Africa		Southern Africa		Eastern Africa		Middle Africa		Northern Africa		Western Africa	
	Rank	Rate	Rank	Rate	Rank	Rate	Rank	Rate	Rank	Rate	Rank	Rate	Rank	Rate
<b>Males</b>														
All sites <sup>b</sup>		95.7		98.1		172.1		105.4		78.5		89.5		80.1
Prostate	1	12.5	1	15.0	3	19.3	3	11.7	2	13.4	5	6.2	1	18.3
Liver	2	11.7	2	13.2	5	14.0	4	7.3	1	19.2	3	7.4	2	16.5
Lung	3	7.9	5	5.6	1	27.4	8	4.0	7	2.7	1	14.0	7	2.9
Esophagus	4	6.5	3	8.2	2	21.4	1	14.3	9	1.4		2.0	10	1.4
Colorectal	5	5.5	6	5.5	4	15.8	7	4.7	5	3.5	6	5.5	3	4.6
Non-Hodgkin lymphoma	6	5.3	8	4.6	8	4.6	6	5.1	4	4.6	4	6.9	5	4.1
Kaposi sarcoma	7	5.1	4	6.9	6	9.6	2	12.7	5	3.5		0.3	9	1.5
Urinary bladder	8	4.8	9	2.8	7	4.9	10	2.6		1.2	2	9.9	6	3.1
Stomach	9	4.5	7	4.9		3.9	5	5.4	3	5.2	8	3.7	4	4.4
Leukemia	10	3.0	10	2.7		3.6	9	2.8	8	2.6	7	4.1	8	2.3
<b>Females</b>														
All sites <sup>b</sup>		86.5		92.8		108.1		95.9		75.6		68.2		91.2
Cervix uteri	1	17.6	1	22.5	2	14.8	1	25.3	1	17.0	4	4.0	1	24.0
Breast	2	16.0	2	15.3	1	19.3	2	11.4	2	13.1	1	17.8	2	18.9
Liver	3	5.5	3	6.6	6	5.0	5	3.8	3	10.6	7	2.5	3	8.3
Colorectal	4	4.0	5	3.8	5	6.1	5	3.8	7	2.7	2	4.5	4	3.5
Non-Hodgkin lymphoma	5	3.5	7	3.2	9	3.5	9	3.1	5	4.1	3	4.1	7	2.7
Ovary	6	3.4	7	3.2	10	2.8	8	3.3	6	3.6	5	3.7	5	3.1
Esophagus	7	3.4	4	4.0	3	11.1	3	6.2		0.8		1.5		1.0
Stomach	8	3.2	6	3.5		2.0	5	3.8	4	4.6	8	2.3	5	3.1
Kaposi sarcoma	9	2.3	9	3.1	7	4.4	4	5.8		0.5		0.1	10	1.0
Leukemia	10	2.1	10	1.9		2.0	10	1.7	8	1.8	6	2.8	8	2.0

Source: GLOBOCAN 2008. Data for Kaposi sarcoma in Northern Africa were estimated separately (see data sources).

<sup>a</sup> Rates are per 100,000 and age-standardized to the world population.

<sup>b</sup> Excluding nonmelanoma skin cancer.

trematode that causes chronic inflammation and cancer of the bladder (see below), during the 1960s and 1970s.<sup>33,34</sup> Contamination of staple foods such as maize and ground nuts with aflatoxins, known hepatocarcinogens produced by molds during cultivation and inadequate storage of crops,<sup>35,36</sup> is another contributing factor to the liver cancer burden in many Sub-Saharan African countries.<sup>37</sup>

### Non-Hodgkin lymphoma

An estimated 37,200 new cases and 30,900 deaths from non-Hodgkin lymphoma (NHL) occurred in 2008. Regional variations in incidence and mortality rates for NHL were not as remarkable as for the other cancer sites shown in Tables 1 and 2, although the incidence rates in men are substantially higher in North Africa. NHL encompasses a variety of histologically distinct forms.<sup>38</sup> In some parts of Sub-Saharan Africa, Burkitt lymphoma (BL) in children and B-cell lymphoma in adults account for about 70% and 55% of the total cases, respectively.<sup>30,39</sup> About 1/4 of NHL cases in the Sub-Saharan region are thought to be associated with AIDS,<sup>30</sup> and the

