

SNAKE BITES IN NIGERIA

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Abstract

The Nigerian Ministry of Health reports that snake bites kill every year. Research in recent years has provided critical data on the conditions that promote snake-human contact, snake bite patient profile, and the necessity of in-state production of large quantities of affordable antivenin. At this time, development of antivenom facilities in Nigeria is in place due to the EchiTab Study Group of Liverpool, England, and novel research with herbal medicine is being conducted at the University of Nigeria Nssuka. **Paramonte B. Snake Bites in Nigeria. Med J Therapeut Africa. 2007;3:222-6.**

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Introduction

According to data presented to a WHO study group in January 2007 by a project director from the Nigerian Ministry of Health, globally over 1 million humans are bitten annually by venomous snakes, resulting in 20,000 deaths. Nigeria is reported to have one fifth of all West African region cases occurring in the country. Data from Nigerian hospitals have shown that out of every 100,000 admissions, 174 are attributed to snake bite envenomation.(1)

This number does not account for unreported incidences, and those who survive envenomation will often deal with secondary effects such as necrosis or limb amputation.(2)

Agriculture, Snakes, and the Monsoon Season

Beginning in May and ending in October, heavy rainfall marks the beginning of the monsoon season. At this time, the agricultural season begins for 60% of the Nigerian population. Crops are produced by family run farms called small-holdings. Farmers may have no or limited access to advanced tools or machinery, and directly harvest crops in the field. This puts individuals

in close contact with wildlife.(1)

The monsoon season also marks the start of the breeding season for various species of venomous snakes. Heavy rains alter the habitat through saturation, humidity, and increased plant growth. Some snake species will migrate from areas of low altitude, which is heavily saturated, to a preferred higher, drier habitat. It is here where they also come to breed and lay eggs. Many Nigerian farms have high altitude locations, with rocky, mountainous states at particular risk for snake encounters.(3) At this time these snakes are in closest contact with farmers: snake bites peak between May and June.

Echis ocellatus, the West African Carpet Viper

Venomous snake species which inhabit Nigeria include *Bitis gabonica* (gaboon viper), *Bitis arietans* (puff adder), and *Naja nigricollis nigricollis* (black necked spitting cobra). However, *Echis ocellatus*, the West African carpet viper, is the most common. It accounts for 90% of bites and 60% of the fatalities in the country, which add up to 20% of all African cases.(1)

