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Niger: Assessment of Malaria Control

Niamey, January 24 – February 15, 1990

by

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and

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Executive Summary

At the request of USAID/Niamey, VBC consultants Dr. Alfred A. Buck, physician-epidemiologist, and Dr. Norman G. Gratz, medical entomologist, conducted an assessment of malaria control in Niger. The assignment had two major goals: 1) to assess the malaria situation in Niger, including its impact on public health and the scope and efficacy of chemoprophylaxis, treatment, transmission dynamics, vector control and other control measures; and 2) to provide an analysis of the needs of the malaria control service and make recommendations for improving malaria surveillance and control at all levels of the national health services.

The work was performed between January 25 and February 15, 1990, in different parts of Niger. The consultants interviewed health officials and other professionals who were knowledgeable about the malaria situation in the country. They made site visits to hospitals, medical centers, dispensaries, laboratories and villages with and without voluntary health workers. Ponds, irrigation ditches, ricefields construction sites and other potential breeding sites of *Anopheles* mosquitoes were inspected in the different ecological areas visited.

The Ministry of Public Health's (MOPH's) malaria coordinator, his deputy and a member of the malaria drug resistance surveillance team accompanied the VBC consultants on their visits and field trips. Additional information about the malaria situation was obtained from the WHO representative, the Tulane University advisory team for health information systems, and practicing physicians and nurses in hospitals and clinics. Information on resistance to antimalarial drugs was based on two sources: anecdotal evidence from clinical observations provided by physicians and the results of the first study by the MOPH using *in vivo* and *in vitro* testing for chloroquine and mefloquine resistance of *Plasmodium falciparum* in four different areas of the country.

The Situation

Malaria is the most important disease in Niger. It accounts for 19 percent of all reported conditions of ill health. It is also one of the leading causes of death in children. During the past five years, the total annual number of reported malaria cases has ranged from 517,00 and 726,900. The true annual incidence of malaria is much higher because of gross underreporting from areas not covered by the government health services. Young children and pregnant women are at the highest risk of malaria infection, disease and death. There are three levels of endemic malaria, ranging from hypoendemic in the

desert zone of northern Niger (average parasite rate of 27 percent in children younger than 10) to meso- and hyperendemic in the sahel (parasite rates between 66 and 93 percent in children 2 to 9 years old) and hyper- to holoendemic in the southern savanna areas (parasite rates in children above 80 percent during the rainy season).

Recently, the malaria situation in Niger has been affected significantly by man-made environmental changes that have extended breeding sites for malaria vectors near human habitations. These include large areas of irrigated rice fields and the many deep borrow pits and pools dug to meet the growing demand for mud bricks to build new houses in rapidly growing urban communities.

Malaria control

Niger's malaria control program is based on one of the strategy options for malaria control adopted by the Expert Committee on Malaria of WHO in 1979: namely, treatment of all cases presumptively diagnosed as malaria at the place of the patient's first encounter with a health service or voluntary village health worker. This control measure is combined with chemoprophylaxis of high risk groups. Originally, pregnant women and all children younger than 10 were given chloroquine during the three months of the rainy season. However, this policy was changed because of inadequate population coverage and poor compliance. Now only pregnant women are receiving chloroquine prophylaxis (300 mg of the base per week) from the third month of pregnancy until six weeks after delivery.

The application of insecticides for malaria vector control is only practiced in the large towns and in a haphazard fashion. The use of bed nets and insect repellents for personal protection is not widespread and plays no major role in malaria control.

Recently, there has been evidence of drug resistance of *Plasmodium falciparum* to chloroquine in Niger. A small, but technically adequate trial using both *in vivo* and *in vitro* tests in children, based on WHO standards, has revealed the existence of two foci of chloroquine resistance in Gaya and Tillabery, located in the southwest of the country, near the borders with Burkina Faso, Benin, Nigeria and Mali. There was no evidence of resistance to mefloquine in these trials. There is also clinical evidence of chloroquine resistance from expatriates in Niger who developed malaria even though they had taken chloroquine prophylaxis regularly and in adequate doses. Studies of drug resistance to antimalarial drugs have not yet been conducted in the larger towns or in Niamey.

Key findings

Malaria control in Niger is based on the treatment of all presumptive cases of malaria and chemoprophylaxis of pregnant women. The program is executed as part of the general health services through dispensaries, rural health centers, medical centers staffed by nurse-practitioners, MCH centers, departmental hospitals, and an as yet incomplete network of voluntary primary health care workers (secouristes) covering about half of the country's 8,615 villages. Malaria diagnosis is based on the presence of fever with chills, accompanied by headache. Although other obvious causes of fever, including measles, tonsillitis, pneumonia and middle ear infection, should be identified, chloroquine is given to most of the febrile cases. Severe cases of presumed malaria characterized by high fever complicated by vomiting, neurological symptoms and loss of consciousness are referred to hospitals and medical centers for treatment.

Chloroquine is the standard drug for malaria treatment. Injectable quinine is used for treating severe cases at most government health services. Because of traditional beliefs that injectable drugs are more effective than oral medications, many patients receive unnecessary or excessive quinine injections.

Chloroquine is manufactured locally in Niger by the semi-private Office National des Produits Pharmaceutiques et Chimiques (ONPPC). The company also imports quinine sulfate and amodiaquine for malaria treatment. The drugs are distributed through 22 pharmaceutical depots (pharmacies populaires), one in each of the seven departments and an additional 15 in the larger arrondissements. There are also 88 private (cooperative) drug depots and four private pharmacies. There have been difficulties with maintaining the supply of chloroquine in many of the dispensaries and medical centers. Vector control plays only a limited role in the malaria control program. Insecticide spraying is limited to Niger's major cities.

Until the end of 1989, all malaria cases and those of nine other diseases of public health importance[1] seen by the health services of each arrondissement were reported to the MOPH by weekly telegram. The prompt analysis of these reports at the national level has much improved since a central service for data processing and health statistics was created at the MOPH in 1986 with the technical assistance of a Tulane University team. The new health information

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[1] measles, meningitis, pertussis, diphtheria, tetanus, polio-myelitis, pneumonia, hepatitis and diarrhea

system has uncovered many deficiencies in the weekly reports. In January 1990, a new system with trimestrial reporting of malaria cases was introduced. Under this system, the departmental health services must collate the case reports before forwarding them to the MOPH. Experiences with the new system are not yet available.

The impact of the current malaria control program on malaria transmission has been minimal. Due to the incomplete and diagnostically equivocal reporting of malaria morbidity and mortality, the true impact of the program on public health cannot be assessed. The following is a list of observed weaknesses in the malaria control program for which remedial action is indicated, practical and apparently feasible:

1. The diagnosis of presumptive malaria in infirmaries, health centers and at the village level must be improved to avoid unnecessary chloroquine treatment of patients with non-malarial fevers. Only a small fraction of blood slides drawn from fever cases presumptively diagnosed as malaria during the dry season were positive for malaria parasites.

2. There is ample evidence that chloroquine is often unavailable for treatment and chemoprophylaxis of malaria in many rural areas during the rainy season, when transmission reaches its peak. Because of additional logistic, economic and manpower problems during that season, the supply difficulties increase with the distance of villages from the major towns where the drug depots are located.

3. Adherence to treatment by traditional healers, lack of knowledge, and unpleasant adverse reactions to chloroquine have all conspired to reduce community compliance in seeking treatment from the health services or participating in chemoprophylaxis programs.

4. As a condition for continuing its assistance to the national malaria control program, the World Bank has proposed that in the future, all patients with a presumptive diagnosis of malaria must pay for the chloroquine tablets they receive for treatment. The other essential drugs available at the village level will continue to be dispensed free of charge.

   Restricting this cost recovery initiative to chloroquine is detrimental to the malaria program for two reasons. It could selectively reduce malaria treatment for those who are at the highest risk of disease but who can least afford to

buy the drug. During the rainy season, malaria transmission and physical labor reach their maximum while the available cash is at its annual minimum. Furthermore, the required payment may make patients use fewer chloroquine tablets than would be required for complete treatment because they may try to save some of the drug for future treatment of family members with fever. This practice would intensify the spread of chloroquine resistance.

5. There is a shortage of health personnel at all levels of the system. Programs for continuing education of health workers are lacking and supervision of the secouristes by professional staff is irregular.

6. The malaria case reports are incomplete and too irregular to furnish the type of data required to make accurate estimates of the amount of the antimalarial drugs needed for timely drug supply to Niger's three ecological zones.

7. Malaria control personnel lack current information about the dynamics of malaria transmission, the different types of vectors and their biology, bionomics and vectorial capacity during the different seasons, as well as the different types and formulations of insecticides available.

8. There is no coordination between the MOPH's vector control activities and the large-scale agricultural pest control measures of the Ministry of Agriculture. Resistance patterns of malaria vectors to specific pesticides are unknown.

9. Information on drug resistance is sketchy. A study of chloroquine resistance has been underway in the Departments of Agadez, Taba and Zinder. It is being conducted by a joint team of OCCGE and the MOPH of Niger as part of the preparations to build a new trans-saharan highway from Algeria with access to Niger, Mali and Burkina Faso.

Key recommendations

1. The Government of Niger (GON) should request the services of a French-speaking team composed of a physician-epidemiologist and an entomologist with field experience in malaria control in West Africa. The visit should be planned for the rainy season, when malaria transmission and morbidity are at their peaks. This four-week assignment would help identify critical deficiencies in the malaria control program and the management of malaria cases that could not be identified during the low-transmission season.

2. After the consultant team has completed its work with the MOPH at the end of the rainy season 1990, a small network of about five sentinel population samples should be created for adequate malaria surveillance. Each of the population samples should be representative of one of the three major ecologic subdivisions of Niger in order to furnish reliable data on the incidence of malaria infection, morbidity, mortality, drug resistance, vector biology, vectorial capacity and transmission rates.

3. A reference library with textbooks, guides and teaching aids on all aspects of malaria should be established as soon as possible at the MOPH. WHO has an excellent collection of publications and guidelines for field malariologists, including sets of teaching slides.

4. The MOPH should conduct *in vivo* and *in vitro* trials on resistance to antimalarials in Niger's cities, where drug pressure is high. Considerable benefit could result from joint technical assistance from the S&T/H VBC Project and WHO's Control of Tropical Disease Division.

5. Soon after the rainy season, the MOPH should make detailed preparations for a pilot study of the acceptability and efficacy of impregnated bed nets and curtains. Trials of these methods must be preceded by a study of attitudes toward the use of bed nets and curtains among people in different parts of the country. Entomological and epidemiological personnel must determine not only the method's effect on mosquito populations, but its effect on malaria transmission and frequency of clinical attacks. Assistance can be obtained from the neighboring countries of Mali and Burkina Faso, as well as the Gambia, where considerable

experience with this method already exists (Prof. Toure in Bamako, Profs. Coluzzi and Guiguemde in Burkina, and Dr. Greenwood in the Gambia).

6. There should an effective program for public health education about malaria using mass media, including radio and village television.

7. The GON should request the full-time services of a French-speaking physician-epidemiologist experienced in malaria control in sahelian Africa for a period of six months to one year and an experienced entomologist for three months, with follow-up visits as indicated. These advisors would help the GON revise the national malaria control program, with special attention to the following areas and tasks:

   a. Current diagnosis of presumptive malaria based on clinical evidence needs to be revised by creating simple diagnostic algorithms for the differential diagnosis of febrile diseases, particularly during the dry season, when the use of chloroquine for non-malarial fevers is very high.

   b. A rotating, medium-term training program for qualified candidates in malaria epidemiology, entomology and parasitology should be created.

   c. A coordinated national research program on malaria transmission, vector biology and vectorial capacity, morbidity, mortality, pregnancy and malaria, drug resistance, health service delivery and malaria control should be established.

   d. Assistance in the design, operation and evaluation of an effective malaria surveillance pilot project should be requested.

8. The network of field laboratories for parasitologic diagnosis of malaria should be strengthened to include appropriate identification of the *Plasmodium* species and parasite densities, supervision and quality control, regular laboratory supplies, training of technicians, including refresher courses, and better integration of the parasitologic diagnosis of malaria into the basic diagnostic laboratory program for medical centers and some strategically located dispensaries.