incidence of this disease in some countries has more than doubled since the AIDS epidemic began.<sup>40-43</sup> In the zone of high incidence of childhood BL in central Africa, almost all cases are associated with Epstein-Barr virus (EBV), as demonstrated by the presence of either EBV nuclear antigen or EBV DNA in the tumor cells.<sup>44</sup> However, because EBV infection is ubiquitous, other cofactors must be involved. Intense (holoendemic) malaria infection has long been suspected on the basis of the similar geographic distribution of BL and malaria; BL cases do seem to have evidence of more frequent or intense infection with malaria than control children,<sup>45</sup> and there is limited evidence that the incidence of BL decreased in parts of Africa after the implementation of malaria control programs.<sup>46</sup>

### Nasopharyngeal cancer

An estimated 8700 incident cancer cases and 5500 cancer deaths occurred in 2008. The incidence rates are twice as high in men as in women. The highest incidence rates are in the Republic of South Africa, and in the countries of the Maghreb (Morocco, Algeria, and Tunisia).



The moderately elevated risk in North Africa has been the focus of a search for environmental risk factors, with the locally popular spice harissa being identified in some studies,<sup>47,48</sup> although it is notable that North African migrant populations retain a high risk after migration to low incidence countries.<sup>49</sup>

### Esophageal cancer

About 27,900 new cancer cases and 26,600 deaths from esophageal cancer (predominantly squamous cell carcinoma) were estimated to have occurred in Africa in 2008. Esophageal cancer is a leading cause of cancer death among both men and women in East Africa and among men in South Africa. Incidence and mortality rates for esophageal cancer in these 2 regions are  $>7\times$  as high as the rates in Western, Middle, or Northern Africa among men and  $>4\times$  as high among women (Tables 1 and 2). Exceptionally high incidence rates have been recorded in the East Cape Province (former Transkei) area of South Africa.<sup>50</sup> Reasons for the high burden of esophageal cancers in several parts of Eastern Africa and Southern Africa are not fully understood, but suspected risk factors include alcohol intake, poor dietary patterns such as consumption of a maize-based diet that is low in fruits and vegetables,<sup>51-53</sup> and contamination of maize with fungi that produce fumonisins, a cancer-initiating agent in experimental animals.<sup>54,55</sup>

### Lung cancer

Lung cancer is the leading cause of cancer death among men in Southern Africa and Northern Africa and the fourth leading cause of death among women in Southern Africa (Tables 1 and 2). The incidence and mortality rates in Southern Africa in both men and women are twice as high as the second highest rates in Northern Africa because of the more advanced stage of the tobacco epidemic in Southern Africa.<sup>3,56</sup> Smoking accounts for 65% of lung cancer cases in South Africa,<sup>57</sup> not dissimilar from the features of the tobacco epidemic in the Western countries.

### Bladder cancer

Bladder cancer incidence and mortality rates among men in Northern Africa are twice as high as those in Southern Africa, which has the second highest regional rates (Tables 1 and 2). Egyptian men have the highest bladder cancer incidence rates worldwide.<sup>58</sup> A large proportion of bladder cancer cases in Africa are squamous cell carcinomas, and between 30% and 60% of all bladder cancer cases in this region are caused by chronic infection

with the parasite *Schistosoma hematobium*.<sup>30,59,60</sup> Infection is acquired when people come in contact with the free swimming larvae (early developmental stage) in fresh water containing the intermediate host, a snail of the *Bulinus* genus. In schistosome-free regions such as Europe and North America,  $>90\%$  of bladder cancer cases are transitional cell carcinomas, and they are caused mainly by smoking and occupational exposures to certain industrial chemicals.<sup>61</sup>

### Prostate cancer

Prostate cancer is the most commonly diagnosed cancer among men in Southern Africa and Western Africa, including South Africa, Nigeria, and Cameroon. However, the incidence rate in Southern Africa is twice as high as the second highest regional rate in Western Africa and nearly  $7\times$  higher than the lowest regional rate in Northern Africa. The high incidence rate in Southern Africa may reflect increased diagnosis, rather than disease occurrence. However, high prostate cancer rates have been reported among Western and Southern African descendents in Jamaica and Trinidad and Tobago,<sup>12,62</sup> where prostate-specific antigen testing is not commonly conducted, suggesting a role for genetic susceptibility.<sup>63,64</sup>

### Opportunities for Cancer Prevention and Control

Opportunities for reducing suffering and death from cancer in Africa exist across all stages of the cancer control spectrum, from prevention to early detection, treatment, and palliative care.<sup>8,65-67</sup>

#### Prevention

Prevention of exposure to cancer-causing agents or risk factors, including infections, tobacco use, and obesity, is by far the most feasible and cost-effective approach to cancer control in Africa.