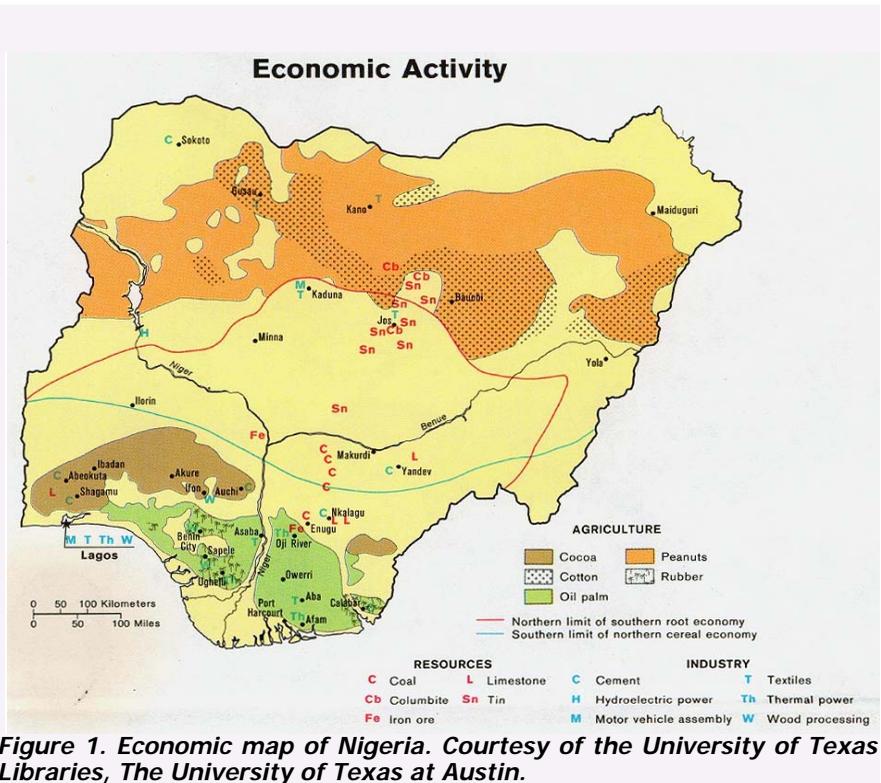


Figure 1. Economic map of Nigeria. Courtesy of the University of Texas Libraries, The University of Texas at Austin.

-HIGH RISK AREAS HAD HIGH NDVI (NORMALIZED DIFFERENCE IN VEGETATION INDEX, A MEASURE OF SEASONAL CHANGES IN VEGETATION OF THE ENVIRONMENT) FROM MARCH TO JULY, OCTOBER AND NOVEMBER

-CORRECT PREDICTION OF HIGH RISK AND LOW RISK AREAS

-IDENTIFIED HIGH PROBABILITY OF SNAKE BITE INCIDENCE IN NORTHERN GHANA AND NORTHWEST NIGERIA

-HIGH PROBABILITY OF SNAKE BITE INCIDENCE OCCURRED FROM MARCH TO JULY

-HIGH PROBABILITY OF SNAKE BITE INCIDENCE OCCURRED AFTER PEAK RAINFALL

-AREAS OF LOW POPULATION DENSITY AND INCREASED TERRAIN ROUGHNESS SAW ELEVATED SNAKE CONTACT.

*NDVI (NORMALIZED DIFFERENCE IN VEGETATION INDEX), MEASURES SEASONAL CHANGES IN VEGETATION OF THE ENVIRONMENT

Table 1. Geographical analysis survey of high risk areas and probability of snake bite incidence. (1)

The natural habitat for the West African carpet viper is forest edges and savannah, up to 1,000 meters above sea level. The breeding season for the carpet viper coincides with the monsoon season, and heavy rainfalls stimulate the snake to search for shelter in higher, drier areas due to habitat preference, breeding, and egg laying.(3)

The carpet viper has been described as naturally aggressive snake, and the stress of searching for habitat and a mate may escalate this animal's predisposed nature. It possesses venom with strong hemotoxic components, and combined with the above factors, makes it the most dangerous snake in Africa.(1)

Hemotoxic Venom

The hemotoxic capabilities in venom in venomous snakes are used by them both to subdue live animals for food and as a defense. The venom's primary effect is as systemic anticoagulant, and also assists in digestion of prey. When a human is envenomated with hemotoxic venom, it acts both locally and systemically.

At the local level, phospholipase A2 and zinc-metalloproteinases cause blistering, swelling, hemorrhaging and tissue damage and can result in necrosis and amputation. Systemically,

anticoagulant enzymes in the venom cause bleeding from various internal organs (typically the chest and the cerebral cavities), and also act as a vasodilator. These drop the blood pressure, putting patients into renal failure or cardiac arrest, the 2 primary causes of death.(2)

Geographical Analysis

In a primary geographical analysis study done in 2003, researchers from the Alistair Reid Venom Unit at the Liverpool School of Tropical Medicine used a Geographic Information System (GIS) to evaluate environmental variables that could indicate high risk areas and probability of incidence for snake bite in West Africa.(3) Data was collected retrospectively from 29 health facilities in Nigeria and Ghana, in areas deemed both high risk and low risk, from 1976 to 2002. All health facilities were in savannah habitat 1,000 above sea level, due to the natural range of *E ocellatus*. Environmental variables analyzed were average rainfall, minimum and maximum temperature, wet day frequency, absolute humidity, and normalized difference in vegetation index (NDVI; seasonal changes of vegetation, or "greenness" in the environment). The only variable which showed statistical significance was NDVI in predicting high incidence of snake bite. High risk areas showed a higher NDVI between March and July, October, and November. A multivariable analysis using average NDVI coupled with the other environmental vari-

