

EPIDEMIC MENINGOCOCCAL MENINGITIS: THE CASE OF MALI

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MUCH of Mali lies within the so-called "meningitis belt" of sub-Saharan Africa, extending roughly from 8° to 16° north latitude. Epidemics of meningococcal meningitis have occurred at varying intervals in this area throughout this century. In Mali they have resulted in morbidity in thousands of people and have killed thousands. Prior to 1950 periodic epidemics of meningococcal meningitis moved sequentially through the belt, affecting one country after another. In 1937, for example, an epidemic cycle began in the Sudan, moved into Chad, and finally reached Mali, then the French Sudan, three years later, in 1940.¹ Since 1950 the epidemiological situation in the belt has been characterized not by cycles of epidemics moving in a fixed direction, but rather by an endemic state out of which periodic local epidemics develop from time to time.¹

Since 1940 Mali has experienced six epidemic cycles, 1940-1941, 1944-1947, 1950-1957, 1960-1961, 1969-1971, and 1981 (Figure 1). The most severe epidemic occurred in 1969-1971, when 18,288 cases and 1,991 deaths occurred. The epidemiology of meningococcal meningitis has been carefully studied and described in several neighboring countries including Upper Volta, Niger, Chad, and Nigeria.¹ However, this has not been done for Mali. The recent development of effective Group A and Group C meningococcal polysaccharide vaccines and their successful use in the field are likely to preclude the evolution of epidemics of the scale that occurred in Mali in 1969-1971. Indeed, the swift and widespread use of combined Group A and Group C meningococcal vaccine during the 1981 epidemic in Mali effectively halted it.

From 1966 through the end of 1971 I worked in Mali as an epidemiologist for the Center For Disease Control of the United States Public Health Service. I was given permission by the Malian Ministry of Public Health

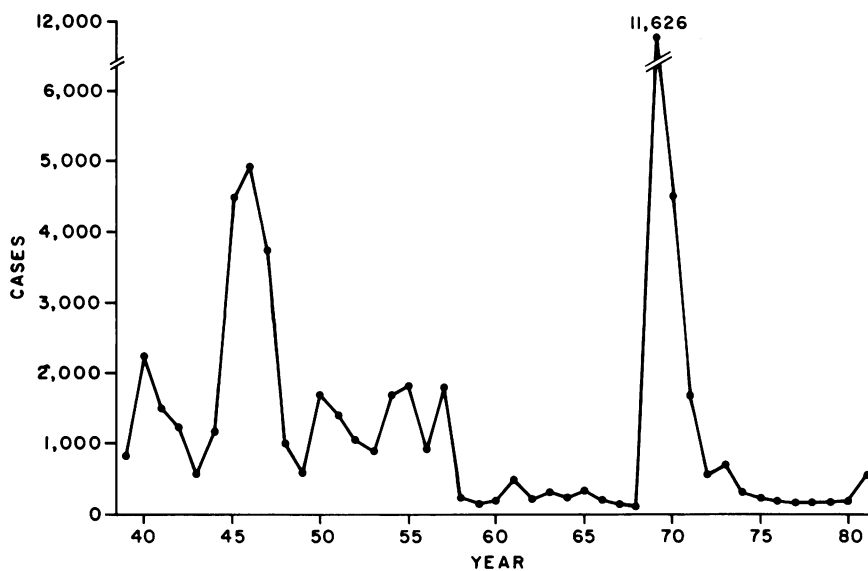


Fig. 1. Reported cases of meningococcal meningitis by year, Mali, 1939-1981

and Social Affairs in January 1969 to conduct epidemiologic investigations of the meningitis epidemic then in progress. However, I was asked not to publish these studies. The national government had just come to power through a military coup d'état that had taken place scarcely two months previously, on November 19, 1968. High government officials were extremely sensitive about the appearance of this epidemic and to the damage they thought it could do to Mali's international image. In addition, it was widely believed by ordinary Malians that the epidemic was the work of the expresident, who was regarded by many as possessing supernatural powers. Although dismissed out of hand as superstitious beliefs by the government, such beliefs presented a serious political problem in a country where the majority of the population still followed traditional religions.