#### Tobacco use

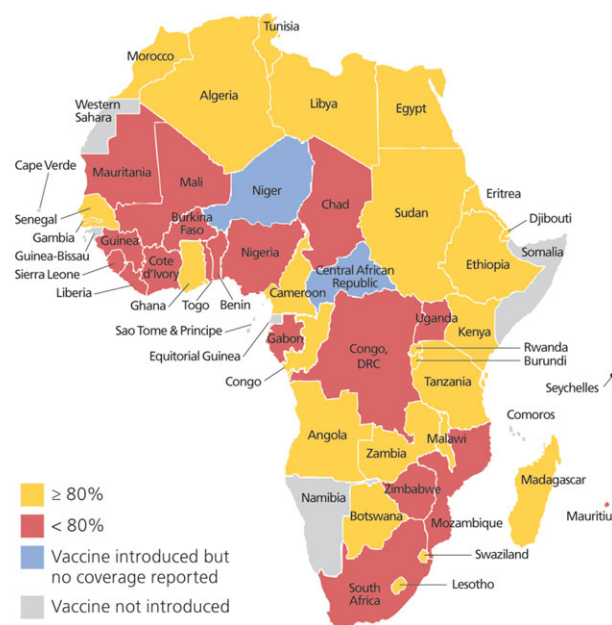
Tobacco use is the most preventable cause of cancer death, accounting for 20% of cancer deaths worldwide and for about 6% of cancer deaths in Africa.<sup>68</sup> The smaller contribution of tobacco use to cancer deaths in Africa reflects the early stage of the tobacco epidemic and low smoking prevalence, especially among women, and the low life expectancy of the population, which does not allow time for the carcinogenic effect of smoking to become manifest. Adult smoking prevalence tends to be  $<10\%$  in men and close to 2% in women in many African countries, including Nigeria and Ethiopia, the 2 most

populous nations on the continent. However, cigarette consumption is increasing in parts of this region because of the adoption of Western behaviors associated with economic growth and increased marketing by tobacco companies.<sup>69</sup>

The World Health Organization (WHO) established the Framework Convention on Tobacco Control, which features internationally coordinated provisions to control the tobacco epidemic that include raising the price of tobacco products, banning smoking in public places, restricting tobacco advertising and promotion, counteradvertising, and providing treatment and counseling for tobacco dependence.<sup>70</sup> However, few African countries have implemented tobacco control measures or policies according to the framework.<sup>3</sup> The worldwide tobacco epidemic resulted in approximately 100 million premature deaths worldwide in the 20th century.<sup>3</sup> African countries have a unique opportunity to avoid such tragedy by curbing the tobacco epidemic at this early stage through the implementation and enforcement of comprehensive tobacco control strategies proven in the developed countries to be effective, such as increased excise tax, restriction of smoking in work places, banning the advertisement of tobacco products, and counteradvertising. Although the relative importance and cost-effectiveness of these measures in reducing smoking prevalence are not known in African countries, increased excise tax in the early 1990s in South Africa is thought to be the major contributing factor to the substantial reduction in smoking prevalence through the early years of this century.<sup>71</sup>

### Obesity

Unhealthy diets, physical inactivity, and obesity have been associated with increased risk of several cancers, including endometrial, colon, postmenopausal breast, renal cell, esophageal (adenocarcinoma), and pancreatic cancers.<sup>72,73</sup> The prevalence of obesity and physical inactivity are increasing in several African countries, and especially in urban areas, as a result of increased consumption of calorie-dense food and declines in energy expenditures at work and in daily life.<sup>74-78</sup> For example, according to a 2003 survey in 4 urban districts of Cameroon, >25% of men and almost 50% of women were overweight or obese, and 6.5% of men and 19.5% of women were obese.<sup>74</sup> Obesity in Africa coexists with serious hunger and food shortages. The WHO developed a global strategy to improve dietary patterns and physical activity through the development of national, regional, and/or community level policies and programs that are comprehensive and sustainable.<sup>79</sup>



**Figure 4.** Proportion of infants covered by national infant hepatitis B immunization programs in Africa is shown for 2008. Source: World Health Organization/United Nations Children's Fund coverage estimates for 1980-2008, July 2009.

