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# Liver Cancer Induced by Viruses in Africa: Epidemiology and Carcinogenesis Mechanisms

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## ABSTRACT

*The proportion of cancers of viral origin can reach 75% of cancers in some countries. The purpose of this work was to take stock of the current epidemiology, carcinogenesis of oncogenic viruses and liver cancer caused by viruses in Africa. Liver cancer is expected to be the sixth most commonly diagnosed cancer and the fourth leading cause of cancer deaths in the world in 2018, with approximately 841,000 new cases and 782,000 deaths annually. Incidence and mortality rates are two to three times higher for men in most parts of the world; for example, liver cancer ranks fifth in terms of new cases and second in terms of deaths among men. The age-standardized incidence rate is higher for men than for women in North Africa, West Africa, Central Africa, South Africa and East Africa. The cumulative incidence and cumulative mortality are higher in North Africa and also higher for men than for women. There are disparities in the incidence of virus-induced liver cancer in different parts of Africa.*

*The resurgence of infectious diseases on the African continent plays a major role in increasing the frequency of cancers. While in developed countries the causes of cancer occurrence are mainly related to non-infectious factors, infectious cancers are becoming a dramatic feature in Africa. The hepatitis B virus is the main cause of liver cancer due to a virus in Africa (southern sub-Saharan Africa, western sub-Saharan Africa); on the other hand, the hepatitis C virus is the leading cause of liver cancer due to a virus in North Africa and the Middle East. On the continent, health problems predominate, owing to the weakness of health policy, particularly in preventive medicine, but also limited technical facilities, lack of personnel and insufficient political commitment. Knowledge of the epidemiology and mechanism of carcinogenesis allows prevention whose understanding is essential to reverse current trends and eventually establish a control of liver cancer induced by viruses.*

## Keywords

Virus-induced liver cancer, Infectious diseases, Tumor virus, Africa.

## Introduction

Despite considerable advances in diagnosis, treatment and prevention, cancer remains a major worldwide burden as it is the first cause of death in developed countries and the second in developing countries [1]. Liver cancer is predicted to be the sixth most commonly diagnosed cancer and the fourth leading cause of cancer death worldwide in 2018, with about 841,000 new cases and 782,000 deaths annually [2]. Rates of both incidence and mortality are 2 to 3 times higher among men in most world regions; thus liver cancer ranks fifth in terms of global cases and second in terms of deaths for males.

Incidence rates are 2-fold greater among men in transitioned countries, but the highest rates are observed mainly in lower HDI settings, with liver cancer the most common cancer in 13 geographically diverse countries that include several in Northern

and Western Africa (Egypt, the Gambia, Guinea) and Eastern and South-Eastern Asia (Mongolia, Cambodia, and Vietnam [1]). Primary liver cancer includes hepatocellular carcinoma (HCC) (comprising 75%-85% of cases) and intrahepatic cholangiocarcinoma (comprising 10%-15% of cases) as well as other rare types. The main risk factors for HCC are chronic infection with hepatitis B virus (HBV) or hepatitis C virus (HCV), aflatoxin-contaminated foodstuffs, heavy alcohol intake, obesity, smoking, and type 2 diabetes [3].

The major risk factors vary from region to region. In most highrisk HCC areas (China, Eastern Africa), the key determinants are chronic HBV infection and aflatoxin exposure, whereas in other countries (Japan, Egypt), HCV infection is likely the predominant cause. In Mongolia, HBV and HCV virus and coinfections of HBV carriers with HCV or hepatitis δ virus, as well as alcohol abuse, all contribute to the high burden [4]. The rising obesity prevalence is considered a contributory factor to the observed increasing incidence of HCC in low-risk HCC areas [5]. Globally, both infections (HBV and HCV) are reported to contribute to greater than ca. 80% of HCC cases [6-8]. In developing countries they account for >90% of all HCC cases, whereas in developed countries - for 40% [9]. Comparing HCC incidence rates due to viral infections versus other etiologies revealed that an increase of HBV or HCV prevalence by 1% elevates by 14% and 10%, respectively, the incidence of liver cancer [9].

