

Measles Epidemiology and Control in Western Nigeria

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CAMPAIGNS to protect 105,000,000, people from smallpox and measles in 19 countries of West Africa were carried on through the combined efforts of the governments of the United States, the African states concerned and the World Health Organization. Nigeria was the keystone country of the entire project. The Federal Republic of Nigeria is the largest single geographic unit on the coast of West Africa. Its area is over 356,669 square miles and its population over 55,000,000. In 1967, 12 states were created out of the four regions of the country. The Western Region became the Western State with the exception of Colony Province which became Lagos State (Fig. 1).

The Western State is the most highly urbanized area of Nigeria and probably of sub-Saharan Africa. Twelve of its cities have a population of more than 100,000 and 129 centers encompass over half of the total population of the state. These cities include the largest black city in Africa, Ibadan, which is a center of trade, education, culture and administration. The estimated 1968 population of the Western State was approximately 10.5 million.

The major ethnic group of the Western State is the Yoruba tribe, comprising over 90% of the population. The Yoruba are a patrilineal agricultural people who were formerly divided into a number of independent states or kingdoms and who possess many religious cult groups and craft organizations. They are unusual in that their indigenous culture is essentially urban. Thus urbanization is a traditional Yoruba pattern and cannot

be explained in terms of European contacts and development of colonial administrative centers, industry, ports or mines.¹

The real basis of the Yoruba economy is farming. However, most of the farmers are city dwellers. The city cannot be called a "non-farm" area

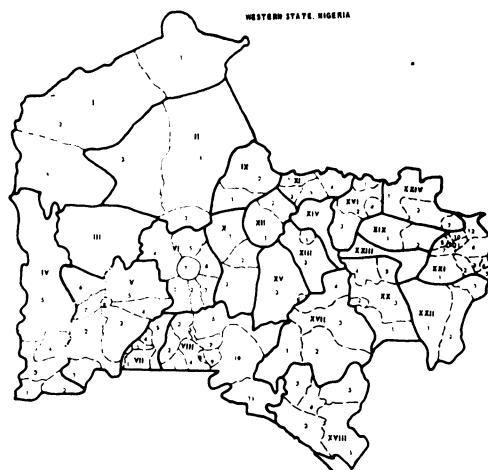


Fig. 1. Map of Western State Nigeria showing provinces and Divisions.

as a belt of peripheral farms surrounds and may extend up to 15 miles outside the city. These farms are visited regularly and families whose farms are distant from the city often have farm homes where they spend several days at a time during the farming season.¹ They maintain a residence in the city and usually return there on the week end. Other Yoruba actually live on farms or in small villages. The probable importance of this degree of urbanization in the epidemiology of measles in the Western State will be discussed.

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EPIDEMIOLOGY

Measles is an endemic and serious disease in Nigeria, producing considerable morbidity and mortality. Measles in the Western State is primarily a disease of children under three years of age. It occurs in all months of the year but reaches its peak in the dry season during February, March and April. It also occurs sometimes immediately after the end of the rainy season and often reaches epidemic proportions in the dry season. During that season there is little farming activity and the people return to their villages or towns. Various festivals are celebrated during this time, and the child is carried about on the mother's back, thus, there are very good circumstances for the spread of droplet infection. With the coming of the rains, the epidemic declines as the people return to their farms. The onset and decline of the measles epidemics may be associated with the population movements.² This may also indicate that measles in the Western State is essentially an urban disease or at least occurs more frequently in the population centers such as villages, towns and cities than in isolated farm groups.

AGE INCIDENCE

Immunity to measles is generally transmitted intrauterine from mother to baby. This immunity has usually disappeared by the end of the first year. In the United States and Britain it is uncommon for measles to occur during the first year of life. In Nigeria, about a third of the cases occur in the first year and it is not unusual for measles to occur as early as four months of age.³

Data on the age incidence of measles in the Western State from May 1967 through July 1968 were analyzed. Age data before May 1967 were not available as this type of measles surveillance system was not in effect before that date.

Of the 10,437 cases recorded by age, 8,257 or 79% had occurred by the age of three years. In the under one year group, 2,243 cases or 21.4% of the total occurred. It is of interest to compare the age incidence of measles in an urban area as against rural areas. Cases of measles occurring the Ibadan City were compared to those from two rural health centers, Igbo Ora and Ikire.