### Infection

Infectious agents are the causes of some of the most commonly diagnosed cancers in Africa, including cervix, liver, and bladder cancers and KS. A substantial proportion of these cancers is potentially preventable by vaccination, improved hygiene, sanitation, and/or treatment. A vaccine against HBV, which causes the majority of liver cancer in Sub-Saharan Africa, has been available since the early 1980s and recommended as part of routine national infant immunization programs since 1992.<sup>80</sup> As of 2008, 48 of the 53 African countries included the vaccine as part of their national infant immunization schedules (Fig. 4). However, the vaccination coverage was less than optimal (<80%) in several countries in Sub-Saharan Africa, where HBV infection is more prevalent.

The human papillomavirus (HPV) is another cancer-causing infectious agent amenable to prevention by vaccination. The vaccines are administered to adolescent girls and offer protection against major subtypes of HPV infections (HPV 16 and 18) that cause 70% of cervical cancer in Africa.<sup>81</sup> Undoubtedly, these vaccines provide the best opportunity in the future for substantially reducing the future burden of cervical cancer in Sub-Saharan Africa, where it is a leading cause of cancer death among women. However, access to adolescent girls, to administer the recommended 3 doses of vaccines, especially in rural

parts of Africa, could be a major impediment in the wide application of the vaccines in the region.<sup>81-83</sup> However, a recent nonrandomized study in Costa Rica showed that 1 or 2 doses of the vaccine could be as effective as 3 doses of the vaccine in preventing persistent infections from HPV 16 or 18 for 4 years after vaccination of noninfected women.<sup>84</sup> This finding, if confirmed in different parts of Sub-Saharan Africa, will have far-reaching implications in dissemination of the vaccine in the region.

HIV has long been known to increase the risk of a variety of cancers, and the diagnosis of some (eg, KS, NHL, and cancer of the cervix) is taken to define the onset of AIDS in HIV-positive individuals.<sup>85</sup> Research on HIV and cancer in Africa has mainly been in terms of comparing the prevalence of HIV infection in patients with different forms of cancer (and sometimes in otherwise healthy controls); there have been few prospective studies of the incidence of different cancers in HIV-positive subjects.<sup>86</sup> As described earlier, the risk of KS and NHL is increased in the presence of HIV infection, although by no means as much as in European and American HIV-positive individuals. Squamous cell cancers of the conjunctiva were noted as being common in HIV-infected individuals in Africa, and the link has subsequently been confirmed in subjects elsewhere.<sup>87</sup>

Transmission of some cancer-causing infectious agents can be prevented by improving hygiene in the health care delivery system and by educating people to modify their high-risk behaviors. Infections that cause liver cancer can be prevented by screening blood products, sterilizing injection needles and equipment, and/or stopping injection drug use. HIV infection can be reduced by practicing safe sex (condom use, commitment to 1 partner), abstinence, and circumcision.<sup>88</sup> More widespread provision of highly active antiretroviral therapy to HIV-infected persons would reduce the occurrence of AIDS-related cancers.<sup>89</sup> *Schistosoma hematobium*, which causes a substantial proportion of bladder cancer in Africa, can be prevented by avoiding swimming, bathing, or wading in fresh water areas known to contain the free swimming stage of the parasite (larvae). People who are already infected with the parasite can be successfully treated with the drug praziquantel. The use of this drug coupled with lower infection rates (probably because of urbanization) are thought to have contributed to the substantial decrease in incidence of *Schistosoma*-associated bladder cancer in Egypt over the past few decades.<sup>90,91</sup>

### Early detection

Although there are almost no published data on stage at diagnosis from population-based registries in