Although the Ministry of Health gave me permission to investigate all aspects of the epidemic, other ministries that had considerable responsibility for dealing with the epidemic were frequently uncooperative. Understandably, this created a very difficult environment in which to study an epidemic.

Given official Malian sensitivities to this epidemic, the results of my epidemiologic investigations were never published. However, 10 years later, in 1981, a relatively small epidemic of meningococcal meningitis

accounting for 831 cases broke out in Mali's capital, Bamako.² Two epidemiologists from the Center for Disease Control happened to be in Mali at the time on a short-term assignment dealing with family planning programs. They investigated the 1981 epidemic and otherwise assisted Malian health officials in controlling it. In attempting to document the 1969-1971 epidemic, they found only scanty data in the Malian public health archives, and were referred to me by both Malians and Americans who knew of my investigations. They strongly urged that the results of my investigations be published, as did Malian health officials in 1982.

The purpose of this communication is to present the epidemiologic characteristics of the 1969-1971 epidemic. It will also review the epidemiologic history of meningococcal meningitis in Mali and to compare it to that of neighboring countries. The data presented here were gathered in Mali at the Ministry of Public Health and Social Affairs and through epidemiologic investigations conducted during the 1969-1971 epidemic.

THE PRE-1950 PERIOD

Because of the rudimentary nature of the disease reporting system in Mali (French Soudan) in the early part of this century, epidemiological information about meningococcal meningitis is somewhat imprecise. However, a number of French colonial medical officers did publish some excellent clinical descriptions of outbreaks and epidemics, providing some epidemiologic information as well.³⁻⁴ Sice et al.,⁴ for example, noted the dry season occurrence of epidemics and isolated both serotypes A and B from patients during an epidemic.

In 1934 an areawide epidemic began in the Sudan and moved westward into Chad and Niger, finally reaching Mali in 1940 (Figure 1). In 1942 another epidemic began simultaneously in Chad and Nigeria, spreading to Niger in 1944 and to Upper Volta in 1945.⁵ This epidemic reached Mali in 1944 and lasted for three years, until 1948. This same epidemic continued in neighboring Upper Volta for six years, until 1951.¹

THE 1950-1959 PERIOD

After two years of relatively low disease incidence, meningococcal meningitis again appeared in Mali in epidemic form from 1950 through 1952. Although the number of cases reported in 1953 fell from the 1952

level of 1,090 to 808, this was well above the usual level previously observed in nonepidemic periods. Thus, it is possible that the three distinct peaks observed between 1950 and 1957 represent one epidemic. In 1959 the annual number of reported cases fell to 186. During the period 1950-1959 a total of 14,045 cases and 2,280 deaths were reported in Mali, with a case fatality rate of 16.2%.

THE 1960-1968 PERIOD

This nine-year period was characterized by a low annual number of cases of meningococcal meningitis (Figure 1). It is significant that since 1929 there had never been such a period of extremely low disease incidence. It can be cogently argued that this situation led to the build up of large pools of susceptibles and culminated in the massive epidemic of 1969-1971.

THE 1969-1971 EPIDEMIC

This epidemic began in Mali's capital, Bamako, in early January 1969 and ended two and a half years later, in June 1971. Initially, the epidemic was confined to Bamako's crowded older quarters, located on the eastern side of the city. These quarters include Niarela, Bozola, Medina-Coura, Ouolofobougou, Missira, Bagadadji, and Quinzambougou (Table III). At that time they were characterized by mud brick construction, narrow alleys, open sewers, and an extremely dense population. In the latter part of February 1969 the epidemic spilled over into the newer western side of the city, but most cases were still found among residents of the eastern quarters. By March 1969 the epidemic had spread to the rural areas surrounding the capital in the Bamako region and both westward into the adjacent Kayes region and eastward into the Segou region (Table I). In April it extended south into the Sikasso region and eastward into Mopti. But in these last two regions the numbers of cases reported were relatively few (Table I).