Admissions for measles at four hospitals in Ibadan were analyzed. These included patients admitted to the wards and the outpatient depart-

ments. Of the 2,016 reported cases of measles, 729 or 36.1% were under one year of age and 87.1% occurred between the ages of four months and three years. When the data for measles cases in Ibadan City prior to the mass measles vaccination campaign are analyzed, it is shown that 1,676 measles cases occurred between January 1, and July 31, 1967.

Over 73,000 children in Ibadan City between six months and three years of age were vaccinated against measles, during a ten day period in July 1967. Prior to the campaign 32.7% of cases were under one year of age. Following the campaign, there were 135 reported cases between August and December 1967. Of these cases, 37.7% were under one year of age. During the period January 1 through August 31, 1968, 254 cases occurred and of these, 119 or 46.8% were under one year of age.

Examination of the measles data from the two rural health centers reveals several interesting things. Figure 2 shows the total number of mea-

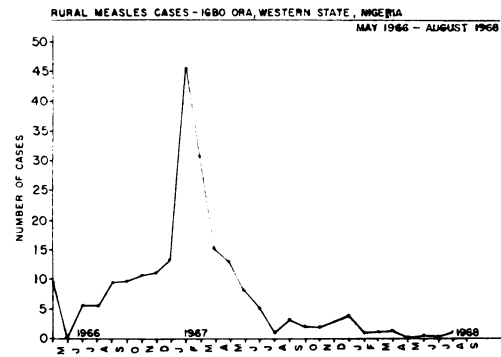


Fig. 2

sles cases reported in Igbo Ora, from May 1966 through August 1968. During the eight month period of May through December 1966 there were 62 reported cases. From January 1 through December 31, 1967 there were 143 cases and from January through August 1968 there were only eight reported cases and four of those occurred in January.

It can be seen that the cases started to build up in late 1966 with the beginning of the dry season and reached their peak in February 1967. Thereafter the number of cases showed a steady decline. A pilot vaccination project was conducted in Igbo Ora during the last two weeks of February 1967 and approximately 1,500 children six months to

three years old were vaccinated against measles. The majority of those vaccinated were from the town of Igbo Ora itself. Later, a neighboring town and a few villages were vaccinated as part of the pilot project. A mass campaign was conducted for the entire division in April 1968 and over 24,000 measles vaccinations were done.

However, even before the mass campaign at Igbo Ora, apparently the pool of susceptibles had been considerably reduced by the occurrence of natural measles and measles vaccinations. Measles had apparently almost disappeared from that community by August 1968. The age incidence of measles in Igbo Ora is quite different from that in Ibadan in that, no cases were recorded under one year of age in 1966 or 1967 and indeed 89% of cases occurred after two years of age and 38% were over three years of age. This contrasts with Ibadan in which only 11% of cases were over three years of age.

Igbo Ora is a town of approximately 35,000 population which is located about 65 miles west of Ibadan. It is in Ibarapa division which covers an area of about 1,000 square miles. It does not lie on a heavily travelled route and is not close to a major city. The people of the town spend much time on their farms and during the planting season, over half of the population lives outside the town on farms, though they return often for the week-end in the town.

Data from the second rural health center at Ikire differ from those of Igbo Ora. Ikire is a town located about 25 miles northeast of Ibadan in Oshun Division. It is on a heavily traveled route and is continuous with another large town Apomu. The population is about 55,000. Although the rural health center is located in the town, it serves both the town and surrounding villages. The entire area is more densely populated than Ibarapa Division. The population den-

sity of Oshun is about 889 per square mile while that of Ibarapa is about 128 per square mile.

There were 18 cases reported from the health center at Ikire in 1967, and eight of these or 44% were under one year of age. Seven of the cases or 38.8% were over three years of age.

In 1968 there were 24 measles cases reported from the Ikire Health Center. Eight cases or 33% under one year of age and five cases or 21% were over three years of age. During April 1968 a mass measles vaccination campaign was conducted at Ikire. Seven cases occurred after the campaign and five of those were under one year of age. Figure 3 compares the age distribution of measles cases in Ibadan, Igbo and Ikire.

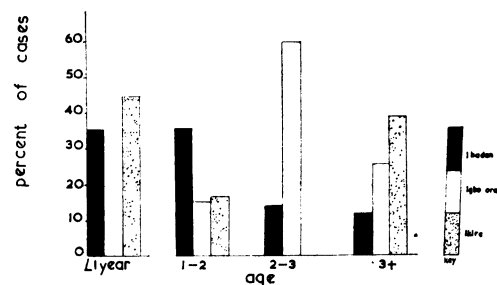


Fig. 3. Age distribution of measles cases in Ibadan, Igbo Ora and Ikire.