9. The system for supervision and counseling of the peripheral health services and secouristes needs improvement, focusing on diagnosis, disease reporting, treatment and chemoprophylaxis, and a seasonally adjusted flow of antimalarial drugs. In areas with unusually difficult transportation during the rainy season, a feasibility study of an inexpensive two-way radio communication system between dispensaries and medical centers should be conducted.

10. The number of properly trained and equipped entomological teams should be increased to make vector identifications, establish man-biting and infection rates, study the seasonal dynamics of malaria transmission and determine insecticide resistance. Consultants could begin these studies while national personnel were receiving advanced training. A council for integrated pest control should be formed to use all of the available information on pesticide resistance in the country.

11. Three Nigeriennes should be trained as M.Sc.-level medical entomologists. An M.Sc. course in medical entomology and vector control is offered at the University of Cote d'Ivoire, Bouake, Cote d'Ivoire. Upon completing their training, the entomologists should have the following responsibilities:

    a. One entomologist should be responsible for conducting baseline studies of the distribution of *Anopheles* vectors in Niger, their bionomics and vectorial capacity in different areas of the country. Specific studies should assess the effects of water development projects and urbanization on vector population densities.

    b. A second entomologist should conduct studies of possible methods of vector control, including insecticide-impregnated bed nets and curtains. Insecticide susceptibility tests should be conducted, as well as trials of the possibility of controlling larval anophelines with larvicides or by eliminating vector breeding sites. In rural areas, it would be impractical to use larvicides against the rainpool-breeding *An. gambiae*, whose larval habitats are found everywhere during and immediately after the rainy season. It is possible, however, that the larval habitats in urban areas are sufficiently restricted to warrant larviciding to control malaria.

c. A third entomologist should be given the responsibility of implementing vector control measures and training health center and village volunteers in the methods that have been found to be cost-effective. He or she should be responsible for training health personnel at the primary health care schools and the central school of public health. This entomologist would also advise, supervise and evaluate urban vector control activities.

12. The malaria program coordinator, Mr. Sani Zaqui, or another person with a similar professional background, would profit greatly from participating in the periodic WHO-Government of Italy course on the epidemiology and control of malaria. The course includes three months of theory at the malaria institute in Italy and three months of practical training at an African site. Should Mr. Sani be selected to participate in such a course, another professional from the MOPH should be enrolled in the next course.

13. The curricula and training courses at the level of the Departments, the Schools of Public Health, Nurses and Midwives should be upgraded to include a program of multidisciplinary continuing education in malariology for physicians, nurses, laboratory technicians and entomologists to enhance the essential team work in malaria control.

14. The MOPH should conduct a pilot study of the use of simple, color-coded checklists to improve the present ineffective system of reporting of presumptive malaria cases seen by the secouristes.

15. The MOPH and USAID/Niamey should assess the advisability of holding a donors' meeting to develop appropriate roles for and promote coordination between international and bilateral funding organizations.

1. Introduction

According to USAID/Niamey's Strategic Objective for Niger[2], the goal of the Mission's health sector is "To improve the health status of the people of Niger, with special efforts made to reach the rural population....Improving health status means improving the health indices, reducing mortality and morbidity...." One of the specific targets listed... "is the control of malaria through better access to medical care and provision of preventive health services." The benchmarks for this target are to revise and implement malaria protocols and to ensure that chloroquine treatment follows standardized medical guidelines and that the supply of the drug is regular. Primary health care now reaches 50 percent of villages, but its operations have not yet been strong enough for a sufficient period to alter basic morbidity and mortality patterns. The USAID document also noted that a large portion of the health infrastructure is now concentrated in urban areas.

Malaria control in Niger has received the attention of several other organizations and donors. WHO and CCCD[3] sponsored a recent workshop in which representatives from Niger participated.

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[2]A.I.D. Country Development Strategy Statement, FY 1988, Niger. Annex B, Assessment of the Niger Health Sector, Washington 1986

[3]CCCD/WHO Atelier Interpays sur la stratégie régionale de la lutte antipaludique basée sur les SSP. Bamako, Mali, 1989

2. Scope of Work

The following is the detailed scope of work provided to the team by cable from USAID to A.I.D.'s S&T/H:

" 1. Meet with GON and other donors to establish a complete list of current malaria control activities in Niger and to ascertain current control strategies. Evaluate national resources available for malaria control.

2. Compile available information on morbidity and mortality associated with malaria in rural and urban areas. Examine ongoing studies on chloroquine resistance, morbidity/mortality, and entomology as basis for follow-on work. Present a comprehensive overview of the situation and provide scopes of work for possible future studies or surveys required to further define the situation.

3. Evaluate guidelines currently prescribed, and actual adherence to them by health workers and their instructors or supervisors for the diagnosis and treatment of malaria. Make recommendations to the MOH for revisions to the existing policy on prophylaxis use and presumptive treatment.

4. Work with the MOH and the Tulane resident advisors on defining needs for the collection and utilization of malaria statistics in Niger.

5. Make recommendations to the MOH as how to establish targets for the malaria control program.

6. Make recommendations on an appropriate stratification plan to make resources available to high risk groups and coordinate with recommendations for improved surveillance.

7. Identify whether vector control is feasible, and if so, recommend means of vector control that might be cost effective. Also establish which areas in Niger might benefit from such schemes and write any scopes of work required to further study vector control activities.

8. Identify training needs for key personnel and recommend to USAID those personnel who might best benefit from further training in malaria control, especially in regards to specific courses, as appropriate."

3. Background

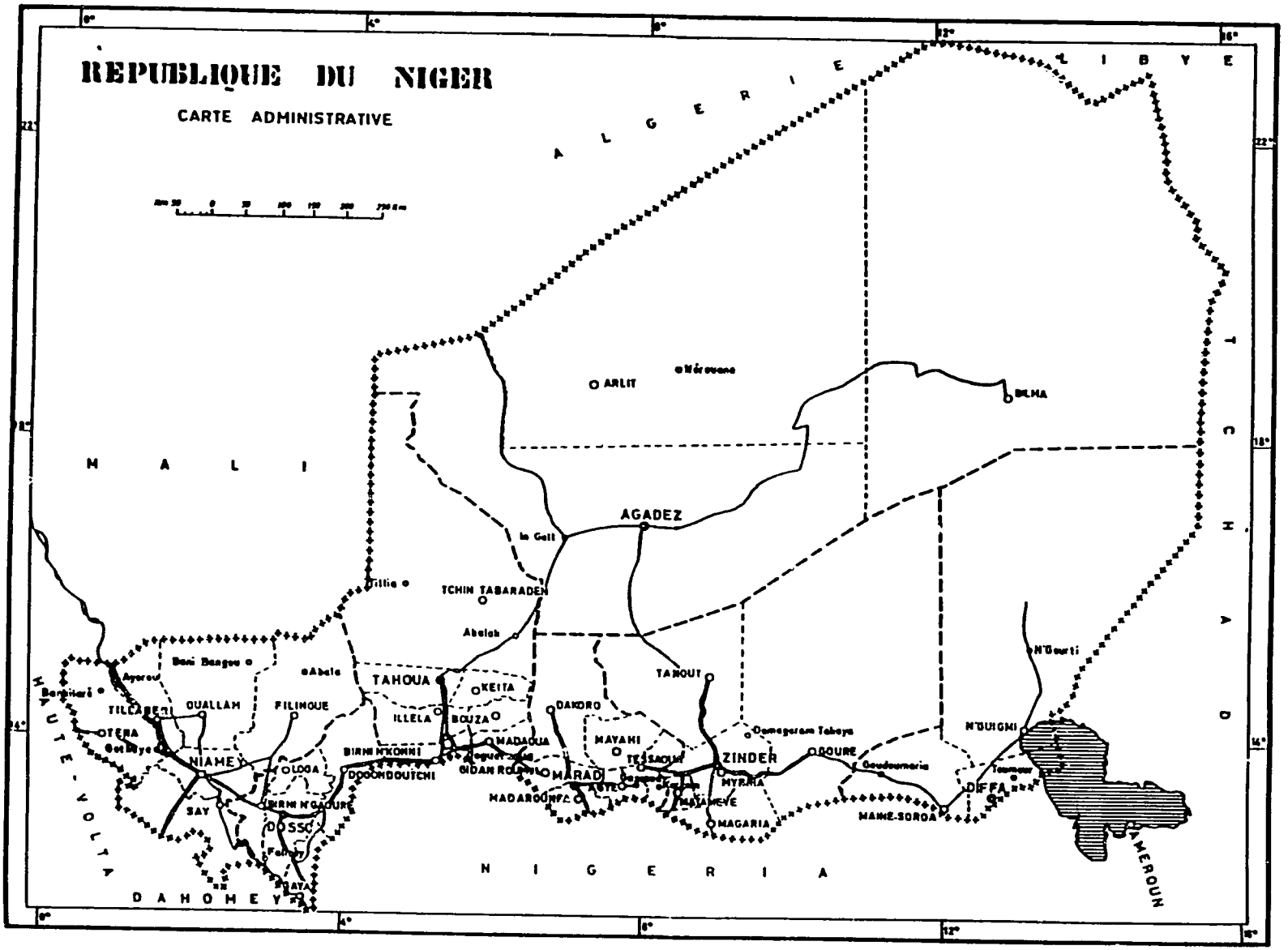
Geography

The Republic of Niger is located in the Sahelian zone of West African between 12 and 23 degrees north latitude and 0 to 16 degrees east longitude (Figure 1). Its total area covers 1,267,000 km, with an east-west distance of about 2,000 km and a north to south range of about 1,300 km. The only perennial river of the country is the Niger, which flows for a distance of some 500 km through its southwest. There are several smaller rivers that cease to flow during the peak of the dry season. The shallow Lake Chad touches the southeast corner of the country at its borders with Chad, Cameroon and Nigeria. There are also a number of permanent brackish, swampy areas in the south of Niger that provide potential habitats for year-round anopheline breeding.

Climate

Climatically, the country can be divided into three major zones whose characteristics greatly influence the transmission of malaria: Sudan savanna, sahel and desert. The savanna, limited in the north by 15^0 latitude, is the region with the highest rainfall, averaging 900 mm per year. Most of the agricultural production of Niger is concentrated in this region. The Sahelian zone is limited in the north by the 16th parallel and receives an average of 370 mm of rainfall per year. Marked by thorn scrub and acacia vegetation, it is a major area of animal husbandry. Further to the north, the vast Sahara desert covers the remaining part of the country. With the exception of some oases, this is a zone without agriculture. The area is characterized by temperature extremes between day and night. The rainfall ranges from 0 to 200 mm per year.

The median temperature for the entire country is 37^0C. The rainy season lasts from June to September, becoming progressively shorter as one moves towards the north. The dry season extends from October to May, with a relatively cool period from November to February and a hot period between April and May.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NIAMEY
OLOGA
SAY
BIRNI N'GAOURE
DOSSO
Falmey
BAGA
BIRNI N'KONNI
DOGONDOUTCHI
GIDAN ROMAN
Dogondoutchi

Figure 1

Demography

In 1988, there were an estimated 7,249,596 inhabitants, most of whom were concentrated in southern Niger along the borders with Nigeria, Benin and Burkina Faso. The annual population growth rate is estimated at 3.1 percent. Forty five percent of the population is younger than 15. A demographic summary is provided in Table 1.

The population density of Niger is 4.9 per km2, but 75 percent of the population live in 12 percent of the territory, mainly in the south, where the density is 27 per km2. The rural proportion of the population is estimated at 85 percent and the overall literacy rate at 8 percent. The economic situation of the country is precarious, with an estimated per capita income of US$ 330.00 in 1981 and of US$ 220.00 in 1987. The drop was caused by both the drought in the Sahel and the decline in the price of uranium. In 1986, the trade deficit reached US$ 6 million.

Table 1. Demographic Indicators of Niger, 1988

Age <12 months	19.4%
12-23 months	4.5%
2 to 3 years	4.1%
3 to 4 years	3.6%
4 to 5 years	3.4%
All <15 years	45.0%
15 to 65 years	50.0%
over >60 years	3.0%
Life expectancy at birth	45.0
Crude birth rate	52/1,000
Crude death rate	21/1,000
Infant mortality	132/1,000
Child mortality	270/1,000
Maternal Death Rate	7.1/1000

Major diseases and health problems

Reliable health statistics and cause-specific mortality data are not available. Disease reporting is incomplete and often lacks diagnostic specificity, except for the common diseases that have characteristic, easily observed symptoms, including measles, meningitis, poliomyelitis, tetanus, diarrhea, pneumonia, accidents, inflammatory eye diseases and gonorrhea.