Both HBV and HCV establish chronic infection of the liver characterized by persistent inflammation that stimulates regenerative liver fibrosis and ultimately cirrhosis. At advanced stages of fibrosis, the risk of HCC incidence increases considerably. HCV RNA-positive patients have a higher risk of HCC and death from HCC than HCV RNA-negative patients [10-12]. Similarly, elevated HBV DNA levels, alanine aminotransferase (ALT) levels, and hepatitis B virus envelope antigen (HBeAg) status are among the most important determinants. Viral involvement in cancer occurrence in Africa may represent an opportunity, as it reflects a hope to significantly reduce cancer incidence and mortality through prevention and/or treatment of viral infections. Our purpose was therefore to review recent advances in epidemiological and control aspects of virus induced liver cancer, as well as the molecular biology of hepatotropic viral carcinogenesis in the context of the African continent.

## Methodology

A thorough literature search was undertaken to dig-up and review recent articles from the PubMed database (National Library of Medicine - National Institutes of Health) using the following key words: "transforming virus", "persistent infection", "liver cancer in Africa" "viruses and cancer", "cancer epidemiology", "molecular basis of cancer", liver cancer and virus. Using access codes, articles in both French and English in relation to our thematic were selected from Science Direct and Springer Link. Data presented at international conferences and published in abstract form were also of interest. Finally, articles published in "Médecine tropicale" and "Médecine d'Afrique Noire" were also analyzed and integrated in our database. Useful information from all items was summarized.

## Burden of liver cancer in Africa: Epidemiological background

There will be an estimated 18.1 million new cancer cases (17.0 million excluding nonmelanoma skin cancer) and 9.6 million cancer deaths (9.5 million excluding nonmelanoma skin cancer) in 2018. In both sexes combined, lung cancer is the most commonly diagnosed cancer (11.6% of the total cases) and the leading cause of cancer death (18.4% of the total cancer deaths), closely followed by female breast cancer (11.6%), prostate cancer (7.1%), and colorectal cancer (6.1%) for incidence and colorectal cancer (9.2%), stomach cancer (8.2%), and liver cancer (8.2%) for mortality [2].

Sub-Saharan Africa is heavily affected by the continuous expansion of cancer with an annual incidence varying from 100 to 120 per 100,000 people. Mortality rates from cancer reach 75% depending on cancer type and country of concern [13,14]. In 2018, incidence rate of cancer and mortality rate due to cancer in Africa stood respectively at 5.8% and 7.3% [2].

Incidence rate and mortality by cancer according to sexes in Africa are represented in (Table 1). WHO's projections (Figure 1) expect that by 2030 between 700,000 and 1.6 million new cases of cancer will be recorded and 500,000 to 1.2 million deaths (20% of the impact on the continent) [15] Prostate, liver cancers, and Kaposi's sarcoma are the most common diagnosed in men while women suffer more often from breast cancer, uterine cervical cancer and liver cancer [13,15]. National cancer registries of most African countries cover only 8.3% of cases, which certainly underestimates actual figures [14].

| Cancer site | Number of case (incidence) | Number of deaths (mortality) |
|---|---|---|
| Liver cancer | 804.080 (4.7%) | 781.631 (8.2%) |

**Table 1:** Age standardized rate per 100000 of mortality and incidence worldwild. Source: Globocan 2018.

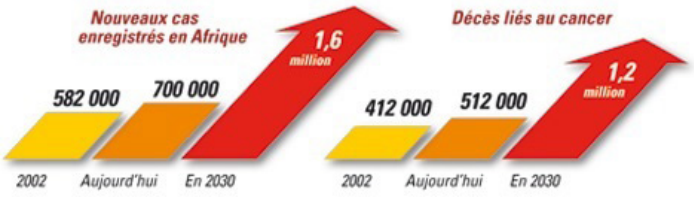


**Figure 1:** Estimated incidence and mortality of cancer in Africa [GLOBOCAN 2008] [9].

Liver cancer is predicted to be the sixth most commonly diagnosed cancer and the fourth leading cause of cancer death worldwide in 2018, with about 841,000 new cases and 782,000 deaths annually (Table 1). Rates of both incidence and mortality are 2 to 3 times higher among men in most world regions; thus liver cancer ranks fifth in terms of global cases and second in terms of deaths for males. Incidence rates are 2-fold greater among men (Table 2). The higher incidence was in Northern Arica and Western Africa table 2. The cumulative incidence and cumulative mortality are higher in North Africa and also higher for men than for women Tables

(3-5) [2]. The cumulative incidence and cumulative mortality are higher in North Africa and also higher for men than for women. There are disparities in the incidence of virus-induced liver cancer in different regions of Africa [16].