MEASLES IMMUNITY

Blood serum was collected from 227 children, randomly selected between the ages of 4-36 months. The children lived in three small villages (Akanran, Gbedun and Araromi) and surrounding hamlets about 15 miles south of Ibadan City. The blood samples were taken prior to measles vaccination, but no attempt was made to obtain a history of prior measles infection. The samples were analyzed for measles antibody using the complement-fixation test. The tests were performed at the virology laboratory, National Communicable

TABLE 1.—IMMUNES AND SUSCEPTIBLES BY MEASLES ANTIBODY TITER, WESTERN STATE

Age Group	No. Tested	No. Immune	% Immune	No. Susceptible	% Susceptible
0-5 months	19	1	5.0	18	95.0
6-12 months	77	12	15.6	65	84.4
13-24 months	118	30	34.0	88	66.0
25-36 months	13	3	23.0	10	77.0
<i>Total</i>	227	46	20.3	181	79.7

Disease Center, Atlanta, Georgia. Of the 227 specimens, 181 had a titer less than 5, thus 79.7% of the group were susceptible to measles (Table 1). The largest number of susceptibles was between the ages of 6-24 months. The results suggest that the majority of the children tested in all age groups were susceptible to measles. In the 13-24 months age group, 34% had antibodies against measles. The under 6 months age group revealed that 95% were susceptible to measles.

The large percentage under 6 months without detectable protective antibody titers helps to explain why some measles occurs under six months of age in Western Nigeria. The children from 25-36 months of age showed only 23% immunity to measles. Those in the 1-12 months group revealed only 15.6% immunity.

These findings differ from those of Hendrickse.⁴ The difference may be due to the fact that the children in this study were from rural villages where it appears that measles is experienced at a later age.

However, the West is highly urbanized and between May 1967 and July 1968, 64.6% of measles cases reported in the Western State occurred in children two years of age or less.

MEASLES MORBIDITY AND MORTALITY

We have seen that measles in Western Nigeria is a disease of the pre-school child and that its greatest frequency is in the two years or less age group. Therefore, in the State, measles occurs most frequently in the age group which is most liable to have complications. The complication rate may be as high as 44.5% according to Ogbeide.³ Much of the difficulty arises from respiratory infections and gastroenteritis. These conditions often precipitate or bring out protein calorie malnutrition, otitis media, ophthalmitis, stomatitis and other complications.

In addition, certain complications are due to the administration of various concoctions by the local medicine man or the child's parents or relatives. These concoctions often aggravate the disease process. The child with convulsions may be given a mixture to drink containing cow's urine and tobacco, among other things. This will often put the child into coma or semi-coma. Other concoctions may be put into the eyes or rubbed on the skin with disastrous consequences. Attempts to

arouse the unconscious child may be made by submerging the feet and buttocks in boiling water.³ These practices are not confined to measles but may be used on any ill child.

Morley² estimated measles mortality in West Africa to be about 5%, however, 20-30% of severe cases admitted to hospital may die.³ The majority of these deaths occur in children under two years of age. An analysis of measles deaths at two Ibadan hospitals between January 1967 and March 1968 revealed 25 measles deaths of 18 or 72% in children two years old or less. All 25 of the deaths occurred in the "central city" although the measles attack rate was the same as for the middle and upper class neighborhoods.

MEASLES CONTROL

The mass vaccination campaign in West Africa has attempted to eradicate smallpox but only control measles. Although theoretically one can eradicate measles, on the practical scale this would be extremely difficult. But when one observes the sharp decline in reported measles cases following a successful campaign, measles eradication does appear feasible.

Figure 4 shows the incidence of measles in Ibadan City in 1967 and 1968 before and after

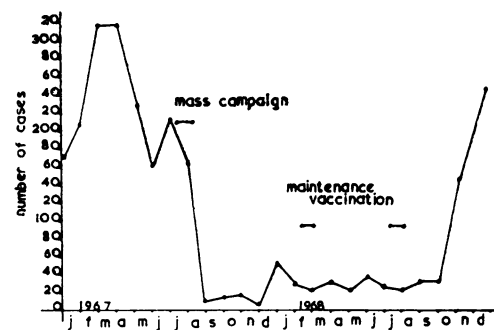


Fig. 4. Incidence of measles in Ibadan City 1967 and 1968, pre- and post vaccination campaign.

the vaccination campaign. Assessment afterward revealed a 92.9% coverage in the six months through three years age group. A dramatic fall in reported measles incidence occurred within two months after the mass campaign and the incidence remained at a low level through October 1968. This fall was apparently due to the marked reduction in the measles susceptible pool by the mass vaccination campaign.