The number of cases reported fell to endemic levels in July 1969, but again rose in late December. A second epidemic peak occurred in March and April 1970, centered primarily in the Bamako region, but present in all regions except Gao (Table II). As in the previous year, the number of cases fell to endemic levels in July 1970, rising again in January 1971, when a new but smaller epidemic peak was reached in February (Figure 2). During 1971, 700 (33.1%) of the 2,111 cases were reported from

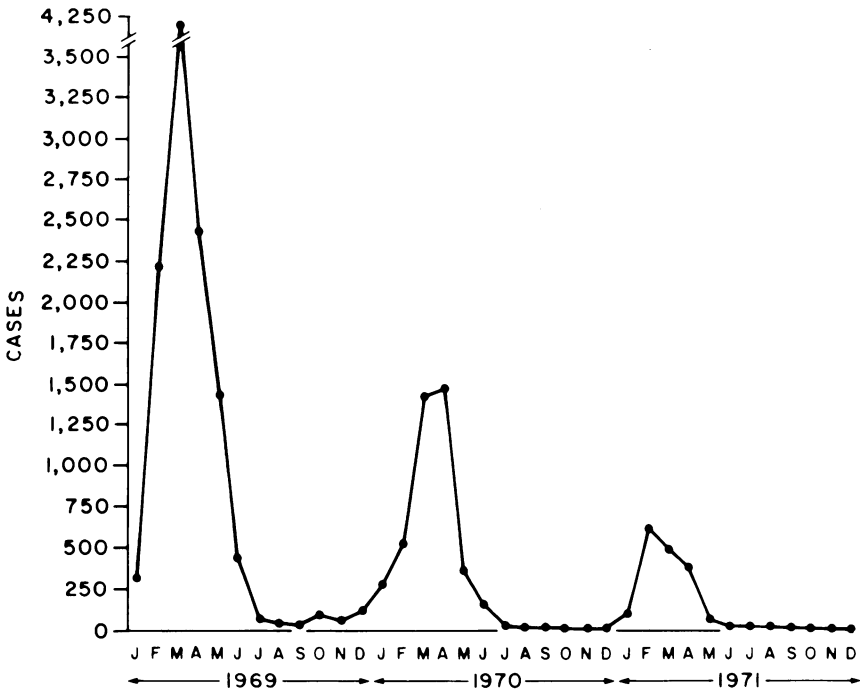


Fig. 2. Reported cases of meningococcal meningitis by month, Mali, 1969-1971

the Bamako region, 427 (20.2%) from Sikasso, and 493 (23.4%) from Segou.

CHARACTERISTICS OF THE 1969-1971 EPIDEMIC

The three peaks of this epidemic occurred during the middle of the dry season in Mali, which extends from October through June. A total of 18,288 cases with 1,991 deaths represented a national attack rate of 4.5 per 1,000 and a case fatality rate of 10.8%. Age and sex data were only haphazardly recorded during 1969 and 1970. However, as shown in Table IV, direct registering of all cases hospitalized at the Bamako Lazaret quarantine facility during the first six weeks of the epidemic revealed that the majority were younger than 16 years of age. Of note, however, is the fact that 39.7% of cases were 16 years of age and older. Age data were not available for 1970. However, the breakdown of cases by age for 1971 shows that the majority of victims, 62.4%, were 15 years of age and older and 37.6% were less than 15 years of age. This represents a complete reversal of the age distribution observed in 1969.