In major towns where laboratory services are available, additional diagnostic specificity can provide information on such chronic infections as tuberculosis, leprosy, syphilis, schistosomiasis and onchocerciasis. But most of information on which annual health statistics are based is obtained from reports of the peripheral health services, which are staffed by licensed nurses, midwives and practical nurses.[4,5]

It has been estimated that only about 10 percent of the deaths in Niger are reported. A 1985 study on morbidity and mortality by Tulane University's Health Information Team at the MOPH ranked the major causes of child mortality as follows: fever presumptively diagnosed as malaria, measles, diarrhea, respiratory infections and tetanus. Multiple causes were listed for the majority of the reported deaths. In a study of the cause of mortality of 0- to 4-year-old children in Niamey, malaria ranked second. Malaria has continuously occupied first place in the list of reported diseases, accounting for 19 percent of all reported health conditions in the MOPH's recent annual health statistics. A synopsis of the reports for 1986 is depicted in Table 2.

There are about 4,000 new cases of tuberculosis in the country each year. The total number of registered leprosy cases is 13,000. There are large endemic areas of urinary schistosomiasis (*Schistosoma hematobium*). Morbidity related to pregnancy and maternal mortality (70 per 10,000) are among the highest in the world. Furthermore, the country has a severe public health problem due to malnutrition, especially during the rainy season, which is also the planting season, when malaria transmission is at its highest and physical labor requirements reach their peak. Vitamin A deficiency among children is said to be frequent.

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[4]Country Development Strategy Statement, FY 1988, Niger. Annex B. A.I.D., Washington, 1986

[5]Programme National de Lutte Contre le Paludisme 1987-1991. Ministry of Public Health, Niamey 1989.

There are 27 different bilateral health projects in the country[6]. Many of these focus either on specific diseases or selected methods of intervention, or are limited to selected target populations. In a country where multiple infections and concomitant diseases are the rule rather than the exception, such health conditions are reported as multiple case reports in the annual health statistics.

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[6]Personal communication, Director, School of Public Health

Table 2. Ten Most Frequently Reported Diseases, 1984–1986

Condition	Year of Reporting 1984	1986	Percent[a]
Presumed malaria	547,845	726,952	19%
Diarrheal diseases	426,196	361,751	9%
Respiratory Infections	272,606	284,233	8%
Eye Infections	250,120	293,149	8%
Rhinopharyngitis	232,640	266,574	7%
Wounds and injuries	222,651	229,754	6%
Ill-defined conditions	199,424	230,355	6%
Abdominal pain	165,147	185,733	5%
Skin diseases	144,887	116,755	3%
Measles	44,228	21,021	1%

[a] percentages are based on all reported cases

Organization of health services

The organizational structure of the health services in Niger is shown in Figures 2 and 3. There are seven major hospitals, one in each of the capitals of the seven Departments of Niger. In addition, special services are provided at the new hospital Center of the Medical School in Niamey and at the two national hospitals in Niamey and Zinder, respectively. Below the level of the Departments are 39 medical centers. They are located at the administrative centers of the arrondissements (districts) and run by a graduate nurses and midwives.

Each major hospital has separate laboratories for parasitology, hematology, basic blood chemistry and some immunodiagnostic and basic bacteriologic tests, as well as facilities for operating a small blood bank. The blood banks do routine screening for syphilis (VDRL), malaria parasitemia and AIDS. The medical centers have small laboratories for urine analyses, blood sedimentation and hemoglobin determination. Most also have a microscope to examine stained bacteriological slides and blood, stool and urine examination for parasites. However, most examinations for schistosomiasis and meningitis are done by special OCCGE[7] teams. Each medical center has twelve beds and a separate maternity unit staffed by graduate nurse-midwives.

At the next lower level are medical posts (25) and rural dispensaries (232). The dispensaries are the most peripheral of the governmental health services. They are staffed by certified nurses, who are also charged with the supervision of the Village Health Teams (VHTs) in their sub-districts. This volunteer health worker primary health care system began during the 1960s. Now there are about 4,000 teams in the country's 8,615 villages. These teams are made up of voluntary health workers composed of secouristes, or first aid providers, and matrones, or traditional birth attendants. The former give basic treatment (chloroquine, aspirin or oral rehydration salts) for fever and diarrhea and provide first aid.

The matrones and the secouristes are selected by the people. They do not receive money from the government. Both groups have received two weeks of initial training and are scheduled for a 10-day refresher course once every three years. Funding for this village health program has come from the USAID/Niger Rural Health

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[7] Organisation De Coordination Pour La Lutte Contre Les Endemies En Afrique Ouest

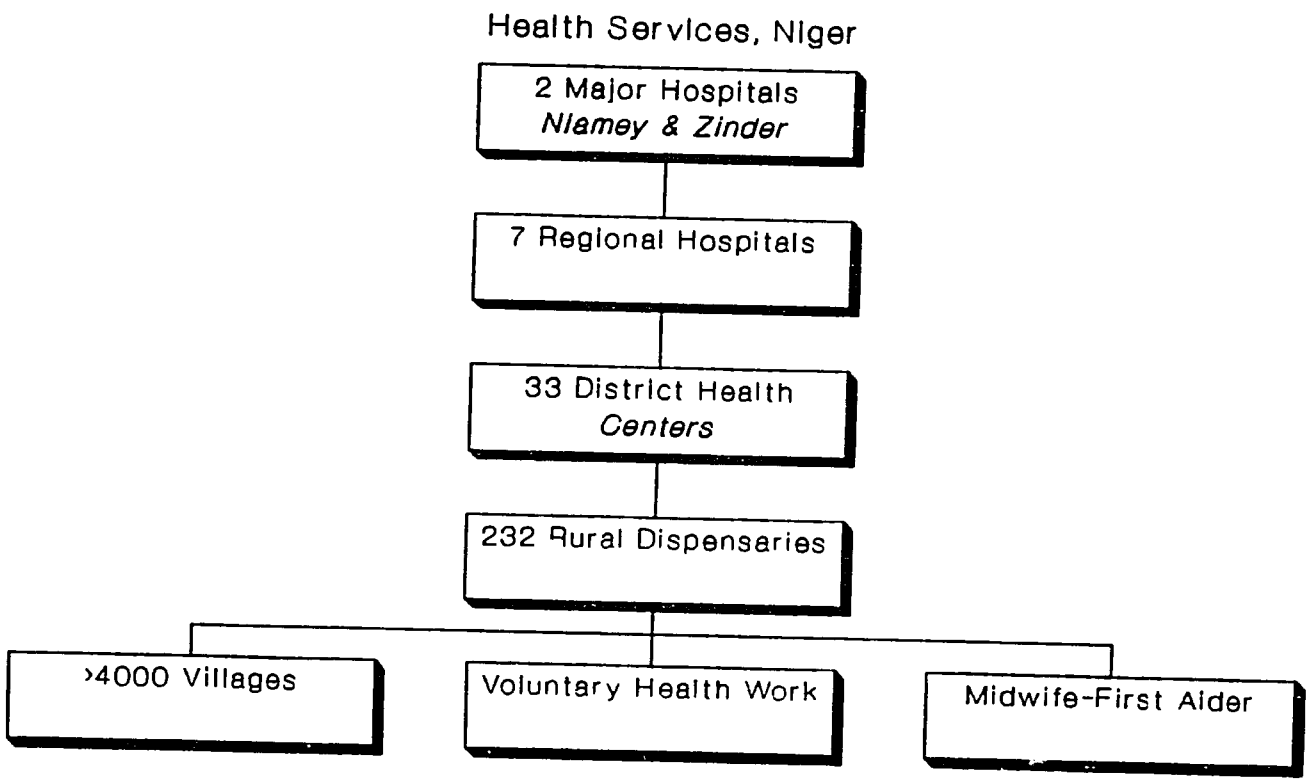
Health Services, Niger
2 Major Hospitals
Niamey & Zinder
7 Regional Hospitals
33 District Health
Centers
232 Rural Dispensaries
>4000 Villages
Voluntary Health Work
Midwife-First Aider

Figure 2

HEALTH ADMINISTRATION
NIGER

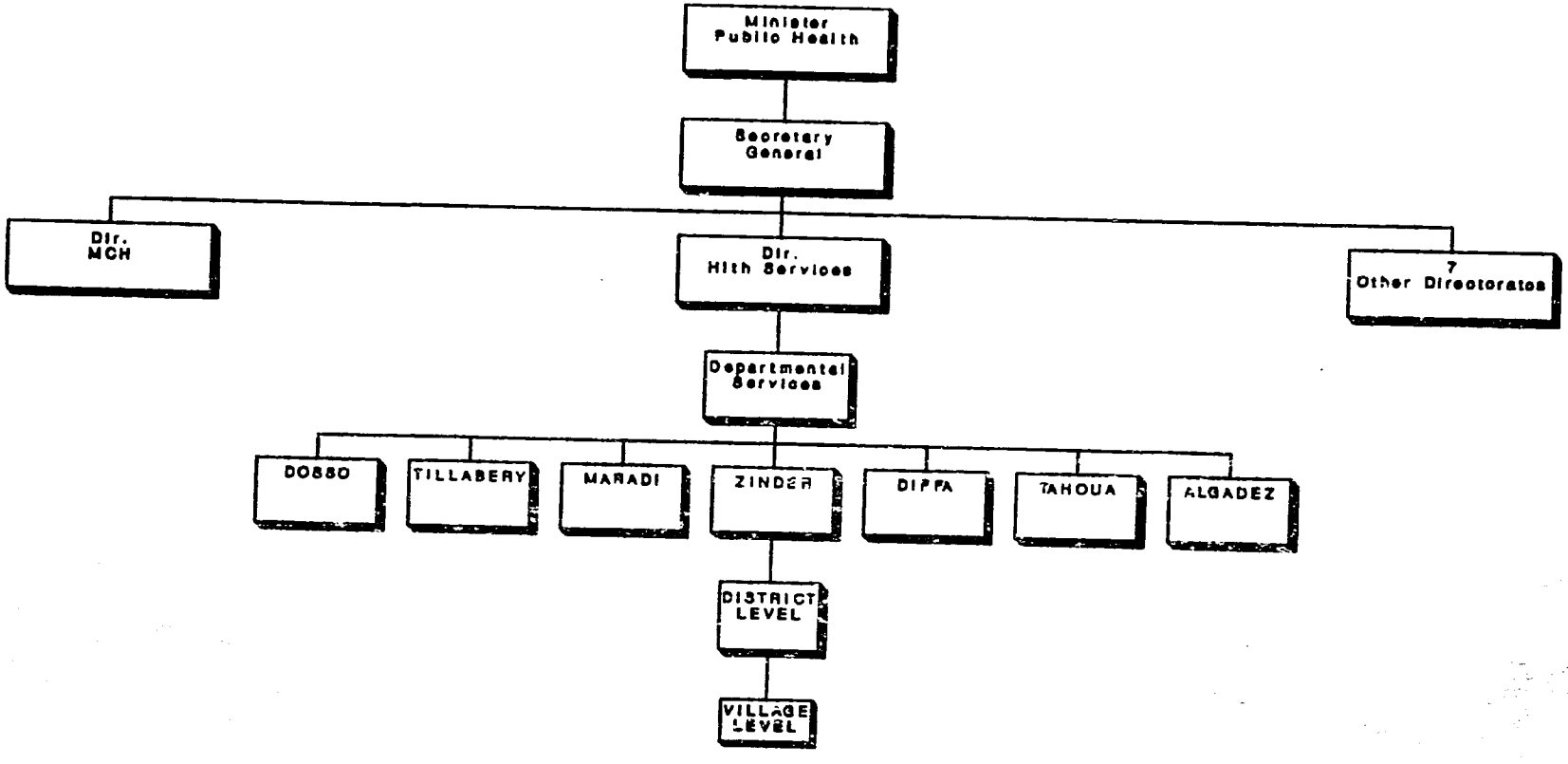

Figure 3

Improvement Project. The secouristes must charge their patients for treatment and use the money to buy the basic medications they are allowed to dispense. Theoretically, they should be supervised by the nurses in charge of rural dispensaries at monthly intervals. However, understaffing, the serious logistical difficulties in supervising an average of 17 village health teams per dispensary, and lack of transportation have made it impossible for the nurses to provide adequate guidance and supervision.