Table 2 shows the estimated measles immunity

TABLE 2.—ESTIMATED MEASLES IMMUNITY IN IBADAN 1967—
PRE-VACCINATION CAMPAIGN

<i>Age Group</i>	<i>Estimated Population</i>	<i>% Nat. IMM.</i>	<i>No. IMM.</i>	<i>% Susceptible</i>	<i>No. Susceptible</i>
6-11 months	11,341	5.9	669	94.1	10,672
1-3 years	67,230	41.0	27,564	59.0	39,668
4 years	22,681	84.4	19,142	15.6	3,539
<i>Total</i>	101,252	46.8	47,375	53.2	53,879

in Ibadan prior to the 1967 vaccination campaign, based on Hendrickse's study of measles antibody levels in children in Eastern Nigeria.⁴ It was estimated that 53.2% of the Ibadan children aged six months to four years were susceptible to measles. Table 3 gives Hendrickse's figures on measles immunity.

The estimated measles immunity in Ibadan following the mass campaign demonstrated that the estimated pool of susceptibles was reduced to 13.8% of the children between six months and four years of age.

If one estimates the measles immunity present in Ibadan six months after the campaign then one finds that the pool of susceptibles has risen to 22.5%, due mainly to the entrance of 6-11 month olds into the pool. That is children who were less than six months of age at the time of the initial campaign.

It therefore appears that in order to maintain measles control at a reasonable level in urban areas that measles maintenance vaccination needs to be done on non-immunized children 6-11 months of age, every six months.

Two measles immunization maintenance campaigns were subsequently conducted in Ibadan. The first campaign was in February 1968 and just over 10,000 measles vaccine doses were given. The second maintenance campaign was carried out

in July 1968 and about 23,000 measles vaccine doses were given. Although both campaigns were primarily aimed at the 6-11 months age groups, over 75% of the doses were given to children in the one to three year age group.

Beginning in November 1968 there was a striking rise in reported measles cases in Ibadan. Table 4 shows the number and age distribution of reported measles cases in Ibadan from September through December 1968. During January 1969, an additional 275 measles cases were reported in Ibadan.¹² A measles vaccination campaign was conducted in the city in January and a preliminary report indicated that the epidemic had probably been truncated.

Several possible explanations for the sudden increase in measles cases in Ibadan may be tendered. Table 4 reveals that of 328 cases reported by age in November and December, 257 (78%) were in children one year old or less. Investigation of 488 of the 704 total cases reported in Ibadan from November 1968 through January 1969 indicated that 355 (72.8%) had not received measles vaccine. The remaining 133 cases (27.2%) had a history of receiving measles vaccine. The age of vaccination was determined in 57 of these cases. Of the 57 cases, 28 (49%) were vaccinated between 4 and 9 months of age and 29 (51%) at 10 months of age and above.

TABLE 3—IMMUNITY BEFORE VACCINATION*

<i>Age Group</i>	<i>No. Tested</i>	<i>No. Immune</i>	<i>% Immune</i>
6-11 months	34	2	5.9
1-1 11/12	37	5	13.5
2-2 11/12	47	20	42.5
3-3 11/12	36	24	66.6
4-5	45	38	84.4
<i>Total</i>	199	89	44.5

* Hendrickse, R. G. et al. Measles Vaccination. *J. Trop. Med. and Hyg.*, 69:112-116, 1966.

TABLE 4.—MEASLES CASES, IBADAN CITY SEPTEMBER-DECEMBER 1968, AGE DISTRIBUTION

Age	September	October	November	December	Total	% Cases
Under 1 year	8	6	21	100	135	35.9
1 year	10	7	35	100	152	40.4
2 years	4	4	12	19	39	10.3
3 years	—	—	3	13	16	4.3
4 years	—	—	2	6	8	2.1
5 years	2	2	7	2	13	3.5
5+	3	2	1	7	13	3.5
Total	27	21	81	247	376	3.5

Those vaccinated at 9 months or less and who subsequently developed measles may have had interference with vaccine virus replication by residual antibody received from their mothers.¹¹ The measles cases in the 10 months and above group probably represent technical failures which need defining. The probabilities include faulty jet-injector technique by the vaccinators and/or loss of potency of the vaccine due to improper handling in the field. Technical failure may also account for the development of measles in some of the 9 months or less group.