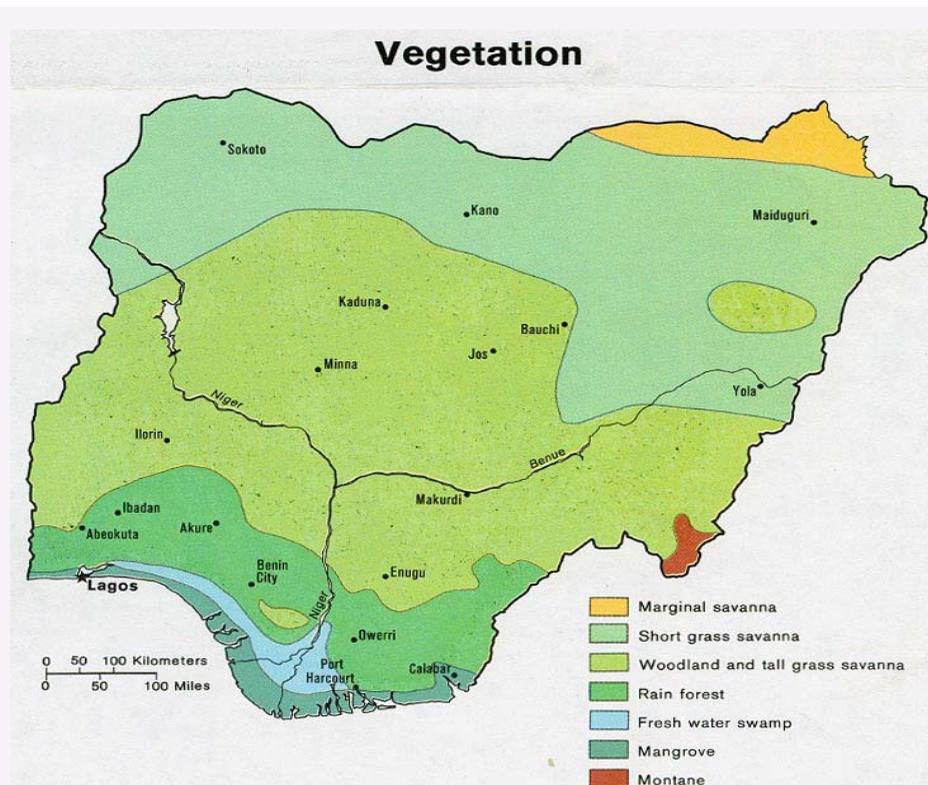


Figure 2. Vegetation map of Nigeria: northwest is prime *Echis ocellatus* habitat. Map reproduced by permission of the University of Texas Libraries, The University of Texas at Austin.

ables correctly predicted 27 of 29 high risk and low risk areas surrounding the respectable high risk and low risk health facilities (all P values less than or equal to 0.05 except rainfall). A geographical map outlining areas of high probability of snake bite incidence in Ghana and Nigeria was created using this final piece of data. Areas with the highest probability of snake bite incidence (>80%) were located in the northern Ghana, and mid to northwest Nigeria. These areas bordered locations with the highest NDVI, suggesting a possible migration of snakes into a preferred habitat. Areas in which elevated NDVI coincided with high probability of snake bite incidence peaked during the months from March to July, and during periods after peak rainfall. This is during the time of high agricultural activity, reinforcing the association of the agricultural season, breeding season, and migration of *E ocellatus*. Areas of low population density and increased terrain roughness also saw elevated human-snake contact, possibly due to encroachment on the preferred natural habitat of *E ocellatus*.