TABLE I CASES AND DEATHS DUE TO MENINGOCOCCAL MENINGITIS, BY MONTH AND REGION, MALI, 1969*

Month	Kayes		Bamako		Sikasso		Segou		Mopti		Gao		Total	
	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths
January	24	3	335	23	4	0	0	0	0	0	2	0	365	26
February	42	7	1,984	238	16	4	168	25	19	2	14	4	2,243	280
March	233	30	2,385	298	62	9	1,319	114	67	7	14	1	4,080	459
April	129	12	1,072	90	131	20	916	86	127	8	3	0	2,378	216
May	97	13	476	48	25	2	618	61	220	18	15	2	1,451	144
June	19	2	120	15	23	1	134	11	162	18	21	3	479	52
July	5	1	54	6	2	0	51	5	0	0	3	1	115	15
August	3	0	43	7	4	0	27	3	3	0	1	0	81	10
September	2	1	45	7	5	0	21	2	0	0	0	0	73	10
October	9	0	49	6	0	0	25	4	27	4	1	0	111	14
November	4	0	38	7	18	2	21	4	11	1	0	0	92	14
December	13	1	111	14	0	0	18	4	25	4	0	0	167	23
Total	580	70	6,712	759	290	38	3,318	319	661	62	74	11	11,626	1,221

*Data from Ministry of Health Archives

TABLE II CASES AND DEATHS DUE TO MENINGOCOCCAL MENINGITIS, BY MONTH AND REGION, MALI, 1970*

Month	Kayes		Bamako		Sikasso		Segou		Mopti		Gao		Total	
	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths
January	25	6	186	26	26	3	35	2	26	0	25	2	323	39
February	94	10	357	46	73	21	31	2	23	1	2	2	580	82
March	203	17	856	88	140	11	96	12	119	13	20	1	1,434	142
April	153	18	570	51	333	36	225	25	168	13	16	4	1,465	147
May	51	6	155	23	50	8	101	5	23	3	18	4	398	49
June	2	0	109	16	8	0	20	0	9	1	1	1	149	18
July	10	1	25	6	0	0	17	2	3	0	1	0	56	9
August	3	1	31	6	0	0	0	0	3	0	1	0	38	7
September	1	0	20	6	1	0	0	0	0	0	0	0	22	6
October	4	0	16	4	0	0	2	0	0	0	0	0	22	4
November	2	0	23	2	1	0	7	2	0	0	0	0	33	4
December	7	1	40	8	3	0	0	0	2	1	1	0	53	9
Total	555	60	2,388	282	635	79	534	60	375	32	95	14	4,551	516

*Data from Ministry of Health Archives

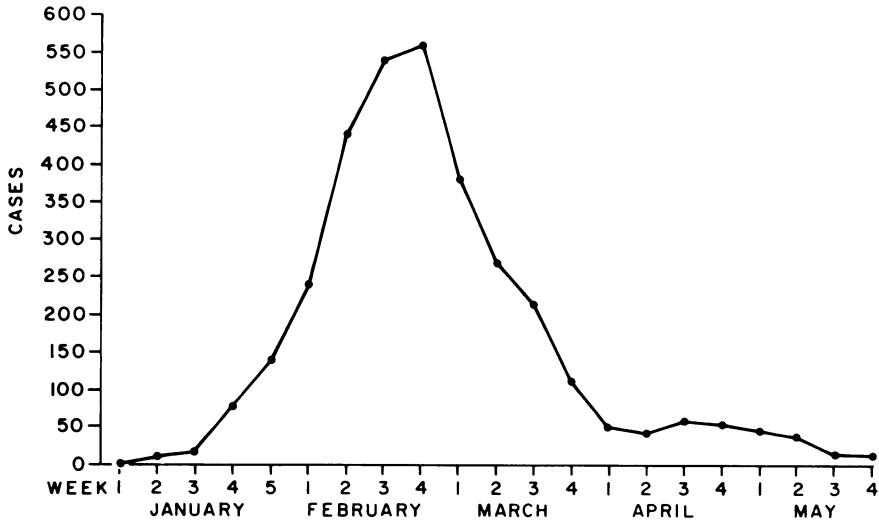


Fig. 3. Reported cases of meningococcal meningitis, Bamako, Mali, January 1 — May 31, 1969.

The male to female ratio during the 1969 phase of the epidemic was 1.6 to 1 and in 1971 1.2 to 1.