Africa, clinical series attest to the finding that the great majority of cancer patients come to medical attention late in the course of disease. For example, at the Ocean Road Cancer Institute (Tanzania), 91% of breast cancer patients were diagnosed in stage III or IV,<sup>92</sup> and in the major hospitals of Harare (Zimbabwe), 80% of cervical cancer cases presented with advanced disease (International Federation of Gynecology and Obstetrics stage 2B or worse).<sup>93</sup> Earlier diagnosis is essential to providing effective cancer control. Achieving this using standard screening methods such as mammography for breast cancer, fecal occult blood testing and sigmoidoscopy/colonoscopy for colorectal cancer, and Pap test for cervical cancer are not only cost-prohibitive in most parts of Africa, but they are also not supportable by the existing health care infrastructure.<sup>94</sup> However, although Pap smear-based screening programs for prevention of cervical cancer have been unsuccessful in Africa, other approaches based on visual inspection using Lugol's iodine or acetic acid, and low-cost DNA tests to detect HPV infections, have been shown to be feasible and effective in many parts of Africa, including Kenya and South Africa.<sup>81,95-97</sup> Studies based on simulation modeling have reported that screening once or twice in a lifetime between the ages of 35 and 55 years using these low-cost/low-tech screening methods can reduce cervical cancer by about 30%.<sup>96,98</sup> Cost considerations have meant that to date visual inspection has been the only feasible approach to screening in Sub-Saharan Africa, although 1 large randomized trial in India showed that this method was inferior to HPV testing in reducing late stage disease and death from cancer of the cervix.<sup>99</sup> A recent model-based analysis in a high-risk area of China demonstrated that a rapid HPV-DNA test, which allows a single-visit screening to be followed by same-day treatment of precancerous lesions with cryotherapy, is cost-effective for cervical cancer prevention.<sup>100</sup> Cost-effectiveness analysis for low-cost and low-tech screening techniques (visual inspection using Lugol iodine vs rapid HPV-DNA test) are lacking in Africa. There is an urgent need to determine the most cost-effective approach to screening, because this remains the only viable option for reducing the high cervical cancer burden in Sub-Saharan Africa in the next 20 to 30 years, as the current HPV vaccines are being given to adolescent girls only.<sup>81</sup>

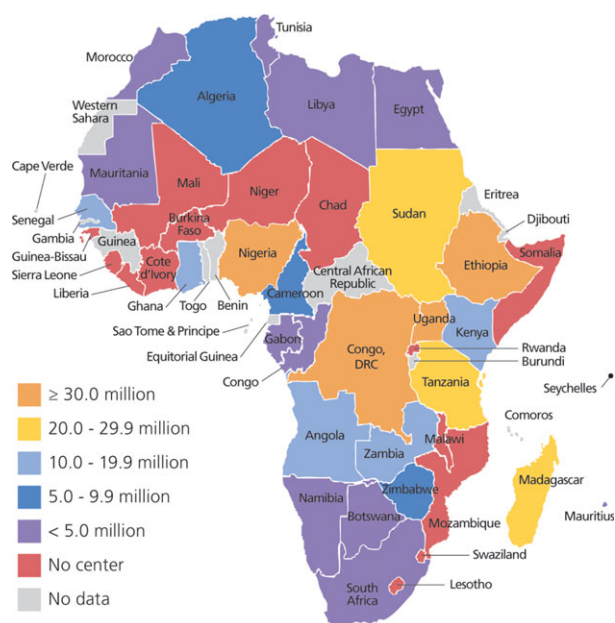
Increasing public awareness of early signs and symptoms of cancers of the breast, cervix, oral cavity, urinary bladder, colorectum, and prostate should increase the detection of these diseases at earlier stages when there are more effective options for treatment leading to better prognosis.<sup>101</sup> Every effort must be made to expand the



capacity of health care delivery systems to provide timely and effective treatment to patients diagnosed with early stage disease for increased awareness initiatives to result in improved patient outcomes.