The latest available health manpower figures from the MOPH indicate that there are 140 physicians, 5 dentists, 14 pharmacists, 272 graduate midwives, 954 registered nurses, 819 certified nurses, 145 laboratory technicians, 79 trained social workers and 5,769 secouristes and 6,380 matrones.

There are special services for maternal and child health and programs for immunization, malaria control (described in the following section), diarrheal disease control, nutrition, sanitation and vector control, and family planning.

The "Division de l'Hygiene et de l'Assainissement" (Hygiene and Sanitation) in the MOPH is responsible for vector control in the country, in addition to being charged with a wide range of activities related to water, food and environmental quality. There are no malaria vector control activities in the country other than the scattered use of insecticide power dusters in major towns and cities. There has been no survey of vector distribution or density in Niger and there is no information about the location, seasonal occurrence or nature of the larval habitats of malaria vectors. No insecticide susceptibility tests have been carried out on any mosquito species in the city in recent years.

Distribution of drugs and chemicals

Since 1974, the semi-private National Office of Pharmaceuticals and Chemicals (ONPPC) has been responsible for the importation, production and distribution of drugs in Niger. It operates under the umbrella of the MOPH. There are presently 22 "people's pharmacies" through which drugs are distributed in the country. In addition, Niger has 88 cooperative, semi-private drug depots and four private pharmacies. The drug depots carry about 50 essential medicines. Two of the most frequently used drugs, aspirin and chloroquine, are produced by ONPPC. The company also manufactures ORS packets.

The supply of drugs is generally sufficient in the hospitals and urban areas, but it is inadequate at and below the level of the medical centers. At the village level, the secouristes are allowed to dispense aspirin and chloroquine for money, which they must use to replenish their stocks from the nearest people's pharmacy. In 1988, the GON spent US $ 78,324 on chloroquine alone. At that time, a tin of 1,000 tablets of 100 mg chloroquine (base) tablets cost 4,920 CFA, the equivalent of about U.S.$ 17.30, or 26 cents per treatment of an adult with a presumptive diagnosis of malaria. The difficulties in distributing drugs at the peripheral level of the official health services will be discussed in more detail in the following section.

4. Malaria: the Situation and the Control Program

Malaria is the most frequently reported disease in the country and is a leading cause of child mortality. There were 726,952 reported cases in 1986, 684,291 cases in 1988 and 519,770 in 1989 (still incomplete). This represents roughly 19 percent of the annual reports of all diseases. Malaria in Niger occurs in three ecologic strata: savanna, sahel and the sahara desert. Because of the differences in rainfall and vegetation patterns in these areas, the disease occurs at hyperendemic, mesoendemic and hypoendemic levels, respectively.

General epidemiologic factors

With the exception of expatriates and some isolated population groups in the northern sahara, malaria in Niger is endemic. This means that the level and intensity of infection is determined by an unstable equilibrium between the force of infection (vector density and vectorial capacity) and the proportion of community members who are non-immune (young children) and those who are immune. The immunity is complex and is specific for each of the different developmental stages of the malaria parasite, but it can be divided into two categories according to its effects: complete immunity, which prevents new infections, and clinical immunity, which prevents disease. Clinical immunity allows people to become infected and transmit the infection to the vector mosquitoes without becoming ill.

Between complete immunity and complete susceptibility there is a nearly infinite range of possible immune states that are expressed in highly variable parasite densities and disease severity. Hence, unlike malaria in expatriates and other non-immune individuals, malaria infections in most residents of endemic areas during peak transmission times are not accompanied by fever or other symptoms. The level of endemicity is determined by the number of infective mosquito bites per person, the proportion of residents in the community who receive infective bites, and the interval and frequency of the infections. In the West African sahel, malaria transmission is seasonal, with far more of the malaria infections and disease occurring during the rainy season than during the dry season (Figure 4).

In the rural savanna region of Niger, the infection rate in children younger than nine was found to range between 80 and 90 percent. The majority of these children were free of symptoms. However, many infants and young children will die before they reach

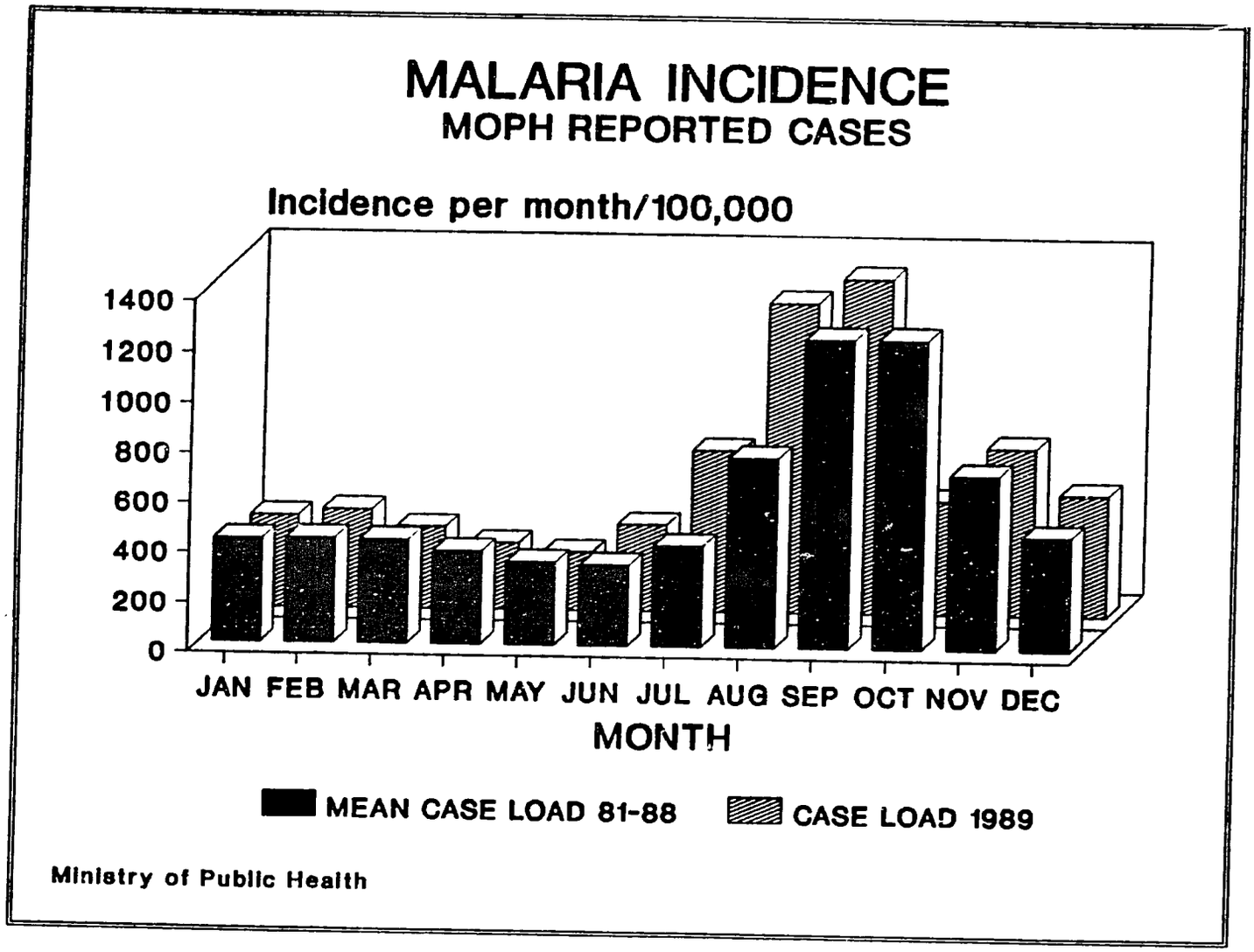
MALARIA INCIDENCE
MOPH REPORTED CASES
Incidence per month/100,000
1400
1200
1000
800
600
400
200
0
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
MONTH
MEAN CASE LOAD 81-88
CASE LOAD 1989
Ministry of Public Health

Figure 4

the level of clinical immunity. Newborns start out with partial protection from malaria through the presence of antibodies transferred from their mothers during pregnancy. These antibodies wane during the first three to six months of life. With new infections occurring each year, all children develop clinical malaria more than once, gradually building up their immunity. Without these natural booster infections, their immunity would decline.

The epidemiologic pattern of malaria is also determined by certain genetic factors. One of these is the sickle-cell gene (S) of hemoglobin. The homozygous combination "SS" causes the often fatal, always severe sickle-cell anemia. The heterozygous combination of a sickle-cell gene and a normal gene, "AS," deters malaria parasites from invading the red blood cells. Therefore, malaria infection and disease are less frequent and severe in people who carry the sickle cell trait than in those who do not.[8] There are no studies of the distribution of the sickle cell gene (S) in the different ethnic groups of Niger. A study of hemoglobin types in five different tribal groups of the neighboring country of Chad revealed a range of AS frequencies between 21 and 0.6 percent[9].

Although the special risks of malaria infections in pregnant women have been recognized in the Niger National Malaria Control Strategy, surprisingly little is known about the relatively greater risk for abortions, stillbirths and low birth weights during a woman's first pregnancy.[10]

Malaria vectors in Niger

Relatively little information is available about the bionomics, vectorial capacity and larval habitats of the malaria vectors in Niger. In 1968, a WHO study indicated that *Anopheles gambiae* was present throughout the country and that *An. funestus* occurred in the region bordering the Niger river. *An. pharoensis* and *An. rufipes* were found in the west and central portions of the country, and *An. dthali* in the desert regions. A more recent, small-scale study conducted by staff of

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[8]F.K. Wurapa et al. Field Studies in Tropical Diseases Research Centre, Ndola, Zambia, pages 60-83. WHO/TDR, Geneva 1985.

[9]Buck AA et al. Health and Disease in Chad. Johns Hopkins Monographs in International Health, Johns Hopkins Press, 1970.

[10]discussions with Directors of MCH services and midwives

the Centre Muraz, Bobo Dioulasso, Burkina Faso, provided additional details about the vectorial capacity of mosquitoes in the Kandaji area of the Niger river. However, no information seems to be available about the presence or distribution of the sub-species of the *Anopheles gambiae* complex in Niger.

If any anti-vector measures are to be carried out in Niger, it is essential to have more information than is now available about the distribution of the various *Anopheles* species and their larval and adult bionomics, particularly the indoor/ outdoor biting habits of the vectors or potential vectors and the seasonal variations of their distribution and populations densities. Unfortunately, there is no one in the country with enough entomological training to conduct such a study or the even more detailed surveys necessary to determine the vector bionomics and distribution. Much more information is available about the anopheline vectors of malaria in neighboring Mali and Burkina Faso, but the ecological differences between the three countries are too great to make reasonably accurate extrapolations from these findings to the situation in Niger.

The National Malaria Control Program

Niger can be divided by the level of malaria endemicity into three broad areas:

The Southern Hyperendemic Zone extends from the borders with Nigeria, Burkina Faso and Benin up to about the 15th degree N latitude, with annual rainfalls between 500 to 1,000 mm per year. This region includes the Departments of Dosso and Tillaberi (Figure 1), with approximately 57.2 percent of the total population of Niger. Parasitemia rates in children younger than 10 are above 80 percent during the rainy season between July and September, when malaria transmission is at its peak.

The seasonality of malaria is quite pronounced. Transmission rises rapidly with the onset of the rains, leading to the rapid expansion of mosquito breeding sites, with marked increases in the house/biting densities of the anopheline vectors (see Figure 4). Near the Niger River, the team noted the presence of numerous rice fields with anopheline breeding, which probably is extensive and occurs during most of the year (Figure 5).

The Central Hyperendemic Zone includes the Departments of Maradi and Zinder and parts of the Departments of Diffa and Tahoua. Approximately 38 percent of the population resides in this

area. Parasite rates in resident children 2-9 years old range between 66 and 93 percent. One out of five infants and one out of four adults have parasitemia. Figure 6 shows the monthly number of cases with presumptive malaria in Tessaoa, an arrondissement in the Department of Maradi, for the past three years (1987-1989). The results show not only the strong seasonal variations of the monthly incidence of clinical malaria cases, but also inter-annual variations in case frequencies related to differences in the total annual rainfall.