Patient Profile and Treatment

Studies

The EchitTab Study Group of Liverpool, England, conducted 2 separate studies on snake bite envenomation in Nigeria.(1) The first study was a 5-year (1989 to 1993) epidemiological survey, used to assess the magnitude and distribution of snakebites in Nigeria.(1) Dividing Nigeria into 1,600 high prevalent areas and 3,200 low prevalent areas, data was collected randomly from households and all of the surrounding health care facilities. Findings showed that Taraba State had the highest number of cases (900), while Jigawa State had the highest frequency (20/1000 admitted due to venomous snake bite) and case fatality rate (31%). The highest percentage of cases took place in patients between the ages of 10 and 29 years old, and the majority of patients stayed in the hospital from 1 to 2 days. The second study was conducted at the Kaltungo Hospital, Gombe State, from 1999 to 2006.(6) Here they assessed characteristics of patients and snake bite rates over time. It was determined that the majority of patients were farmers and students, 75% male. Most patients were 11 to 20. Snake bites rose in April and peaked in October, which coincides directly with the



Figure 3. Clockwise from top left: *Bitis arietans* (courtesy of Victory Reptiles), *Naja nigricolis nigricolis* (courtesy of E Brewer, The Gambia Flora and Fauna Pictorial Database), *Echis ocellatus* (courtesy of L Barnett, The Gambia Flora and Fauna Pictorial Database), *Bitis gabonica* (courtesy of LT Shears).

STUDY	PATIENT CHARACTERISTICS
ECHITAB: GOMBE STATE, 1999-2006	>50% FARMERS, YOUNG CHILDREN 75% MALE BITE RATE HIGHER MAY TO OCTOBER FATALITY HIGHER IN 2000
BENIN CITY, 1980-	>50% BITTEN IN FIELD BITES ON RIGHT LOWER LIMB > 90% PATIENTS GIVEN ANTI-TETANUS MEDICATION < 70% GIVEN ANTIVENOM OR ANTIBIOTICS PATIENT HOSPITAL STAY 2 TO 5 DAYS
NORTHERN CAMEROON, 1993-2003	> 50% PATIENTS WORK IN THE FIELD > 50% BITES DURING DAY >50% BITES IN AGRICULTURAL SEASON BITES ON LOWER EXTREMITY NO IMMEDIATE HOSPITAL TREATMENT FIRST THERAPY HERBAL REMEDIES 33% VENOM DOSAGE ADEQUATE FATALITY HIGHER IN 2000
TETANUS INFECTION: KADUNA, 1990-1995; KANO STATE 2000-2001	POOR TRAINING IN WOUND MANAGEMENT AND TREATMENT MISSED VACCINATIONS LACK OF EDUCATION OF PATIENTS AND HEALTHCARE WORKERS PATIENT INACCESSIBLE TO HOSPITALS RELIANCE ON HERBAL REMEDIES

Table 2. Patient profiles after bites

agricultural/breeding season. A fatality increase was seen in the year 2000.

A 2002 study collected data on patient profiles and treatments from University of Benin Teaching Hospital and the Central Hospital in Benin City (in Edo State) from 1980 to 1999.(4) The majority of patients were young men, bitten on the lower right limb while in the bush. Almost 40% of patients had waited 2 to 5 days to be treated. Hypersensitivity reactions to antivenin occurred. This study also evaluated treatments, and found the majority of patients received antitetanus toxoid (90.8%) and intravenous fluids (82.3%), while only 68% received antivenin, and 67% received antibiotics. Researchers suggested that the low mortality rate was due to location, as Edo State is known for excellent health care compared with other states.