| Sexes | Indence (%) | Mortality (%) |
|---|---|---|
| Males | 6.3 | 10.2 |
| Females | 2.8 | 5.6 |

**Table 2:** liver cancer Incidence and Mortality rate worldwild according to sexes. Source: Globocan 2018.

| | Standardized incidence rate (0/00) | |
|---|---|---|
| Region | Males | Females |
| Northern Africa | 20.8 | 7.8 |
| Western Africa | 11.1 | 5.7 |
| Middle Africa | 9.4 | 3.9 |
| South Africa | 7.4 | 3.2 |
| Eastern Africa | 5.8 | 3.5 |

**Table 3:** Region-Specific Incidence Age-Standardized Rates by Sex for Cancers of the Liver in 2018. Rates are shown in descending order of world (W) age-standardized rates among men, and the highest national rates among men and women. source: Globocan 2018.

| Incidence | | | | | | |
|---|---|---|---|---|---|---|
| | Both sexes | | Males | | Females | |
| | New cases | Cum risk (0-74%) | New cases | Cum risk (0-74%) | New cases | Cum risk (0-74%) |
| Eastern Africa | 11500 | 0.52 | 7011 | 0.66 | 4539 | 0.40 |
| Midlle Africa | 6010 | 0.69 | 4137 | 0.98 | 1873 | 0.43 |
| Northern Africa | 27935 | 1.71 | 19912 | 2.50 | 8023 | 0.96 |
| Southern Africa | 2710 | 0.53 | 1692 | 0.79 | 1018 | 0.33 |
| Western Africa | 16574 | 0.91 | 10778 | 1.21 | 5796 | 0.54 |

**Table 4:** Incidence and cumulate risk according to sexes. Source: Globocan 2018.


| Incidence | | | | | | |
|---|---|---|---|---|---|---|
| | Both sexes | | Males | | Females | |
| | New cases | Cum risk (0-74%) | New cases | Cum risk (0-74%) | New cases | Cum risk (0-74%) |
| Eastern Africa | 11500 | 0.52 | 7011 | 0.66 | 4539 | 0.40 |
| Midlle Africa | 6010 | 0.69 | 4137 | 0.98 | 1873 | 0.43 |
| Northern Africa | 27935 | 1.71 | 19912 | 2.50 | 8023 | 0.96 |
| Southern Africa | 2710 | 0.53 | 1692 | 0.79 | 1018 | 0.33 |
| Western Africa | 16574 | 0.91 | 10778 | 1.21 | 5796 | 0.54 |

**Table 4:** Incidence and cumulate risk according to sexes. Source: Globocan 2018.


| Mortality | | | | | | |
|---|---|---|---|---|---|---|
| | Both Sexes | | Males | | Females | |
| | Deaths | Cum risk (0-74%) | Deaths | Cum risk (0-74%) | Deaths | Cum risk (0-74%) |
| Eastern Africa | 11251 | 0.52 | 6799 | 0.67 | 4452 | 0.40 |
| Midlle Africa | 5853 | 0.69 | 4056 | 0.99 | 1797 | 0.42 |
| Northern Africa | 27505 | 1.69 | 19570 | 2.47 | 7935 | 0.95 |
| Southern Africa | 2597 | 0.51 | 1614 | 0.75 | 983 | 0.32 |
| Western Africa | 16356 | 0.90 | 10747 | 1.20 | 5609 | 0.62 |

**Table 5:** Mortality and cumulate risk according to sexes. Source: Globocan 2018.

The hepatitis B virus is the most represented cause of liver cancer due to a virus in Africa (southern sub-Saharan Africa, western sub-Saharan Africa); on the other hand, the hepatitis C virus is the leading cause of liver cancer due to a virus in North Africa and the Middle East tables (6-8) [16]. The alleged causes of the severity of this situation in Africa are multiple and can be summarized as follows: late access to care and drugs; poverty and weakness of infrastructure technical patient care facilities, especially regarding the use of specific high cost diagnosis and treatment; lack of skills of health workers; and lack of political drive [14,17].

| Cancer | ASIR 2015, Male | 95%UI, ASIR 2015, Male | ASIR 2015, Female | 95%UI, ASIR 2015, Female | Ratio Male/ Female |
|---|---|---|---|---|---|
| Liver cancer | 8.1 | (7.1-9.1) | 4.7 | (3.7-5.4) | 1.7 |
| Liver cancer due to hepatitis B | 2.2 | (1.7-2.6) | 1 | (0.7-1.2) | 2.2 |
| Liver cancer due to hepatitis C | 3.5 | (3.0-4.1) | 2.4 | (1.9- 2.9) | 1.5 |