The Northern Mesoendemic To Hypoendemic Zone has desert and semi-desert terrain and includes the Department of Agadez, as well as parts of Diffa and Tahoua. A high proportion of its population is nomadic or semi-nomadic. The parasite rate averages 27 percent (maximum 52 percent) in resident children and 10 percent in adults. Malaria transmission in this zone is confined to the short rainy season. Nomads become infected during their migration to the south in the dry season.

In most of the country, malaria transmission is strongly seasonal. It practically triples during the rainy season, when it is highest along the banks of the Niger. Its incidence falls to virtual insignificance during the dry season in large areas of the country. However, little attention or study has been given to the effect of the many marshy areas in the southern region and the growing number of rice fields along the Niger (Figure 5) on *Anopheles* densities. These agricultural developments have prolonged the malaria transmission season for the people who live nearby and who work in the rice fields.

Figure 5

TOTAL CASES OF MALARIA
TESSAOUA: 1987-1989

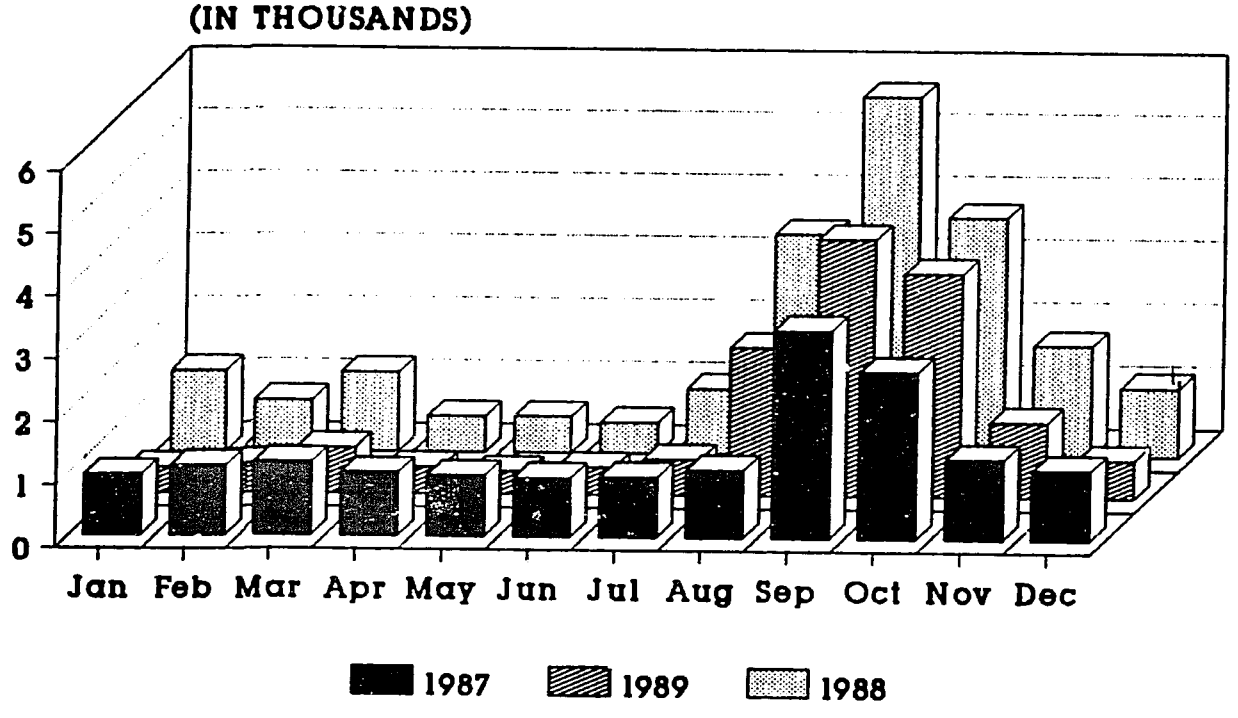

Figure 6

Urban areas

The percentage of Niger's population living in urban areas is increasing. A recent study compared an urban and a rural community during the wet and dry seasons. The incidence of malaria was lower during both seasons in the urban community and its children developed antibodies to malaria later in life. All of the 20- to 29-year-old urban residents had serologic evidence of past malaria infections. In the rural community, evidence of past infections had reached this level among 15 year olds.

The lower level of transmission in urban areas is probably due to better housing, greater use of bed nets, availability of aerosol insecticide bombs, better access to medical services and greater use of antimalarial drugs. However, with a sizeable proportion of the urban population remaining non-immune at the age of 15, conditions are ripe for an urban malaria epidemic, particularly if vector densities should increase significantly in the water collections at the many excavation sites or if some malaria vectors should become adapted to more polluted water sources in urban areas.

There is growing concern about the urban malaria situation in Niger because of the vicious combination of population growth (3.2 percent per year) and migration. The resulting rapid urbanization creates a demand for construction of many new houses built with mud bricks, which are obtained by digging progressively larger and deeper borrow pits to the groundwater level (Figures 7 and 8). These pits expand and prolong vector breeding. Some eventually become man-made lakes that are filled with water even during the dry season (Figure 9).

Malaria control strategy

The GON's strategy for malaria control GON follows the recommendations of the 17th WHO Expert Committee on Malaria.[11,12] The control program is based on two tactical variants of that report: reduction of malaria mortality and prevention of stillbirths, abortions and infant mortality caused by malaria in pregnant women. Both of

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[11] WHO. Expert Committee On Malaria, 17th Report. WHO Tech Rep Ser 640. Geneva 1979

[12] Bruce-Chwatt LJ. Malaria control and primary health care: or the art of squaring the circle. Bull Soc Path exot, 76:477-485, 1983

Figure 7

New borrow pit for mud bricks

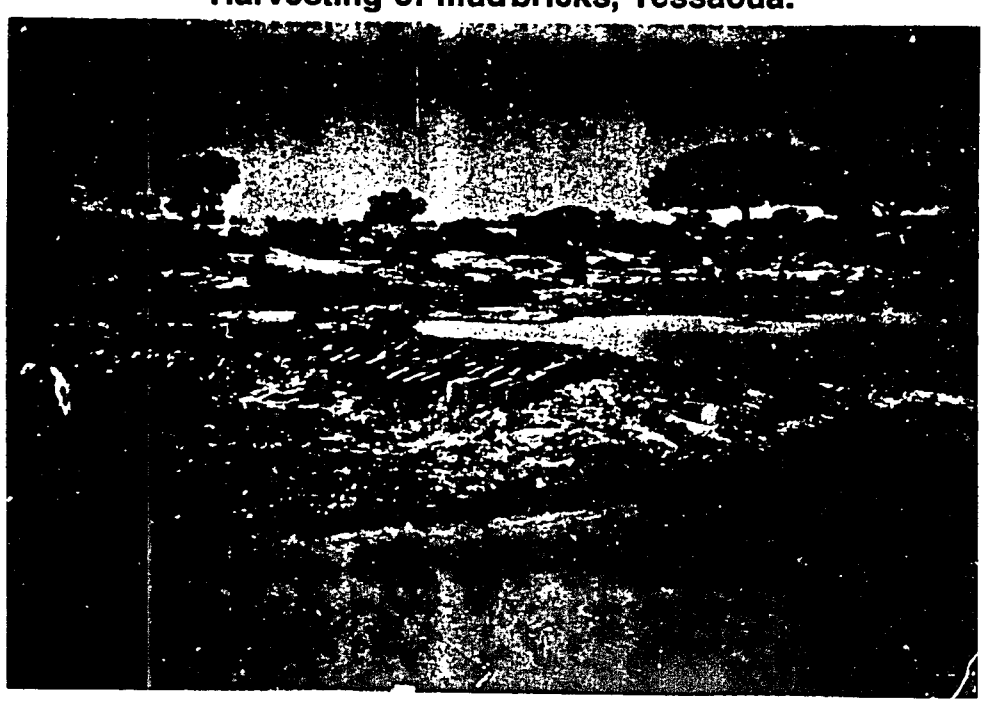

Figure 8
Harvesting of mud bricks, Tessaoua.

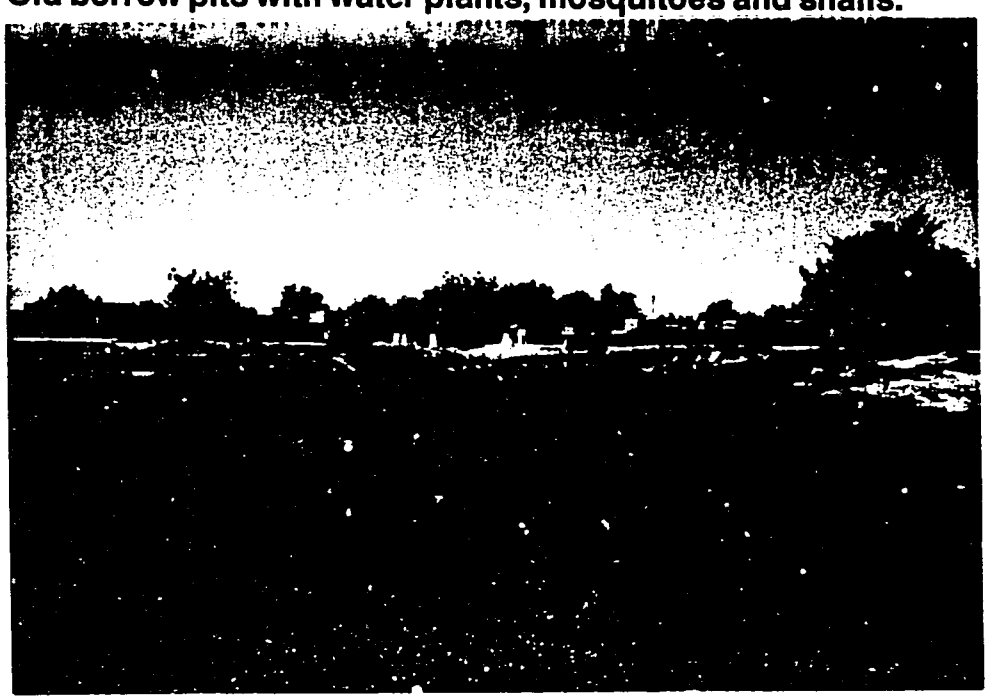

Figure 9
Old borrow pits with water plants, mosquitoes and snails.

these variants require systematic administration of chloroquine to treat all cases presumptively diagnosed as malaria and providing chemoprophylaxis to all pregnant women from the third month of gestation to six weeks after delivery.

Treatment of all fever cases presumptively diagnosed as malaria is provided at all levels of the health services in Niger. However, since only 30 percent of the villages have "easy" access to a health service facility within an hour's walking distance (5 km) from their residences, most of the malaria treatment and chemoprophylaxis for pregnant women has been administered by secouristes, who cover about half of all rural communities.

Chloroquine, aspirin and ORS packets are the three essential medications manufactured in Niger and distributed through a network of public pharmacies, drug depots and distribution centers. The demand for chloroquine varies considerably by season and according to the level of endemicity in different parts of Niger. In the past, systematic chemoprophylaxis for malaria was attempted for all children younger than 10 during the three months of the rainy season. Due to poor compliance, irregular and insufficient drug supply, and the inaccessibility of a high percentage of the target population, this practice was discontinued.

Severe cases of malaria are treated with intramuscular injections of quinine (Quinimax^{R}) available only from the regular health services. Many patients prefer injections, which they consider stronger and more effective than oral medications. Therefore, Quinimax is often injected without a proper medical indication.

Case reporting

The malaria reporting system has an important role to play in making reasonably accurate estimates of the need for chloroquine by season and geographic region. Until the end of 1989, malaria cases were reported every week by telegram. The telegrams also included reports of nine other diseases of great public health importance. This reporting system proved to be inefficient and was replaced in January 1990 with a new schedule of quarterly reports. Now the individual reports from each of the seven departments are being collated and analyzed at the local Directorates of Health before they are submitted to the MOPH. Experiences with the new system are not yet available.

Vector control

With the exception of major towns, notably the capital of Niamey, there is no vector control program in the country. The anti-vector activities are poorly coordinated with the malaria control program. They basically consist of applications of malathion to houses and to suspected larval breeding sites with power dusters and the use of oil solutions of propoxur applied with fogging machines. The insecticides and application methods used are inappropriate. No information could be obtained as to why these chemicals and methods were selected, nor were the control personnel aware of alternative pesticides and control methods.