### Curative treatment

Surgery and/or radiation are the most important methods of treating early stage (local) cancers, including cancers of the breast, colorectum, cervix, head and neck,



**Figure 5.** The numbers of people served by a single radiotherapy center in Africa countries are shown. Sources: International Atomic Energy Agency, Directory of Radiotherapy Centers, <http://www.naweb.iaea.org/nahu/dirac/>; Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, World Population Prospects, 2008 revision, <http://esa.un.org/unpp>

esophagus, stomach, and prostate.<sup>102</sup> However, the availability of such treatments in Africa is limited because of lack of skilled manpower, surgical equipment, and radiation facilities. On the basis of data from the International Atomic Energy Agency (IAEA) that have been updated through 2010, only 24 of 53 countries in Africa have reported the availability of radiation treatment centers (Fig. 5). It is evident that, even where such facilities exist, the number of centers is inadequate in relation to the size of the catchment population. For example, >80 million people in Ethiopia are served by a single radiotherapy center in the capital city, Addis Ababa. The actual supply of radiation treatment in Africa in 2002 was only 18% of the total needed.<sup>103</sup> The IAEA, through its Program of Action for Cancer Therapy, has been working with the WHO and other interested international and national organizations to establish safe and effective radiotherapy facilities to deliver high-quality treatment to cancer patients in Africa and in other developing areas.<sup>104</sup>

Because of late presentation and inadequate or unavailable treatment facilities, the prognosis for cancers that in high income countries are largely curable is rather poor in Africa.<sup>105</sup> Table 3 compares the 5-year survival of patients with cancer from 2 African cities (Harare and Kampala) with that among US patients diagnosed during the same years.<sup>106,107</sup>

### Palliative care

Lack of access to basic pain relief continues to make living and dying with cancer in Africa a very different experience from that in developed countries. About 80% of cancer patients in Africa are thought to be diagnosed at advanced stages of disease, when pain relief is often the only choice of treatment. In Sub-Saharan Africa, in

**Table 3.** Five-Year Relative Survival of Cancer Patients Diagnosed in 1993-1997 in Harare (Zimbabwe), Kampala (Uganda), and the US Surveillance, Epidemiology, and End Results Program

Site	Harare (Zimbabwe)		Kampala (Uganda)	USA (SEER)	
	Black	White		Black <sup>a</sup>	White <sup>b</sup>
Esophagus	7.6	—	4.5	7.9	—
Stomach	13.2	—	0	19.5	—
Colorectal	17.4	19.4	8.3	51.9	61.2
Lung	5.7	10.2	0	12.8	14.3
Breast	37.9	74.4	45.4	70.1	87.3
Cervix	30.5	—	18.2	58.1	—
Ovary	38	—	16.2	62.7	—
Lymphomas	23.1	—	35.4	53.2	—

Sources: Sankaranarayanan 2010,<sup>105</sup> Gondos 2005.<sup>106</sup>

<sup>a</sup> Adjusted to the age distribution of black Zimbabwean patients.

<sup>b</sup> Adjusted to the age distribution of white Zimbabwean patients.

particular, weak health systems, legal and regulatory restrictions, inadequate training of health care providers, concern about diversion, addiction, and abuse, and cultural misperceptions about pain create a web of barriers that keep safe, effective, and inexpensive opioid analgesics out of the reach of more than a million people with treatable pain.

In 2008, there were approximately 421,000 deaths because of cancer<sup>9</sup> and 1.4 million deaths because of HIV<sup>24</sup> in Sub-Saharan Africa. It has been estimated that 50% of HIV deaths and 80% of cancer deaths require pain treatment lasting an average of 3 months; the amount of morphine needed for these deaths alone is approximately 6413 kg.<sup>108</sup> However, in 2008, the actual procurement of morphine and equivalent opioids (pethidine, oxycodone, and hydromorphone) reported by Sub-Saharan African governments to the International Narcotics Control Board was just 639 kg,<sup>109</sup> about 10% of the quantity needed just for the terminal months of cancer and HIV patients, and not considering the need for pain treatment among those living with cancer, HIV, traumatic injury, or chronic pain. These data clearly indicate that for the vast majority of those in severe pain in Sub-Saharan Africa, treatment is simply not available.

Although it is the responsibility of each African government to take the lead in making pain relief accessible to its citizens who need it, the activities of palliative care organizations and other civil society groups are critical to supporting government efforts. In several countries, these groups have been instrumental in getting pain relief on the agenda of governments, articulating technical solutions, and leading efforts to work across disease areas, particularly cancer and HIV, to address this issue jointly. International and national nongovernmental health organizations have generally been slow to integrate pain relief into their programs, often believing it is outside of their disease-specific treatment or prevention mandate. A reclassification of pain treatment from a separate entity to a part of comprehensive treatment of cancer and HIV—and a full recognition of pain-relieving medications as a cornerstone of the global essential medicines agenda—would assist governments with a more rational programming of attention and resources to address untreated pain.