**Table 6:** North and Middle East Africa Age standardized rate Liver cancer due to viruses. Source: Global Burden of Disease Liver Cancer Collaboration. JAMA Oncology 2017.


| Cancer | ASIR 2015, Male | 95%UI, ASIR 2015, Male | ASIR 2015, Female | 95%UI, ASIR 2015, Female | Ratio Male/ Female |
|---|---|---|---|---|---|
| Liver cancer | 8.1 | (7.1-9.1) | 4.7 | (3.7-5.4) | 1.7 |
| Liver cancer due to hepatitis B | 2.2 | (1.7-2.6) | 1 | (0.7-1.2) | 2.2 |
| Liver cancer due to hepatitis C | 3.5 | (3.0-4.1) | 2.4 | (1.9- 2.9) | 1.5 |

**Table 7:** Southern sub-Saharan Africa Age standardized rate Liver cancer due to viruses. Source: Global Burden of Disease Liver Cancer Collaboration. JAMA Oncology 2017.


Despite the commitment by African countries to allocate 15% of their Gross Domestic Product (GDP) to health improvement in

2001 (Declaration of Abuja, Nigeria), only four out of 53 countries have reached the target set in 2008 (Rwanda 18.9%; Liberia, 16.8%; Tanzania and Zambia 16.2% and 15.2%, respectively) [18]. As a result, the economic consequences of cancer in Africa remains at a high estimate of 849 million USD in 2009 [19].

| Cancer | ASIR 2015, Male | 95%UI, ASIR 2015, Male | ASIR 2015, Female | 95%UI, ASIR 2015, Female | Ratio Male/ Female |
|---|---|---|---|---|---|
| Liver cancer | 23.4 | (16.8-33.9) | 10.9 | (7.0-15.8) | 2.1 |
| Liver cancer due to hepatitis B | 9.2 | (6.5- 13.3) | 3.6 | (2.3 -5.3) | 2.6 |
| Liver cancer due to hepatitis C | 2.6 | (1.8 - 3.7) | 2.1 | (1.4, 3.2) | 1.2 |

**Table 8:** Western Sub-Saharan Africa Age standardized rate Liver cancer due to viruses. Source: Global Burden of Disease Liver Cancer Collaboration. JAMA Oncology 2017.

## Problem of virus-induced human cancers in Africa

It is now recognized that many cancers have an infectious etiology [20]. Between 15 to 20% of human cancers worldwide are virus-induced. Approximately 80% of virus-induced cancer cases are represented by cervical cancer and hepatocellular carcinoma. In 2008, about 23% of cancers of infectious origin were recorded in developing countries compared to only 7.4% in developed countries. The situation was most critical in Sub-Saharan Africa, where infections were responsible of 32.7% of cases versus 3.3% in Oceania, as an example. The high prevalence of hepatitis B and C, HPV and HIV in cancers such as Kaposi's sarcoma does not improve the situation on the continent [17]. Virus-induced cancers represent a true African continent specificity, compared to cancers affecting developed countries that depend mainly on hormonal and genetic factors [21]. This etiological profile may be explained by several reasons other than weakness of health systems and lack of political will of Governors. Several armed conflicts ravage Africa, with immediate consequences such as population displacement, promiscuity epidemics eased by the lack of drinking water and famine, sexual crimes with increased sexually transmitted infections (STIs).

The economic consequences of cancers of infectious origin, especially virus-induced cancers, imposes to take appropriate measures to control viral diseases across the continent. It is our belief that improving public awareness of virus-induced cancer pathology may also represent a major axis of prevention [22]. In terms of human development, the WHO study through the International Agency for Research on Cancer (IARC) stated: "the evolution of the cancer burden in the world is based on human development as it is (?) mainly affecting some countries social and economic transition ... "[23].