5. Observations

Changing epidemiologic patterns

The team found two major epidemiologic determinants that have changed the pattern of hyperendemic malaria in Niger. The first is the creation of numerous man-made breeding sites that expand and prolong malaria transmission beyond the rainy season. The second is the high population growth rate and increased migration to urban areas. The economically important agricultural development of Niger has included extensive irrigated rice cultivation (Figure 5). These vast water bodies provide favorable conditions for numerous new breeding sites for vectors of malaria and other diseases. Interviews with local residents and health personnel confirmed that in these areas, malaria has become a health problem for most of the year.

The need for new housing as a result of the rapid expansion of cities, towns and large villages has created a huge demand for mud bricks, which has led to the excavation of many borrow pits. These pits become larger and deeper to meet the never-ending requirements for new housing. New sections of the towns often grow around the pits. In these areas, malaria transmission is intense throughout the year (Figures 7 and 8). Unfortunately, nothing is known about the vectors that breed in these man-made lakes.

Figure 10 shows the monthly distribution of "critical" cases as the percentage of all presumptive cases of malaria in the arrondissement of Tessaoua for 1987 to 1989 (see also Figure 6). In addition to fever, chills and headache, critical malaria cases have other serious symptoms, including vomiting, convulsions, unconsciousness and coma. Most of these cases are treated at the medical centers. As can be seen from Figure 10, there are large seasonal and inter-annual differences in the relative frequency of the critical cases, which continue to occur after the rainy season.

The differences in the reported number of cases between the three years can be explained in part by the large variations in the total annual rainfall. However, they are probably also related to the problems inherent in the clinical differential diagnosis of malaria when there are many other causes of disease in a community and no laboratory facilities for parasitologic confirmation of the diagnosis. Changes in the epidemiologic pattern of malaria also may be related to the relatively late development of malaria immunity in urban areas, where large fluctuations in the biting rates of infected mosquitoes have created unstable conditions for malaria transmission.

CRITICAL MALARIA CASES
TESSAOUA: 1987-1989

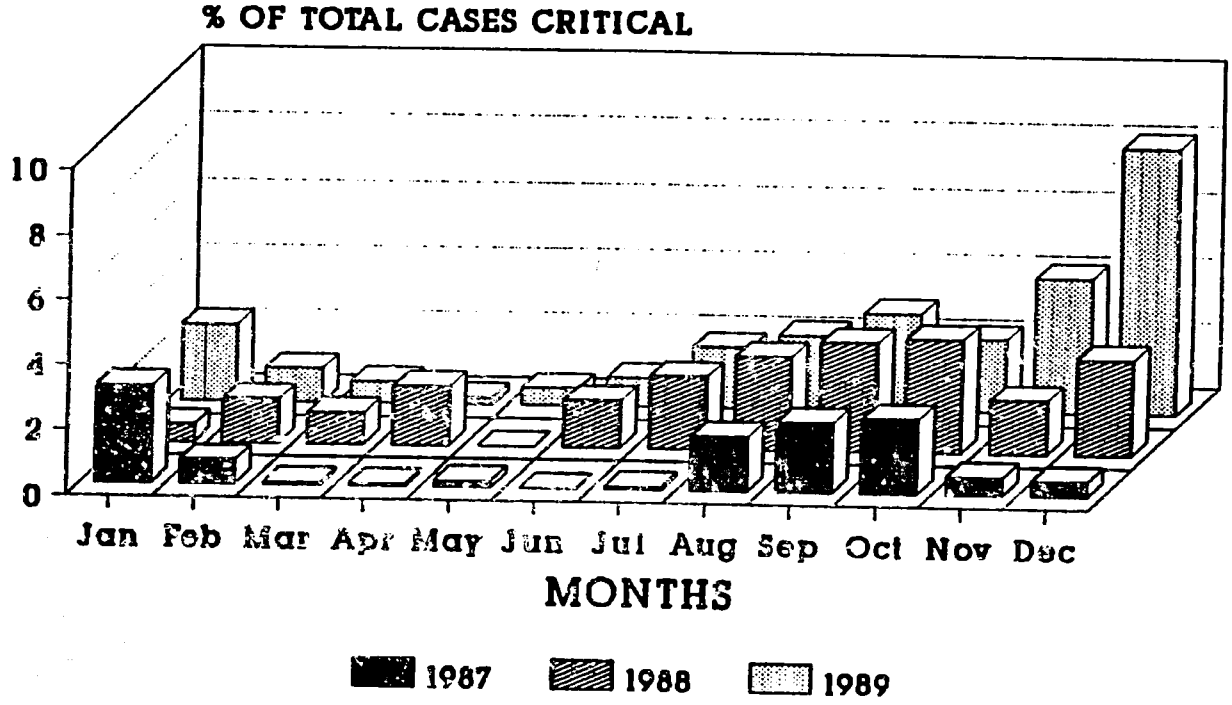

Figure 10

Diagnosis

With the exception of the major hospitals and medical centers, the diagnosis of malaria is based on clinical symptoms alone. Laboratory facilities and trained technicians who can prepare properly stained blood films and thick smears and examine them under a microscope are scarce. Both are limited to hospitals and medical centers.

During our visits to these facilities, it became evident that the only available microscope in some of the peripherally located centers was often unusable and the supply of diagnostic reagents irregular. Even in hospitals and medical centers with functional laboratories, there are irreconcilable discrepancies between the large number of outpatients seeking treatment and the laboratories' limited capacity to do the required microscopic blood examinations.

Most patients in rural areas receive treatment for malaria from the secouristes of the VHTs in their villages. Chloroquine, aspirin and ORS packets are the only medications administered by these voluntary health workers. Ideally, the diagnosis of presumptive malaria should be made on the basis of a physical examination and brief medical history to exclude other common febrile diseases, primarily measles, middle ear infection, tonsillitis, common colds, pneumonia and epidemic meningitis. An evaluation of VHT malaria activities by a joint MOPH/PRICOR team revealed that their diagnostic approaches were inadequate. In addition to diagnostic deficiencies, the quality of the treatment given to the malaria patients also was insufficient. Only 50 percent of the chloroquine doses were considered adequate. According to the report, which is summarized in Annex 2, 15 percent of the doses were judged to be too low, 22 percent were excessive and the remainder of were given without any instructions.[13]

Many patients who have febrile diseases during the dry season are incorrectly diagnosed and treated for malaria with chloroquine. On the other hand, during the rainy season, when children in hyperendemic areas have parasite rates of 80 percent and more, there is a high probability that any other illness could be associated with malaria parasitemia. Figure 11 shows the number of all patients with presumptive malaria in Tessaoua for 1988 and 1989 from whom a blood sample was obtained for microscopic examination. The number of specimens found positive for malaria parasites in these tests are represented by the black bars.

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[13]MOPH/PRICOR. Résumé Exécutif de l'Analyse Systématique Programme de Santé Villageoise, Niamey, July 1989

Microscopic Examination For Malaria
Tessaoua: 1988 and 1989

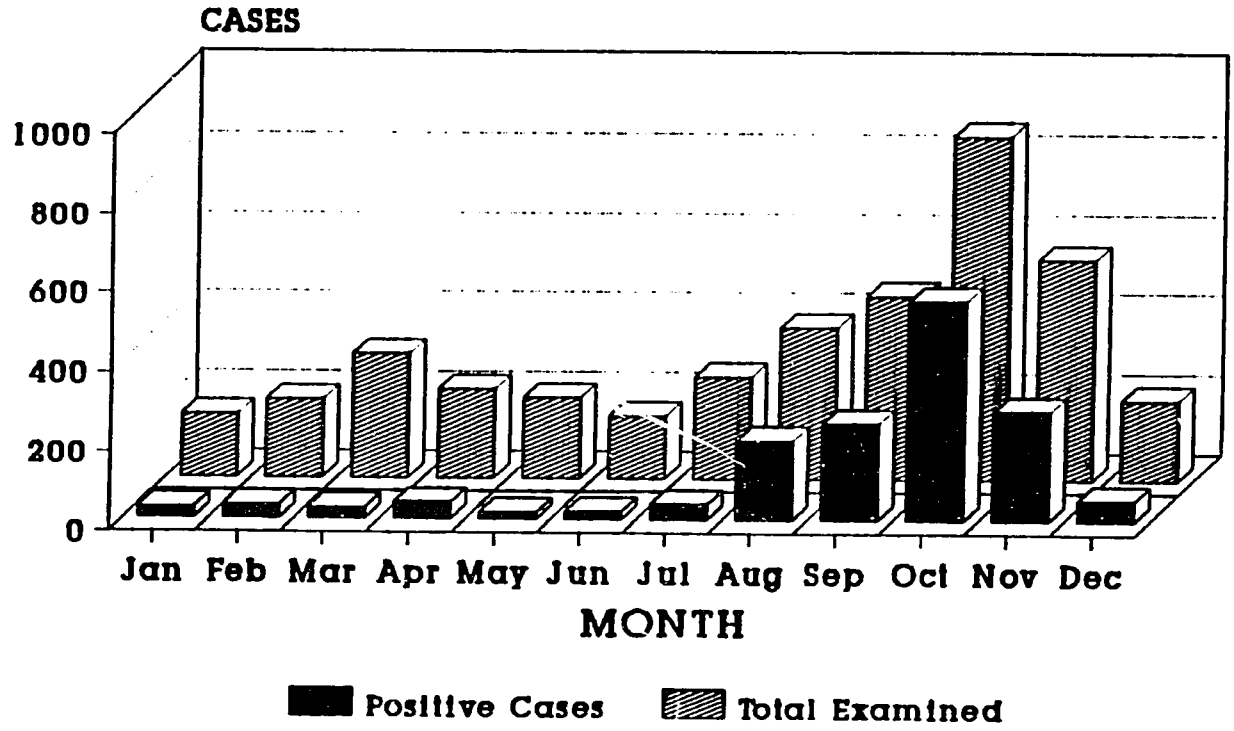

Figure 11

The results are striking. Fifty-six percent of the blood samples taken from patients during and immediately after the rainy season (August through October) were found positive, but the average parasite rate for the period from December to July was only 12 percent. The monthly maximum of 64 percent was reached in October and the minimum in May, when only 8 percent of presumptively diagnosed cases had malaria parasites. From the results it can be concluded that 44 percent of the diagnoses of malaria were incorrect for the four months of high malaria transmission rates, compared with 88 percent of false diagnoses for the eight months of the dry season.

If the results from Tessaoua were extrapolated to all reported cases of presumptive malaria -- an annual average of about 600,000 cases for the past five years -- more than 60 percent of them would not have been confirmed parasitologically. Allowing for laboratory errors due to the low sensitivity of microscopic examinations to detect low densities of infection, one would arrive at the estimate that about half of the chloroquine treatments were given to people who did not have malaria.

Treatment, chemoprophylaxis and supply

Chloroquine is the drug of choice for malaria treatment and chemoprophylaxis in Niger. It is manufactured locally and supplied in bottles of 1,000 tablets of 100 mg base as chloroquine phosphate.[14] The MOPH's final goal is to include the entire population in the program by providing universal access to the professional and voluntary health services. Only about half of the more than 8,000 villages of Niger now have voluntary health teams. Therefore, the program's immediate objective is to reach 50 percent of the population for treatment and chemoprophylaxis. A regular drug supply, well adapted to the regional and seasonal variations in needs, is an essential prerequisite for the program's success.

The new, reduced price for a bottle of 1,000 tablets containing 100 mg of the chloroquine base is 3,690 CFA (previously 4,920 CFA), or about $12.90.[5] The recommended dose for the treatment of presumptive malaria is 10 mg/kg of body weight. Chemoprophylaxis of pregnant women is based on the administration of 300 mg of chloroquine

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[14]Programme Nationale de Lutte Contre Paludisme, 1987-1991, MOPH, Niamey

bi-weekly. The semi-private organization ONPPC[15] produced 37,113 bottles of 1,000 tablets in 1989 and aims to increase production to 39,440 bottles by 1991 to meet the annual need for treatment and chemoprophylaxis. Amodiaquine tablets and quinine vials also are available to the health services for treatment of severe malaria or for patients with adverse reactions to chloroquine.