From 2000 to 2003, a study conducted at the Kolofata District Hospital in Northern Cameroon focused on patients bitten by *E. ocellatus*.(5) This study included both retrospective data from January 1993 to December 2000, and observed cases from 2000 to 2003. Northern Cameroon bor-

STATE	STATISTIC	FREQUENCY
TARABA	BITES	900 CASES
JIGAWA	ADMISSIONS DUE TO SNAKE BITE	20/1000 ADMISSION
JIGAWA	CASE FATALITY RATES DUE TO SNAKE BITE	31%

Table 3. Echitab Study state statistics.(1)

ders the Borno State of northwestern Nigeria, and 53% of these patients were Nigerian citizens. Patients were primarily bitten during the day on the lower extremity, and 71% of the bites occurred during the agricultural season. Less than half of the patients sought treatment before 6 hours, and death was strongly associated with long delay from bite to presentation. It was observed that patients either refused or were too far away to seek immediate treatment. Patients observed from 2000 to 2003 were given 33% of the actual suggested dosage (10.8mL rather than 40mL) of antivenin. This was done because 33% of the dose was adequate for most cases, and this is closer to the actual dosage received at health care facilities. This is due to high the cost of antivenin (USD7,500 per dose), and the scarcity of antivenin in the region. It was observed that had the research project not taken place, most patients would have died without antivenom treatment available at the research facility. A fatality increase was also reported in 2000.

In venomous snake bites, fangs produce a pair of deep puncture wounds which are susceptible to infection. At the Ahmudo Bello University Hospital,



Figure 4. State divisions of Nigeria; western Nigeria is bordered by Cameroon. Courtesy of the University of Texas Libraries, the University of Texas at Austin.

Kaduna State, (1990 to 1995) and Aminu Kano Teaching Hospital, Kano State (2000 to 2001), 4 snake bite patients were observed with tetanus infection.(6) Researchers cited a decline in the health care system provided inadequate vaccinations policies, poor training of health care workers in proper wound site management, ignorance of the patient for the immediate necessity of antivenom, and the inaccessibility of rural communities. The actual age bracket for vaccinations did not include older farmers who missed recent tetanus toxoid vaccinations, which targeted young children. Of the 4 subjects studied, 3 died after bites from the *E ocellatus*. These patients took between 10 and 25 days to reach their respective hospital, and used herbal remedies at home for treatment before seeking medical assistance.

A Solution

The EchiTab Study Group of the Liverpool Study of Tropical Medicine has developed a polyspecific (multi-snake) antivenin for regional production in Nigeria. With clinical trials recently completed and a presentation given to the World Health Organization in March 2007, EchiTab reported 0.63% fatality rate with use of their new antivenin. It has also demonstrated to be cheaply produced, so cost for treatment has become a non-factor. Building of facilities and training of workers for proper and efficient treatment has begun in 2007.(1)

In Nigeria, Dr Issac U Asuzu, of the University of Nigeria Nsukka, has used a novel approach to snake antivenom. Taking local herbal medicines from village medicine men, he has used extracts of these plants to prevent hemorrhaging in chick embryos from viper venom, and prevent contractions of chick-muscle tissue exposed to cobra venom, which is neurotoxic.(8) This is promising for 3 reasons: it is polyspecific for hemotoxic and neurotoxic venom, the dangerous reactions to antibody based antivenom are non-existent, and being based on plant products allows for inexpensive mass production.

Conclusions

Interactions with venomous snakes are unavoidable for the farmers of Nigeria. Unlike diseases such as HIV/AIDS and malaria, envenomation can be easily prevented and treated if the proper conditions are met. The regional production of affordable, mass-produced antivenin is an immediate necessity. Education of hospital workers and farmers on the necessity of immediate and proper treatment are a must. A better health care system and a provision of sophisticated farming equipment could help deter many possible interactions with these animals as well.

With the first condition looking to be met, education and knowledge becomes key. Although venomous snakes are dangerous animals, they are a part of nature that deserves our respect and admiration. With this respect brings knowledge of the animal, and the prevention of a dangerous situation.

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