## Viral mechanism of carcinogenesis

Oncogenic DNA or RNA viruses can induce the formation of tumors. Transforming viral infections are still persistent, chronic, latent or abortive. The persistent viral genome integrates all or part of the DNA of the infected cell to persist as proviral form or remain in episomal form in the cytoplasm [24]. Although the mechanism of viral oncogenesis depends on the type of virus, certain physiological or metabolic pathways are common to all cancers. The process of initiation and development of virus-induced cancers is due to an accumulation of anomalies leading to immortalization and physiological and morphological alterations that define the state of transformation, i.e., the increased viability in a poorer growth factor environment, the locking mechanisms of apoptosis and senescence, the exhaustion of the immune system, etc. [25]. These modifications involve either the activation of genes that stimulate cell proliferation (viral or cellular oncogenes) or inactivation of genes that inhibit cell growth (tumor suppressor genes), but also those involved in DNA repair [25,26]. In general, oncogenesis induced by RNA viruses is based on insertion of a viral activator near a cellular proto-oncogene (insertional mutagenesis), or integration into the cellular genome of a viral oncogene activated while oncogenesis induced DNA viruses. Such an integration is based either on the inactivation of a cellular anti-oncogene (tumor suppressor gene) as p53 or pRb, or on mutations, or even on the insertion of the virus genome at a critical point in the cellular genome. In some cases, the virus plays a prolonged role in the initiation of tumor in the persistence of the malignant phenotype [26].

## Hepatotropic viruses and liver cancer

Among the families of known human tumor viruses, the following can be distinguished: Retroviridae and Flaviviridae for RNA viruses; Hepadnaviridae, Herpesviridae and Papillomaviridae for DNA tumor viruses (Table 9).

| Virus | Family | Virus | Tumors associated |
|---|---|---|---|
| RNA | Retroviridae | HTLV1 HIV | Adult T leukemia, lymphoma |
| | Flaviviridae | HVC | hepatocellular carcinoma |
| DNA | Papillomaviridae | HPV -HR | Papilloma, anogenital carcinomas, cancers of the skin and upper respiratory tract |
| | Hepadnaviridae | HBV | hepatocellular carcinoma |
| | Herpesviridae | EBV | Burkitt's lymphoma, nasopharyngeal carcinoma, leiomyoma and leiomyosarcoma, lymphoma immuno-blastic, Hodgkin's disease? |
| | | HHV8 (KSHV) | Kaposi's sarcoma, B-cell lymphoma |

**Table 9:** Oncogenic human Viruses and tumors associated.
HTLV1: Human T-lymphotropic virus type I; HIV: Human immunodeficiency virus; HCV: Hepatitis C virus; HBV: Hepatitis B virus; HPV-HR: High-risk human papillomavirus oncogen; EBV: Epstein-Barr virus; KSHV: Herpesvirus associated with Kaposi's sarcoma; HHV8: Human herpesvirus.

## Hepatitis viruses B and hepatocellular carcinoma

Around 5-8% of immunocompetent adults and 30 to 40% of immunosuppressed people develop chronic infection with HBV. Figures can reach 90% of cases when HBV is contracted at birth with a risk of developing HCC equal to 50% in boys and 20%

in girls. A prevalence rate of chronic carriage of HBsAg equals 8% in sub-Saharan Africa, 15% of patients developing HCC [13]. HBV is the leading cause of hepatocellular carcinoma; about 350 million people worldwide are chronic carriers. Of those who are infected around the time of birth, 90% develop chronic as against less than 10% of those infected after the age of five [27]. Chronic infection is usually asymptomatic but cirrhosis and liver cancer may eventually develop [28]. These complications result in the death of 15 to 25% of those with chronic disease [29]. HBV is an enveloped DNA virus with an icosahedral nucleocapsid core structure. The virus is small, diameter 42 nM, and its tropism is confined to hepatocytes. HBV is classified as the prototype member of the Hepadnaviridae. The genome consists of circular, only partially double-stranded DNA. One end of the full-length strand is linked to the viral DNA polymerase. Viral replication includes RNA intermediates. Therefore, viral genomic DNA must be transferred to the cell nucleus, where the partially double-stranded viral DNA is then made fully double-stranded by viral polymerase and transformed into covalently closed circular DNA (cccDNA). This cccDNA serves as a template for transcription and translation of the four viral proteins C (core, HBcAg), X (HBx), P (DNA polymerase), and S (surface antigen, HBsAg). The function of the protein coded for by gene X is not fully understood but is associated with the development of liver cancer. It stimulates genes that promote cell growth and inactivates growth regulating molecules. In chronic HBV infection, the host immune response causes both hepatocellular damage and viral clearance. In particular, the adaptive immune response, such as virus-specific cytotoxic T lymphocytes (CTLs), contributes to most of the liver injury by eliminating infected hepatocytes and stimulating production of inflammatory cytokines [30]. Although liver damage is initiated and promoted by the CTLs, direct interaction of HBV within the hepatocytes is also thought to have a detrimental effect on liver physiology.