In the city of Bamako, where more than half of the 1969 cases were recorded, the first wave of the epidemic reached its peak in the fourth week of February, when 557 cases were recorded (Figure 3). At this time and during the previous three weeks the case fatality rate was 15.4%. In part this was the result of poor nursing care and dehydration at the hastily established Lazaret quarantine station. However, on March 8, 1969 the Center for Disease Control in Atlanta informed us that half of the isolates were resistant to sulfadiazine, the sole drug then being used for treatment. The following day chloramphenicol and tetracycline were given to all patients and thereafter the fatality rate fell to about 11%.

Laboratory facilities for culturing cerebrospinal fluid from patients were not available in Mali. Several specimens were sent by air to the Center for Disease Control in Atlanta for culture and serotyping. All proved to be Group A, half of which were resistant to sulfadiazine.

PREVENTION AND CONTROL MEASURES

The first wave of the epidemic put an enormous strain on Mali's limited medical care resources. At its inception, Bamako's Lazaret consisted of

TABLE III CASES AND ATTACK RATES PER 1,000, MENINGOCOCCAL MENINGITIS, BY CITY QUARTER, BAMAKO, MALI, JANUARY — FEBRUARY 1969

<i>Quarter</i>	<i>No. cases</i>	<i>Population of quarter</i>	<i>Attack rate per 1,000</i>
Niarela	203	15,800	12.8
Bozola	118	6,000	19.6
Medina-Coura	182	18,600	9.7
Ouolofobougou	96	3,500	27.4
Missira	115	14,500	7.9
Quinzambougou	35	1,500	23.3
Badialan	82	12,000	6.8
Nomiriambougou	17	2,000	8.5
Dravela	47	5,500	8.5
Darsalam	61	8,000	7.6
Djikoroni	27	2,000	13.5
Hamdallaye	86	20,000	4.2
Bagadadji	133	22,000	5.9
Korofina	16	3,000	6.0
Tomikorobougou	50	5,000	10.0
Badalabougou	75	1,500	5.0
Koulouba	8	500	16.0
Lafiabougou	37	15,000	2.5
Bamako-Coura	81	15,000	5.4
Other	129	25,000	5.1
Total	1,698	198,400	8.5

one small cement block building with one faucet, three latrines, and no electricity for a dozen patients. During the first six weeks of the epidemic, when approximately 30 patients a day were being admitted, an emergency expansion program was undertaken. It consisted of the construction of several huge straw shelters, 50 meters square, the extension of a piped water supply, the digging of latrines, the installation of electric wires and lights to replace kerosene lamps, and the erection of kitchen facilities for patients and their families. At the height of this first wave of the epidemic, up to 3,000 people were housed at the Lazaret, including both patients and their families.

Physicians and nurses were brought out of retirement for duty at the Lazaret and to administer sulfa drugs prophylactically to case contacts. Schools and cinemas were closed, public assemblies banned, the streets watered down to reduce dust levels, and 2,000 doses of a French experimental vaccine administered to students.⁶

TABLE IV CASES OF MENINGOCOCCAL MENINGITIS REGISTERED AT THE LAZARET, BY AGE, BAMAKO, MALI, JANUARY 5 — FEBRUARY 18, 1969

<i>Age group</i>	<i>No. cases</i>	<i>% of cases in group</i>
0 -1 yr.	50	5.1
2 -5 yr.	63	6.5
6 -15 yr.	473	48.6
16-19 yr.	191	19.6
20+	196	20.1
Total	973	100

TABLE V CASES OF MENINGOCOCCAL MENINGITIS BY AGE AND REGION, MALI, 1971

<i>Region</i>	<i>Less than 1 yr.</i>	<i>Age group</i>			<i>Total</i>
		<i>1-4</i>	<i>5-14</i>	<i>15+</i>	
Kayes	0	15	51	63	129
Bamako	14	58	132	496	700
Sikasso	0	33	173	221	427
Segou	70	147	167	109	493
Mopti	0	1	28	308	336
Gao	0	0	5	20	25
Total	84	254	456	1,317	2,111