With only half of the villages served by VHTs and gross deficiencies in case reporting, it is impossible to make realistic estimates of the total annual demand for chloroquine, especially since the drug is also sold without a prescription on the open market. The plan of action calls for 50 percent coverage of about 8 million fever episodes due to presumptive malaria per year, or 4 million cases and chemoprophylaxis for half of the estimated 300,000 women who become pregnant during a year. If these targets are met, the projected total of 39,450,000 chloroquine tablets -- 20,000,000 for treatment and 19,450,000 for chemoprophylaxis -- would provide an average of 500 mg of chloroquine for each of the 4 million febrile episodes and 350 mg/week of chloroquine for the eight-month course of chemoprophylaxis for each of the 150,000 pregnant women.

There are, however, serious difficulties in the drug supply and distribution at the peripheral levels of the health services and the volunteer health worker system. All of the health delivery units visited have complained about grave shortages of chloroquine during and immediately after the rainy season. In addition, there are difficulties in drug administration by the secouristes and matrones.

In 1988, a MOPH/PRICOR team has conducted a systematic sample survey to evaluate the performance of Niger's voluntary health teams. The studies confirmed that there were serious problems with the drug supply. The team also found inadequacies in diagnosis, incorrect chloroquine treatment doses and a lack of instructions given to the patients by the VHTs. Supervisory visits to the secouristes by the nurses in charge of the local dispensaries were infrequent and too short to be effective. Lack of transportation was cited as a major cause of this deficiency. Only 24 percent of all women of childbearing age interviewed stated that they had had malaria chemoprophylaxis during their last pregnancy.

A growing, not yet fully appreciated problem leading to drug noncompliance is the adverse reactions to chloroquine, most often itching

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[15]according to the Malaria Coordinator, Mr. Sani Zaqui, Office National des Produits Pharmaceutiques et Chimiques

and burning of the skin, that some patients develop. These reaction were observed in the relatively small samples of children who were included in the first field trial for drug resistance in four different parts of Niger. The results of this trial will be reported in following section of this report.

Malaria treatment with chloroquine is theoretically free at all levels of the health services, but the secouristes must charge their patients about 5 CFA (about one U.S. cent) per chloroquine tablet. This money permits them to replenish their stocks by purchasing chloroquine from the nearest people's pharmacy depot. It should be emphasized that the available cash reserve of villagers, whose livelihood depends on farming, is usually depleted by the time the rains begin. This is also the planting season, when malaria is most severe and travel by road is practically impossible. Many of the voluntary health workers are also farmers and have less time during the planting season to attend to their medical duties or to make a journey to the district town to purchase drugs from the people's pharmacy.

In 1986, the World Bank signed a loan agreement with the GON to provide assistance in certain priority health areas, including malaria control. The project has not yet started. The World Bank would provide a loan of $1.6 million under the condition that the project attempt to recover the cost of antimalarials from the patients in order to replenish the stock of chloroquine. The medical staff of the health services has expressed serious reservations about the proposal. They specifically object to the fact that the cost recovery plan has singled out malaria as the only disease for which patients are made to pay for their treatment at a time when they can least afford it. It is reasonable for a poor country like Niger to attempt recovery of some of the costs of medical services and drugs, but a more realistic approach should be found.

Drug resistance to *Plasmodium falciparum*

Drug resistance of *P. falciparum* malaria has rapidly spread from East to West Africa. Treatment failures with chloroquine have now been recorded from most of the West African countries. A new surveillance program including all of the member states of the OCCGE was established to monitor the spread of drug resistance in the region. Its headquarters and central laboratory are in Bobo Dioulassou, Burkina Faso. Branch laboratories and surveillance teams have been established in each of the member countries, including Niger, where a unit was created in 1989.

There have been sporadic clinical reports about chloroquine resistance in Niger. Most of these have come from non-immune expatriates who developed malaria although they had taken regular chemoprophylaxis at the recommended dose of 300 mg of chloroquine base per week. With a few exceptions, most of these anecdotal reports have not been confirmed by objective tests. The report of the first systematic study of drug resistance in Niger was released in February 1990.[16]

The studies were conducted between November and December 1989 in four ecologically different parts of Niger (see map, Figure 1): Gaya in the Department of Dosso, an area of sudan-savanna; Tessaoua, Department of Maradi, sahel; Tillabery, Department of Tillabery, sudan-sahel and Arly, Department of Agadez, sahara desert. Both *in vivo* and *in vitro* tests were performed following the methods and standards developed by WHO. A total of 1,395 children between the ages of 2 to 9 years were examined: 440 in Tessaoua, 279 in Tillabery, 437 in Arly and 239 in Gaya. Two hundred and three children, or 14.5 percent, had malaria parasites. A dozen of these children, or about five percent, had mixed infections, including *P. falciparum*, *P. malariae* and *P. ovale*. From this sample, 84 children were selected for the *in vivo* test and 47 for the *in vitro* study. The children were in generally good health, were negative in the chloroquine urine test by Berquist, had single infections with *P. falciparum*, and parasite densities of 1,000 per ml of blood and above.

Twenty nine of the children in the *in vivo* test showed some degree of resistance to a chloroquine treatment dose of 25 mg/kg of body weight. Six of them also had evidence of resistance in the *in vitro* test. Since there were different denominators for the two types of tests, no further cross tabulations are possible at this time. A follow-up study confirmed that chloroquine resistance existed in more than 10 percent of treatments given to children in the Gaya and Tillabery areas. There was no evidence of chloroquine resistance in Tessaoua and Arlit. None of the four population samples studied showed any evidence of mefloquine resistance in the *in vitro* test.

On the basis of these results, the MOPH concluded that chloroquine resistance had reached Niger, but was still confined to foci in areas with heavy traffic across the country borders with Nigeria, Burkina Faso and Benin. The drug will remain the mainstay of the malaria control program. However, the MOPH has recommended

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[16]Rapport Préliminaire: Etude sur la chimiosensibilité du *Plasmodium falciparum* aux médicaments antipaludiques, MOPH, 1990

that the standard therapeutic dose of chloroquine in the areas affected should be raised from 10 mg to 25 mg/kg of body weight, to be given over three days as follows: 10 mg/kg on days one and two and 5 mg/kg on day three. The MOPH will also inform all of its health units that the possibility of treatment failures should be considered when chloroquine doses of 10 mg/kg or less are given to malaria patients.

Treatment failures with supposedly adequate doses of chloroquine could also occur if the uniformly sized tablets of chloroquine diphosphate were adulterated, having real drug concentrations of considerably less than the official standard of 100 mg of chloroquine base per tablet. In order to rule out this possibility, the team acquired three randomly selected batches of 100 tablets of locally manufactured chloroquine from the MOPH's malaria coordinator. We sent these batches to the U.S. Centers for Disease Control, where they were analyzed for potency.

Ten tablets from each batch of chloroquine (CQ) were dissolved in 0.002 N HCI in corresponding one-liter volumetric flasks and further diluted (1:50) for analysis by ultra violet spectrophotometry. Potency values are presented in Table 3.

Table 3. Potency of Chloroquine Samples

Sample Designation	Average amount of CQ (mg) per tablet expressed as base
Lot A	99.2
Lot B	97.8
Lot C	100.1

These results are excellent. They indicate that the range of concentration of the drug in these batches is within the normal range of variation, which is 5 percent.

Vector control

There is no systematic, coordinated vector control program for malaria in Niger. All vector control activities are the responsibility of the Division of Hygiene and Sanitation of the MOPH's Directorate of Hygiene and Mobile Medicine. There are a few technicians and sanitation inspectors in each of the seven arrondissements, but there is no professionally qualified entomologist in the country to direct, supervise and evaluate the vector control efforts, which are confined almost exclusively to Niamey and some of the larger towns. The insecticides used and the manner in which the applied are inappropriate. No information was available about why the insecticides and methods were selected.

During our visit, we also noted that there was a complete lack of literature on vector control and pesticides for public health in the city office of the Division of Hygiene and Sanitation and the MOPH. Thus, Niamey and the other population centers are sorely exposed not only to increases in the transmission of malaria, but probably also to potential epidemics of other mosquito-borne diseases, notably yellow fever.

Vector avoidance and other control methods

Some other methods of personal protection and vector avoidance have been practiced in Niger. These include the use of bed nets, insecticide spray cans, coil repellents[17] and window screens and reduction of mosquito breeding near homes and in family compounds.[18] While most of these methods are practiced in the urban areas only, some are also frequently used by rural residents. Contrary to the often held opinion that bed nets are unpopular among rural residents because they often sleep outdoors and do not like the feeling of being oppressed in the narrow confines of the net, bed nets are actually so popular among some of the ethnic groups of the country that they are part of the dowry at rural weddings.[18] This observation offers excellent opportunities for future studies of the impact and acceptability of impregnated bed nets in Niger. This

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[17]Olivar M et al. Rapport des Résultats Préliminaires de l'Enquete "Paludisme et Gestation" Menée dans l'Arondissement de Filingue, April 1989

[18]MOPH/PRICOR. Résultats de L'Analyse Systémique du Programme de Santé Villageoise. Niamey, July 1989

method is already in use in other West African countries, including Gambia, Mali, Burkina Faso, Senegal and Cote d'Ivoire.

Window screens and insecticide spray cans have remained the domain of urban residents, but cheap mosquito repellent coils, both locally manufactured and imported from China, have found widespread use and are sold in the open markets all over the country. The composition and efficacy of these coils are unknown.

Public education sessions and messages about simple methods of mosquito source reduction near houses and in villages and their importance have been an integral part of the primary health care system. The content and frequency of the malaria messages in the health education sessions at the village level have been evaluated (53 percent of all sessions), but their impact on transmission has not yet been assessed.

6. Recommendations

1. The Government of Niger (GON) should request the services of a French-speaking team composed of a physician-epidemiologist and an entomologist with field experience in malaria control in West Africa. The visit should be planned for the rainy season, when malaria transmission and morbidity are at their peaks. This four-week assignment would help identify critical deficiencies in the malaria control program and the management of malaria cases that could not be identified during the low-transmission season.

2. After the consultant team has completed its work with the MOPH at the end of the rainy season 1990, a small network of about five sentinel population samples should be created for adequate malaria surveillance. Each of the population samples should be representative of one of the three major ecologic subdivisions of Niger in order to furnish reliable data on the incidence of malaria infection, morbidity, mortality, drug resistance, vector biology, vectorial capacity and transmission rates.

3. A reference library with textbooks, guides and teaching aids on all aspects of malaria should be established as soon as possible at the MOPH. WHO has an excellent collection of publications and guidelines for field malariologists, including sets of teaching slides.

4. The MOPH should conduct *in vivo* and *in vitro* trials on resistance to antimalarials in Niger's cities, where drug pressure is high. Considerable benefit could result from joint technical assistance from the S&T/H VBC Project and WHO's Control of Tropical Disease Division.

5. Soon after the rainy season, the MOPH should make detailed preparations for a pilot study of the acceptability and efficacy of impregnated bed nets and curtains. Trials of these methods must be preceded by a study of attitudes toward the use of bed nets and curtains among people in different parts of the country. Entomological and epidemiological personnel must determine not only the method's effect on mosquito populations, but its effect on malaria transmission and frequency of clinical attacks. Assistance can be obtained from the neighboring countries of Mali and Burkina Faso, as well as the

Gambia, where considerable experience with this method already exists (Prof. Toure in Bamako, Profs. Coluzzi and Guiguemde in Burkina, and Dr. Greenwood in the Gambia).

6. There should be an effective program for public health education about malaria using mass media, including radio and village television.

7. The GON should request the full-time services of a French-speaking physician-epidemiologist with experience in malaria control in sahelian Africa for a period of six months to one year and an experienced entomologist for three months, with follow-up visits as indicated. These advisors would assist the GON in revising the national malaria control program, with special attention to the following areas and tasks:

   a. Current diagnosis of presumptive malaria based on clinical evidence needs to be revised by creating simple diagnostic algorithms for the differential diagnosis of febrile diseases, particularly during the dry season, when the use of chloroquine for non-malarial fevers is very high.

   b. A rotating, medium-term training program for qualified candidates in malaria epidemiology, entomology and parasitology should be created.

   c. A coordinated national research program on malaria transmission, vector biology and vectorial capacity, morbidity, mortality, pregnancy and malaria, drug resistance, health service delivery and malaria control should be established.

   d. Assistance in the design, operation and evaluation of an effective malaria surveillance pilot project should be requested.