HBx-expressing cells exhibit a reduced enzymatic activity of the respiratory complexes I, III, IV, and V, and a decreased expression of several of their subunits [31]. Their dysregulation is thought to cause a loss of mitochondrial membrane potential and an enhanced production of ROS. Although HBx protein localizes to different compartments: cytoplasm, nucleus, and mitochondria (mt) [32–34], the induction of oxidative stress is thought to be mainly due to its mt localization and its effect(s) on this organelle. In mitochondria, HBx was shown to be bound to the outer membrane [34].

### Hepatitis viruses C and hepatocellular carcinoma

Viral hepatitis B virus presents the smallest human DNA genome with a 3,200 base pair double-stranded circular of 50 to 80% of its length. It encodes four genes: the C genes with a pre-core region (capsid or core) consisting of HBc antigen; the S genes, a zone with pre-S1 and pre-S2 (the envelope) consisting of HBsAg gene; P is for polymerase gene X transactivator, involved in virus carcinogenesis [35]. Hepatitis C virus is a wrapped flavivirus with a 30 to 60-nm icosahedral capsid diameter. The genome is a positive single-stranded RNA of 9600 base pairs coding for ten proteins from a single reading frame [35]. Both viruses are involved in the onset of liver cancer, which represents the fifth most diagnosed cancer in men in the world, but the second global cause of death from cancer. In women, it occupies the 7th place and 6th leading cause of death. In 2008, about 748,300 cases were recorded for 695,900 deaths worldwide, half being registered in China. [36] The highest rates are recorded in the less developed countries especially in Western Africa, while the lowest rates are found in Europe.

Of all cancers of the liver, hepatocellular carcinoma (HCC) is the most common histological type covering 70-85% of the total liver cancer. Cholangiocarcinoma, although rare, is frequently observed in Thailand and East Asia [37]. In Africa, it is the second leading cause of cancer in men and the third in women. The high incidence in sub-Saharan Africa is related to chronic infection with HBV and HCV [38]. Around 5-8% of immunocompetent adults and 30 to 40% of immunosuppressed people develop chronic infection with HBV. Figures can reach 90% of cases when HBV is contracted at birth with a risk of developing HCC equal to 50% in boys and 20% in girls. A prevalence rate of chronic carriage of HBsAg equals 8% in sub-Saharan Africa, 15% of patients developing HCC [13].

Carcinogenesis induced by HBV involves several mechanisms: insertional mutagenesis due to the partial integration of the virus into the DNA of liver cells. This leads to the activation of cellular proto-oncogenes C-myc, the action of different regulatory proteins of viral origin (pre-S, HBx) that stimulate many oncogenic promoters, and chronic inflammation causing death by hepatocyte apoptosis and increased cell regeneration promoting mutations. Protein X is known to activate the kinase src and can also interact with p53 [39]. For its part, HCV infection becomes chronic in 70% of patients, of whom 1-5% develop HCC. It represents 33% of cases in developing countries versus 20% in developed countries. HCV replicates in the cytoplasm of hepatocytes and does not integrate into the cellular genome, which explains why its carcinogenetic power remains obscure. HCV intervenes directly in the process of hepatic carcinogenesis transactivation of some cellular oncogenes, deregulation of the control of apoptosis and, indirectly, in inflammation, necrosis and cell regeneration [40].

## Conclusion

Virus-induced liver cancer should be regarded as a public health problem in sub-Saharan Africa. The epidemic situation relative to these diseases reflects the magnitude of the weaknesses of health systems in the African continent. But also, antiviral treatment may be less effective than in other infectious diseases. However, we believe that anticipating viral infections will help controlling the burden of liver cancer in Africa. Prevention of viral infections with vaccine or therapeutic approaches represents one efficient lever on which African health authorities should pay large efforts. Besides the building environment, such a policy requires qualified staff and adequate financial resources allocated to both basic and clinical research, as well as resources for teaching and formation for a more efficient capacity building in Africa itself. But there are again other ways to prevention regarding African public information and

awareness for adapted hygiene measures on goods and certain risk behaviors related to feeding and eating habits and sexual behavior. The framework of cooperation and transfer of knowledge between countries of the South should be amplified in order to launch a dynamic over the continent. This constitutes another major capital lever to specifically control virus-induced liver cancer in Africa.

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