THE 1981 EPIDEMIC

After 1971 meningococcal meningitis returned to low endemic levels in Mali. However, in January 1981 the Lazaret quarantine station in Bamako observed a 50% increase in meningitis cases over January figures for the previous two years.² By the last week of February the weekly number of cases had risen to 72, prompting health officials to declare an epidemic on March 2. A mass immunization campaign was begun on March 5, in which two thirds of Bamako's population was vaccinated over a period of three weeks with bivalent meningococcal AC vaccine.²

A total of 831 cases and 88 deaths were recorded. Attack rates were highest in children aged less than one year and in those 15 to 19 years, while case fatality rates were highest in infants and those aged 35 or older. In contrast to the epidemic a decade before, both Groups A and B were isolated and all strains were susceptible to sulfadiazine.² During the 1969-

1971 epidemic only type A was isolated, of which several strains were resistant to sulfonamides.

Binkin and Band² found that the attack rate in vaccine recipients was low (0.7/10,000) compared to that among the unvaccinated (4.7/10,000). They also found that the case fatality rate among those who developed meningitis was lower (5.9%) than that among the unvaccinated (11.2%). They concluded that vaccination is a useful and practical method to limit morbidity and mortality when implemented early in the course of an epidemic.

DISCUSSION

The epidemiology of meningococcal meningitis in Mali has not differed overall from that observed in neighboring African countries.^{1,5,7-11} Since the early part of this century, the association between the dry season, October through May, has always been observed and no epidemics have been observed during the rainy season. Epidemic peaks have usually occurred from late February through early April. The period between epidemics in Mali has varied from one to 11 years and epidemics have lasted from three to eight years. The pattern of multiyear epidemics has been consistently that of seasonal peaking of cases during the dry season, usually some time between late February and early April (Figure 2). A rapid fall off of cases has occurred after that, just before the rainy season begins, and only a few cases have been reported during the rainy season itself. Some of these long established patterns will no doubt be changed by the use of currently available meningococcal vaccines. Although it is too early to assess the full impact of vaccination on all aspects of the disease's epidemiology, it is clear that vaccination confers significant protection on certain age groups for the short term.^{12,13} The 1981 Bamako experience confirms this observation².

Much is being written about the dry season prevalence of meningococcal meningitis epidemics in the savanna lands of Africa.¹⁴ Lapeyssonnie¹ has cogently summarized the characteristics of this season, which include high daily temperatures, varying from 37°C to 42°C on the average, low relative mid-day humidity of anywhere from 10% to 30%, and a sharp drop in evening and nocturnal temperatures during the early part of the dry season, in November and December. Sicé et al.,⁴ among others, pointed out the probable damaging effect of hot dry air on the integrity and physiological defense mechanisms of the mucous membranes of the upper respiratory tract. It has also been pointed out that the nocturnal drop in

temperatures during November and December forces people to sleep indoors, often in crowded and unventilated or poorly ventilated quarters.¹

The dry season is also a time of intensified human contacts characterized by travel, active markets, and postharvest celebrations. During the rainy season, much of Mali's population, which is agricultural, is relatively isolated on family fields.

Many years ago Kirk¹⁵ pointed out that two convergent factors were required for an epidemic of meningococcal meningitis: a critical mass of susceptible people and a strain of the meningococcus that is virulent and transmissible. Clearly, immunity factors and certain characteristics of the organism play an important role in shaping epidemics. But climatic factors and the types of human behavior and activities they permit are not negligible.