8. The network of field laboratories for parasitologic diagnosis of malaria should be strengthened to include appropriate identification of the *Plasmodium* species and parasite densities, supervision and quality control, regular laboratory supplies, training of technicians, including refresher courses, and better integration of the parasitologic diagnosis of malaria into the basic diagnostic laboratory program for medical centers and some strategically located dispensaries.

9. The system for supervision and counseling of the peripheral health services and secouristes needs improvement, focusing on diagnosis, disease reporting, treatment and chemoprophylaxis, and a seasonally adjusted flow of antimalarial drugs. In areas with unusually difficult transportation during the rainy season, a feasibility study of an inexpensive two-way radio communication system between dispensaries and medical centers should be conducted.

10. The number of properly trained and equipped entomological teams should be increased to make vector identifications, establish man-biting and infection rates, study the seasonal dynamics of malaria transmission and determine insecticide resistance. Consultants could begin these studies while national personnel were receiving advanced training. A council for integrated pest control should be formed to use all of the available information on pesticide resistance in the country.

11. Three Nigeriennes should be trained as M.Sc.-level medical entomologists. An M.Sc. course in medical entomology and vector control is offered at the University of Cote d'Ivoire, Bouake, Cote d'Ivoire. Upon completing their training, the entomologists should have the following responsibilities:

    a. One entomologist should be responsible for conducting baseline studies of the distribution of *Anopheles* vectors in Niger, their bionomics and vectorial capacity in different areas of the country. Specific studies should assess the effects of water development projects and urbanization on vector population densities.

    b. A second entomologist should conduct studies of possible methods of vector control, including insecticide-impregnated bed nets and curtains. Insecticide susceptibility tests should be conducted, as well as trials of the possibility of controlling larval anophelines with larvicides or by eliminating vector breeding sites. In rural areas, it would be impractical to use larvicides against the rainpool-breeding *An. gambiae*, whose larval habitats are found everywhere during and immediately after the rainy season. It is possible, however, that the larval habitats in urban areas are sufficiently restricted to warrant larviciding to control malaria.

c. A third entomologist should be given the responsibility of implementing vector control measures and training health center and village volunteers in the methods that have been found to be cost-effective. He or she should be responsible for training health personnel at the primary health care schools and the central school of public health. This entomologist would also advise, supervise and evaluate urban vector control activities.

12. The malaria program coordinator, Mr. Sani Zaqui, or another person with a similar professional background, would profit greatly from participating in the periodic WHO-Government of Italy course on the epidemiology and control of malaria. The course includes three months of theory at the malaria institute in Italy and three months of practical training at an African site. Should Mr. Sani be selected to participate in such a course, another professional from the MOPH should be enrolled in the next course.

13. The curricula and training courses at the level of the Departments, the Schools of Public Health, Nurses and Midwives should be upgraded to include a program of multidisciplinary continuing education in malariology for physicians, nurses, laboratory technicians and entomologists to enhance the essential team work in malaria control.

14. The MOPH should conduct a pilot study of the use of simple, color-coded checklists to improve the present ineffective system of reporting of presumptive malaria cases seen by the secouristes.

15. The MOPH and USAID/Niamey should assess the advisability of holding a donors' meeting to develop appropriate roles for and promote coordination between international and bilateral funding organizations.

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Annex 1. Itinerary

January

25 Meet with Director of Health Services
Pay courtesy visit to the Secretary-General
Establish contact with the Coordinator of the Malaria Control Program
Briefing at USAID
Meet with the Director of the Health Project/IDA NIR

26 Meet with Director of Sanitation and Hygiene/Medical Mobile Units
Meet with the Division of Health Statistics/Tulane University Health Information Systems staff
OCCGE: local "antenne" is responsible for schistosomiasis and meningitis research and control

29 Visit OCP/Niamey
Visit OCCGE
Meet with the Direct, Department of Maternal and infant Health
Meet with the Director, Department of Training and Health Education/Division of Health Education
Visit the Department of Financial and Administrative Affairs

30 Courtesy visit to the WHO Representative
Courtesy visit to the organizers of the International Symposium on Schistosomiasis in Niamey
USAID/preparations for field trip
Visit the Chief of the Division of Village Health Teams
Visit to the laboratory for surveillance of drug resistance to malaria parasites
Visit to the Medical School of Niamey, Michael Olivar, M.D., Tufts University, Visiting Professor, Epidemiology

31 Field trip: travel to Maradi

February

1 Discussions with the Director of Health of the Department of Maradi
Courtesy visits to the Prefect of the Department
Visit the Medical Director of the central departmental hospital and the central laboratory
Visit a maternal and child health clinic
Visit the departmental pharmacy (pharmacie populaire)
Visit a medical center in Andome dispensary

2 Dr. Buck: travel to Tessaoua, discussions with the Chief of the medical center

3 *Dr. Gratz returns to Niamey
Dr. Buck: Visit the rural dispensary Kaona (30 km from Tessaoua)
Visit the village of Gawo Sohoua Haousa and interview the secouriste and two matrones of the voluntary village health team
Examination of large borrow pits ("mare") in the center of Tessaoua for mosquito larvae. Interviews with the local chef de quartier and local residents about malaria in the dry season
Travel to Madarounfa
Visit the medical center of Madarounfa, where urinary *schistosomiasis* is hyperendemic

4 Travel to Niamey (665 km)

5 Ministry of Public Health
USAID
Visit the arrondissement medical center of Tillabery
Visit the rural dispensary of Kollo.
Inspection of irrigated rice fields near the Niger River for *anopheles* breeding

6 Ministry of Health: analysis of health data, retrieval of documents for preparation of first draft of report
USAID: mini-debriefing

7 Courtesy visit to the Minister of Public Health
Analysis of data at the information computer center
U.S. Embassy and USAID: talk on the malaria situation and state-of-the-art malaria vaccine development to the American community.
Reception at the Stovers

8 Dr. Gratz departs for Geneva
All day report writing

9 Discussions at USAID
First draft of the executive summary delivered for adjustments and modifications

10 Executive summary modified and given to USAID for translation into French.
Working lunch with the Director of Health Maradi, Malaria Project Coordinator and Drug Surveillance Team Leader

11 Draft report for VBC and A.I.D./W

12 Visit the Director of the School of Public Health in Niamey, discuss curriculum
Debriefing meetings with MOPH and USAID
Discussion with Sani Zaqui about modifications of the French text of the Executive Summary

13 Visit Ministry for discussion about the new findings of two foci of chloroquine resistance in Niger
Working lunch with Dr. Michael Olivar to discuss follow-up activities
Debriefing session with the Secretary-General of the MOPH and the Malaria Program Coordinator

14 Formal debriefing at MOPH with the USAID Officer for Health Projects and the Secretary-General
Debriefing for USAID staff

15 Dr. Buck departs for Washington

Annex 2

Summary of Results from a Systems Analysis of Niger's Village Health Worker System

PRICOR

CHILD SURVIVAL REPORT

• Results from SYSTEMS ANALYSIS •

NIGER DECEMBER 1989

SYSTEMS ANALYSIS FINDS WEAK PREVENTIVE AND PROMOTIVE ACTIVITIES AMONG VILLAGE HEALTH WORKERS.

The Government of Niger pioneered village health worker (VHW) programs in the 1960's, and has relied on VHWs ever since to extend basic services to widely dispersed rural populations. The program now covers 45% of the villages in the country, using an estimated total of 13110 workers. Numerous donors and private voluntary organizations provide financial and technical support to the program.

In light of the importance of the VHW program, a better understanding of how it works and where its weaknesses may lie is needed. As in most health programs, the complexity of the village environment and of rural development in general makes it difficult to document whatever health effects may have occurred. Concerned about the present condition and future direction of its VHW program, the Government of Niger requested PRICOR assistance for a systems analysis starting in January 1989.

The Ministry of Public Health, Social Affairs, and Women's Condition, with PRICOR assistance, analyzed the performance of key health worker tasks in oral rehydration therapy, maternal health, malaria treatment, nutrition, and water and sanitation. Using local program guides as well as the PRICOR Thesaurus, researchers developed approximately 15 observation and interview instruments and applied them over a two month period in 54 villages in three of Niger's seven regions. Researchers observed service delivery, supervision visits, and health education sessions; they also interviewed mothers, community leaders, supervisors, district medical directors, and the workers themselves.

The results proved more positive than expected: while their performance was imperfect and occasionally deficient, VHWs were found to contribute to improved treatment of diarrhea and malaria and to have made inroads into traditional labor and delivery practices. Approximately 40 to 50% of rehydration solution recipes given by observed health workers, and about 50% of chloroquine dosages, were correct; and those that were incorrect were almost never dangerous. Those correctly treated would probably not have received care at all if VHWs had not been present, and the others, while not helped, were at least not diverted from higher quality sources.

Nevertheless, the findings from the systems analysis highlighted significant operational problems and documented major gaps between the roles officially assigned to VHWs and those actually performed.

VHWs, for example, are supposed to devote a substantial portion of their time to education and assistance to community members for the improvement of basic hygiene and sanitation, well maintenance, water conservation, nutrition, and maternal and child health. Female matrones, in particular, are to screen for and refer high risk pregnancies. VHWs' initial two week training emphasizes promotive roles: 31% of the training time for male secouristes and 45% for matrones is devoted to community education. Provision of curative care, while considered important, is secondary; and only slightly over a quarter of training time is devoted to specific case management skills for oral rehydration therapy, treatment of malaria, and maternity care.

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The absence of standardized recordkeeping systems made precise measurement difficult, but the majority of VHWs observed during the PRICOR study appeared to be more active in curative care than in preventive/promotive activities. 15% of secouristes told PRICOR interviewers that they had conducted a water and sanitation education session in the week prior to our visit, compared to 49% who said that they had treated a diarrhea case and 40% a malaria case. Self-reports from female matrones were higher (33% for nutrition education sessions), but only 25% of interviewed mothers said that they had ever attended a group health education session by either type of worker.

Patient counselling was found to be weak or non-existent during observed diarrhea and malaria treatment sessions and in antenatal and postnatal consultations. For example, observations of health worker counselling of mothers about diarrhea (n=134) showed that they told mothers to give oral rehydration solution and to increase liquids during bouts of diarrhea 23% of the time; explained the correct recipe for preparing oral rehydration solution in only 8% of the cases; and explained the importance of continuing feeding in only 1% of the cases. Maternity patients, observed both before and after delivery, were also given extremely little information. The median length of treatment sessions of all types was only slightly over three minutes, obviously leaving little time for education.

Observed group educational sessions also averaged about three minutes, although they tended to include more information than did patient counselling. Most used a lecture format rather than encouraging interaction between the health staff and audience members.

Weaknesses in the support systems of the VHW program clearly contributed to problems in VHWs' performance. According to worker notebooks, the average VHW was supervised only 1.2 times during 1988, mostly in December when funds finally became available. None of the observed supervisors participated in a VHW treatment or educational session. The picture was better for inservice training. A small majority of VHWs had participated in training classes the past two years. The availability of these training programs will probably deteriorate with time because only donor funding is currently available.

The medical kits of only 36% of secouristes and 40% of matrones included educational materials, almost always for oral rehydration. Only about half of the secouristes had chloroquine on the day of our visit, and only a quarter had ORS packets. Almost none of the matrones carried clean razor blades for cutting the umbilical cord (though these may have been available when needed from local shops.)

The Ministry of Health is now determined to improve quality of care through operations research. A five-day workshop in June 1989 brought together approximately 50 regional and national officials to discuss study results and recommend future actions. Operations research, revision of the training guide, and development of supervision protocols are all likely.

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This systems analysis was a collaborative effort between the Ministry of Public Health, Social Affairs, and Women's Condition, and the PRICOR Project. Further information is available about the project from Tisna Veldhuyzen, BP 11201, Niamey, Niger, or from Dr. Wayne Stinson, PRICOR Study Monitor, 49 Twickenham Dr., Northwood, Harare, Zimbabwe.

The PRICOR Project was established in 1981 to help developing countries improve primary health care programs through practical, decision-oriented management studies and operations research. The *PRICOR Child Survival Report* series presents results from PRICOR systems analyses and operations research to strengthen the delivery of child survival services.