In addition to the low vaccination coverage of the 6-11 months age group in Ibadan in July 1968, there was difficulty with crowd control in some areas of the city. The less experienced vaccinators found difficulty in maintaining field procedures under the stress of facing several thousand anxious mothers crowding in upon them, seeking vaccination for their children.

Although it appears that in urban areas one should conduct measles maintenance vaccination in non-immunized 6-11 month olds every six months, the picture in the rural areas is not so clear. It appears that in a rural area such as Igbo Ora the age for vaccination could be shifted upward as the disease occurs later than in urban areas. In rural areas such as Ikire, the age distribution does not differ markedly from the urban distribution with the exception that the 3+ years age group has a higher incidence of measles than the Ibadan group of the same age. Thus, it appears that Ikire falls into a category in between urban and rural.

From the above data one could draw vaccination schedules for three different age groups, six

months to three years, two to three years and six months to five years. However, such a plan does not seem feasible for a mass campaign. This is so because of problems of logistics and coverage of as many persons as possible in a two year attack phase. A uniform schedule of vaccination under the circumstances facilitates operations and coverage.

During the maintenance phase however, measles maintenance vaccination in rural area such as Igbo Ora could probably be done every two years. Whereas, maintenance vaccination in a rural area such as Ikire would probably need doing every six months. Ideally such maintenance programs should be carried out by local health facilities such as infant clinics, rural health centers, etc. However, mobile teams will probably still be necessary to carry the service to the more remote small villages. The eventual long term success of measles maintenance vaccination is almost certainly tied to a strong basic health service.

The schedules of the campaign were possible to maintain because of the use of the jet injector (Ped-O-Jet) This instrument works on hydraulic pressure supplied by a foot pump. It is possible to vaccinate up to 1,000 persons per hour with the injector. In fact, single vaccination teams in the Western State have done over 13,000 smallpox vaccinations per eight hour day using the Ped-O-Jet. Figure 5 shows a child receiving smallpox vaccine and measles vaccine simultaneously by means of Ped-O-Jet needleless injectors.

This means of delivering vaccine allows the rapid build-up of a large number of immunes in the community. The importance of this build up was shown by the experience in Ibadan. Figure 6

shows the occurrence of reported measles and the cumulative measles vaccinations 1966-1968, in the Western State.

The measles vaccine used in the project was Schwartz further attenuated vaccine. The incidence of febrile reactions and other reactions is lower with this vaccine than with the Edmonston B vaccine and it can be given without gamma globulin.

DISCUSSION

The need for measles immunization in West Africa has been well documented by reports on the severity and prevalence of measles in that region.^{2,6} The efficacy of live attenuated and further attenuated measles virus vaccine in producing ade-

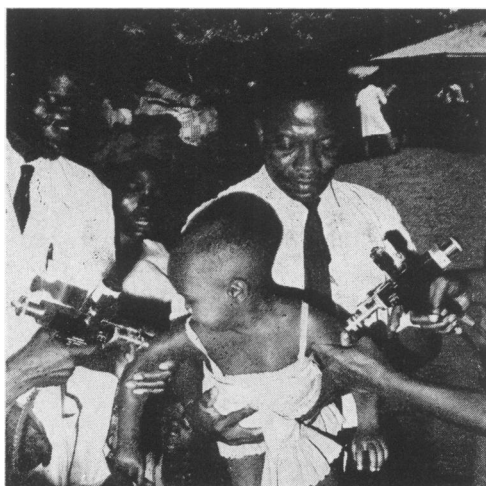


Fig. 5. A child receiving simultaneous injections of measles vaccine (rt. arm) and smallpox vaccine (left arm), by means of hydraulic hypodermic injectors (Ped-O-Jet). (USIA photograph).

quate antibody responses and reduction in the reported morbidity of measles in West Africa has also been demonstrated.⁴⁻¹⁰

Analysis of the epidemiology of measles in the Western State, Nigeria reveals at least three patterns of age incidence, urban, rural and intermediate. The urban pattern shows that over one third of the cases occur in children under one year and that about 87% of the cases occur between the ages four months and three years.