It is of interest that meningococcal meningitis is known in Mali as *finyabana*, "air illness" or "wind illness," among the country's major ethnic group, the Bambara. The occurrence of the disease during the dry season is well recognized by people, as is the belief that epidemics end at the onset of the rainy season. In November and December of 1968, before the epidemic began, many ordinary citizens of Bamako expressed their fears of an impending meningitis epidemic. In light of what subsequently happened, this is quite remarkable. These fears were based on unusually high ambient temperatures and the low relative humidity, which was 10% on many days, not only at that time but also during the epidemic. The epidemic curve began to fall on March 4, 1969, two months before the onset of the rainy season. It is noteworthy that this fall followed a gradual rise in the relative humidity that began on February 14th. Lapeyssonie¹ has carefully documented the relationship between increasing relative humidity and declining epidemic curves. Caution must be exercised in interpreting this relationship as one of cause and effect, because immunity factors play a very important role in the decline of epidemics.

It has been often stated that epidemic meningococcal meningitis is primarily a rural disease in the meningitis belt.¹ Yet the 1969-1971 and the 1981 epidemics in Mali were centered in the capital city. It can be argued that Bamako is essentially a rural environment in many respects. Indeed, housing, space, and human behavior and activities in most of the city's quarters are identical to those in any large Malian village.

The overall case fatality rate for the 1969-1971 epidemic was 10.8%, which compares favorably with rates recorded during other African epidemics.¹ The case fatality rate was positively influenced by a number of

factors, including promptness of appropriate antibiotic therapy, nutritional status, and general physical health, nursing care, and adequate hydration. During the early part of the epidemic, before it was known that sulfonamide resistance was present among some strains and when medical care facilities were not adequately organized, the case fatality rate was 15.4%.

It has long been observed that epidemic meningococcal meningitis in Africa is most common among those between five and 15 years of age. However, as Lapeyssonnie has documented, there are frequent exceptions to this pattern.¹ Horn,¹⁶ for example, noticed a progressive increase in the proportion of cases over 16 years of age in northern Nigeria from 22% in 1948, to 28% in 1949, and to 61% in 1950. In 1949 11% of the cases reported in Upper Volta were 15 years of age and older. In 1955 this had risen to 59% and in 1956 it was 40%.¹ This progressive shift of a larger proportion of cases from younger groups to older ones in successive years has been documented elsewhere in Africa. Lapeyssonnie rightly states that one would expect most cases to occur in the five to 15 year age group since they are the most numerous in the average African population.¹ Binkin and Band found that the highest attack rates were in those under one year of age and 15 to 19 years of age.² But rates were also high in the 5 to 9 and 10 to 15 year age groups as well.

The preponderance of cases among males over females has been documented in a number of epidemics.¹ A possible explanation for this may lie in the habits of young boys who constitute a very large proportion of cases in any epidemic. In Mali, young boys generally sleep together in a huddled mass with their heads together and their bodies stretched out like the spokes of a wheel. Such nocturnal proximity greatly enhances transmission of *Neisseria meningitidis*. Young girls, however, do not regularly sleep this way. In addition, young boys roam about during the dry season engaging in play and close physical contact whereas young girls remain at home helping with domestic chores, having only occasional contact with friends. Thus the dry season behavior of boys five to 15 years of age in Mali is characterized by both close daily and nocturnal contact.

During the 1969-1971 epidemic, only Group A strains were isolated. But in 1981 both Group A and Group B were isolated. In general, Group A organisms have been usually found in the western part of the meningitis belt, with Group B organisms restricted to the Sudan. However, as documented in the 1981 Bamako epidemic, Group B organisms are now present in the western part of the belt.

The 1969-1971 epidemic of meningococcal meningitis in Mali was the

largest recorded in this century. It provided perhaps one of the last opportunities to study certain epidemiological characteristics of the disease since the development and use of meningococcal vaccines is likely to prevent the development of such large epidemics in the future.

SUMMARY

Since the beginning of this century, epidemics of meningococcal meningitis have occurred in Mali at regular intervals. Six such epidemics occurred during the 40 year period, 1940-1981. The most serious of these extended over a three year period, 1969-1971, causing 18,288 cases and 1,991 deaths. The epidemiological characteristics of this epidemic are presented in detail and compared to those of other epidemics in Mali and neighboring African states.

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