### ***Establishing and Maintaining Cancer Control Programs in Africa***

The WHO has developed guidelines for evidence-based regional and national cancer control programs according to national economic development.<sup>110,111</sup> The WHO recommends cancer control programs in Africa begin in a

stepwise approach by implementing 1 or 2 key priorities in a demonstration project. Such projects could be sustainable only when African countries take the initiative and make the political commitment to invest in the programs with a dedicated budget and required staff, although international public health agencies and donors can and should play major roles in strengthening and broadening such government-based initiatives.

When possible, cancer control programs should be integrated with other established disease control programs, because some diseases share the same risk factors or routes of transmission. For example, unsafe sexual practice is a risk factor for both HIV and HPV infections. Therefore, some aspects of cervical cancer prevention programs in Sub-Saharan African countries could be integrated with ongoing HIV prevention programs.<sup>89</sup> The successful integration of HBV vaccination into infant immunization programs in Africa and other parts of the world should serve as a model for integration of preventive measures for many diseases.

The inclusion of a pledge to halt and reverse the spread of HIV-1, malaria, and other diseases by 2015 as 1 of the Millennium Development Goals set out by the UN General Assembly in 2000 has led to impressive levels of funding through the Global Fund for AIDS, Tuberculosis, and Malaria and the US President's Emergency Plan for AIDS Relief. In addition to the benefit that has accrued in reducing the incidence of some HIV-related cancers (as already described), and possibly impacting on the incidence of BL in areas where malaria is endemic, HIV-related programs have created treatment and prevention platforms that can be leveraged for other purposes—for example, screening or vaccination for cancer of the cervix.<sup>112,113</sup>

The availability of a high-quality population-based cancer registration system is an important component of any evidence-based cancer control program, because cancer registration is essential for assessing the burden of cancer, setting priorities, and planning and evaluating cancer control programs.<sup>114,115</sup> However, only 11% of the African population is covered by population-based cancer registries, and about 1% of the population by registries that meet the IARC's criteria for high-quality incidence (related to indicators of comparability, accuracy, and completeness) in volume IX of *Cancer Incidence in Five Continents*.<sup>10,116</sup> Therefore, there is a greater need for establishing or strengthening population-based cancer registration in Africa to implement effective and evidence-based national and regional cancer control programs.

In addition to guiding and evaluating cancer control programs, cancer registries are also useful for studying the

causes (risk factors) of cancer.<sup>117</sup> There are opportunities to identify novel risk factors for cancer in Africa that could advance cancer prevention measures worldwide in view of the diverse African population with respect to culture, dietary patterns, and other environmental factors and the very limited prior efforts to study the causes of cancer in this population.

### Limitation and Summary

The interpretation of the incidence and mortality data from GLOBOCAN presented in this paper is limited by the precision of the estimates. Of the 53 countries that constitute Africa, incidence estimates were based on either national or regional population-based cancer registries in 23 countries (Fig. 1). For the remaining 30 nations, incidence was estimated from local frequency data (8 countries) or, where no reliable sources were found (22 countries), from corresponding estimates from neighboring countries within the region. In compiling the country-specific mortality estimates, there are very few national vital registration systems with adequate data in Africa, and none was considered to be of sufficient quality to be used directly in compiling the GLOBOCAN estimates for 2008. Despite this limitation, GLOBOCAN remains the only comprehensive data source for assessing regional cancer burden and for promoting cancer prevention and control worldwide.

In summary, cancer is an emerging public health problem in Africa because of the aging and growth of the population and increased prevalence of economic transition-associated risk factors for cancers such as smoking, obesity, physical inactivity, poor diet, and reproductive factors. There are opportunities for substantially reducing the growing burden through the application of resource level interventions, including vaccination for liver and cervical cancers, tobacco control policies, low-tech early detection methods for cervical cancers, and palliative care. Achieving this requires collaborative efforts among private and government public health agencies, the health industries, and donors.

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