Following a mass vaccination campaign the incidence of measles in the under one year group rose although absolute numbers of cases fall. After two maintenance campaigns the age distribution of cases made an additional shift so that between January and August 1968, 46.8% of the cases

were under one year of age. This shift reflects the reduction of the susceptible pool in other age groups, whereas those under one year of age who were less than six months of age at the time of the campaign were not vaccinated. Therefore, the age group 6-11 months forms the largest susceptible pool. During an outbreak of measles in November and December 1968 in Ibadan, 78% of reported cases were in children one year of age or less.

The rural pattern of measles in the Western State reveals that 89% of the cases occur after age two years and 38% are over three years of age. This is shown by data from Igbo Ora. The combination of natural measles and measles vaccination had apparently practically eliminated measles in that area for the period studied.

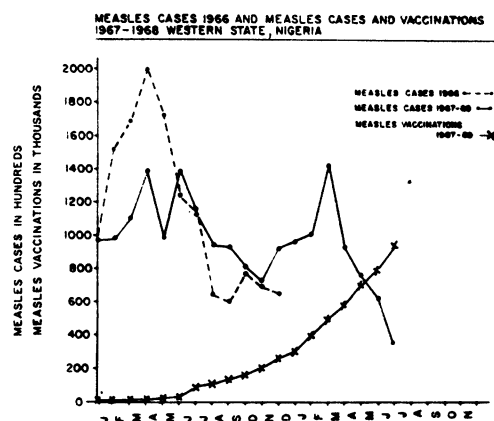


Fig. 6

The intermediate pattern shows characteristics of urban and rural measles age incidence. That is measles in this pattern shows a high incidence in the under one year and over three years old children. This was shown at Ikire. After a mass campaign there in April 1968, seven cases were reported and five of those were under one year of age.

Mass vaccination therefore seems to have the same effect in urban and intermediate measles patterns in that following the mass campaign the age distribution of case shifts even more to the left. Unfortunately it was not possible to obtain the ages of the eight cases which occurred in Igbo Ora in 1968, but four of those occurred in January before the mass campaign.

The factors which make the urban or semi-urban child more susceptible to measles under two years

of age than the child from the rural area are not clear. The crowding in the cities and increased opportunity for rapid spread of droplet infection are probably contributory factors.

Since about 80% of the people in the Western State live in towns of over 5,000 in population, the majority of the measles in the state is of the urban variety, as 79% had occurred by the age of three years and 21.4% of the cases were less than one year of age. Thus, the remarkable tendency of the Yoruba for urbanization seems to be a major factor in determining the overall pattern of age incidence of measles in the Western State of Nigeria.

The seasonal incidence of measles also appears to be due more to population movements, than to some special epidemiological characteristic of the disease per se. That is, during the dry season when very little farming is done, people move into the villages, towns, and cities and the measles incidence rapidly rises. Since the disease is endemic and there is usually a good size pool of susceptibles available, it reaches epidemic proportions fairly soon after onset.

Mass campaigns to vaccinate all susceptibles against measles are initially effective, but maintenance vaccinations of new susceptibles is essential to keep the disease under control.

SUMMARY

The epidemiological pattern of measles in the Western State and the mass vaccination campaign to control the disease has been presented. It appears that measles can be controlled and that the epidemiological pattern may be altered by mass measles vaccination. Eventual improvements in housing, hygiene, and nutrition should in the long

run act to reduce the severity of measles in West Africa.

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CHILD MORTALITY IN AFRICA per 1000 Live Births with Selected Comparative Data

Country	Rate	Country	Rate	Country	Rate	Country	Rate
Morocco	149	Egypt	178	Tanzania	162	Zambia	259
Ethiopia	190	Sudan	187	Burundi	156	Lestho	181
Ivory Coast	195	Dahomey	221	Rhodesia	122	Maurice Island	65
Guinea	246	Mali	123	Haiti	190	Jamaica	35
Mauritania	187	Niger	200	Puerto Rico	34	Barbados	46
Togo	127	Upper Volta	270	Surinam	32	Peru	106
Ghana	156	Liberia	137	Israel	25	Turkey	153
Cameroons	161	Central Afrique	190	U.S.A.	19		
Congo	180	Gabon	229				
Chad	165	Zaire	163				
Kenya	132	Uganda	172				

Source: National Center for Health Statistics. Population: L'Institut National des Etudes Demographiques, Paris, France.