International Journal of Epidemiology
© International Epidemiological Association 1993
Vol. 22, No. 1
Printed in Great Britain

Rapid Decline in Child Mortality in a Rural Area of Senegal

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Pison G, (Musée de l'Homme, 17 place du Trocadéro, 75116 Paris, France), Trape J F, Lefebvre M and Enel C. Rapid decline in child mortality in a rural area of Senegal. *International Journal of Epidemiology* 1993; 22: 72–80.

Retrospective and prospective demographic and health data collected on the population of Mlomp (6352 people in 1985), a rural area of Senegal, show that the probability of dying before the age of 5 years declined from 350 to 81 deaths per hundred livebirths in the last 25 years. This decline is greater and faster than ever observed in Senegal. The drop in mortality mainly results from improved access to new and efficient health services—a dispensary and a maternity clinic—and from growth surveillance, health education, vaccination and malaria programmes initiated in the 1960s and 1970s. Although socioeconomic conditions have changed in the area, the influence of classical factors such as women's educational level and improvement in transportation has probably been limited. Deaths from diseases that can be prevented by immunization (such as neonatal tetanus, measles, whooping cough) are now very rare (3% of the deaths of children under 5 years during the period 1985–1989). Although the risks of dying from diarrhoea or acute respiratory infections are much lower than in other rural areas of Senegal, these are still the main causes of deaths (33% and 19% of deaths after 1 month of age). Malaria, despite its high morbidity during the rainy season, causes few deaths (4%). This reflects the success of the health education programme promoting chemoprophylaxis and early treatment of fever cases. Mlomp is one example of an African rural area where the provision of well-organized health services at a reasonable cost has produced a dramatic decline in child mortality.

The decline in mortality is fairly well documented for much of the developing world, even for Africa.[1] Its causes, however, are not really understood. The extremely rapid decline in mortality observed in Latin America after the Second World War was attributed to the introduction of medical technology.[2] In Africa, demographic surveys carried out during the last two decades have shown that child mortality is highly correlated with the socioeconomic level of the parents, in particular with their educational level.[3–5] Socioeconomic factors are considered by most authors as key factors for future mortality declines and some have argued that social change may contribute more to mortality decline than health care provision.[4] The interrelations between economic level, sociological factors and health care provision and their impact on mortality are complex, may vary from setting to setting and need to be more carefully documented.[6] The community study presented here provides some insights into this question. Retrospective and prospective demographic and health data which were collected from 1985 to 1989 in the rural area of Mlomp in Senegal (West Africa) are analysed with a view to providing 1) a detailed description of both the levels and trends in mortality and the changes in health conditions which occurred in the area over the last 25 years and 2) an evaluation of the different health interventions and of their impact on mortality, with special attention to infant delivery and malaria programmes.

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METHODS

Study Area and Population

Mlomp is a rural area in the Ziguinchor region of South Senegal. Its population, 6352 on 1 January 1985 according to our census, is distributed among 11 villages grouped in a 15 km circle surrounded by lands which are flooded during the rainy season and cultivated for rice. Traditionally, dwellings are built of mud with thatched roofs, water is taken from wells and there are no toilet facilities. However, living conditions for the whole country are changing: thatched roofs have been partly replaced by corrugated iron (33% of houses) and a minority of houses have pit latrines (26%).

Before 1980, transport to Ziguinchor, the closest town at 50 km away, was difficult. A river had to be crossed by ferry and the roads were impassable during part of the rainy season. Since 1980 a bridge has been built to replace the ferry and roads have been upgraded. The first school opened in 1949 (only one classroom until 1953) and two other schools were created in 1960 and 1972. The number of classrooms have increased regularly, from three classrooms in 1960 to 26 in 1990. A secondary school opened in 1985. In 1985, 73% of children aged 7–14 years attended school or had completed at least 1 year of schooling (boys: 93%, girls: 53%). The overall proportion of adult women, aged ⩾15 years, who had been to school (even for just 1 year) was 17% (35, 32, 14, 2 and 0% for those aged 15–19, 20–29, 30–39, 40–49 years and ⩾50 years respectively).

Demographic Surveillance

A population census of the area was carried out at the end of 1984 and the beginning of 1985. A biography of all women aged ⩾15 years was collected on this occasion. Each woman was interviewed about each of her pregnancies. Topics covered included pregnancy outcome (miscarriage or abortion, stillbirth, livebirth), date and place of delivery, whether the woman delivered in a maternity clinic or not, whether the child was alive or not, and in the latter case the age at death. For each child born alive information was obtained on vaccinations and participation in growth surveillance and other health programmes. Dates were copied from documents, when available, and checked afterwards using registers from maternity clinics, civil authorities (civil register, administrative census), religious missions (parish registers) and dispensaries (growth surveillance and vaccination registers). Although these registers rarely cover the entire population and are sometimes subject to errors, their use improved the quality of the data.

The census was followed by a multi-round survey: each house was visited yearly from 1986 to 1990, in January or February, to establish the whereabouts of every person present at the previous visit and to record events that had occurred between visits (deaths, pregnancies, deliveries, marriages, divorces and migrations). Births and deaths were recorded independently by the dispensaries and maternity clinics of the area. Both sets of information were matched afterwards to detect errors and to correct them.

Health Surveys

Interviews of health personnel (one nurse had been working in the area since 1967) and examination of the local archives (a register had been held for each health activity—dispensary, maternity clinic, growth surveillance, vaccination) provided information on the history of health services and programmes. Coverage rates for vaccination and growth surveillance programmes were estimated for the year 1988 after matching the records of the registers with the census files. Information on traditional delivery methods was collected by interview of a few older women.

The cause of death for those which occurred during the period 1985–1989 was determined using two kinds of information: clinical examination carried out by the nurses working at the dispensary—most of the people who die consult them during their final illness—and post-mortem interview during the yearly visit, using a standard questionnaire.[7,8]

Parasitological and clinical data were collected in 1989 to measure the prevalence and incidence of malaria and evaluate the anti-malarial programme. Blood was taken and examined from samples of children and adults selected randomly. Data collection was repeated twice, at the end of the dry season (March) and the end of the rainy season (October), with about 900 people examined at each period. Thick films were classified as positive or negative after examination of 200 oil-immersion fields and an estimation of parasite density was made.[9] During the two periods March–April (end of the dry season) and July–October (rainy season) a random sample of people coming to the dispensary and having fever (⩾38°C) was also investigated.

RESULTS

History of Health Services

The main changes in health services provided in the area over the last 30 years are shown in Figure 1. A dispensary was opened in 1961. During the preceding 3-year period, 1958–1961 consultations were organized three times a week by nurses coming from the nearest dispensary, 10 km away. This was the closest health facility before 1958. The Mlomp dispensary is non-governmental and run by French missionary nurses. There was only one nurse from 1961 to 1978 and two from 1979 to 1983; there have been three nurses since 1984. In addition, three local women without previous training have been hired and trained by the nurses to help them at the dispensary (one performs thick films and examinations of faeces and the second gives injections and applies dressings) and at the maternity clinic (the third woman acts as matron). In comparison with many dispensaries in the country, the Mlomp dispensary is well supplied with medicines, often used (24 517 consultations in 1989, an average of 67 per day, with a minimum of 39 in January and a maximum of 102 in October) and equipped to perform simple laboratory tests.

Before the opening of maternity clinics, women used to deliver outside the village, in huts specially built for this purpose and called 'kalambas'. Women were pro-

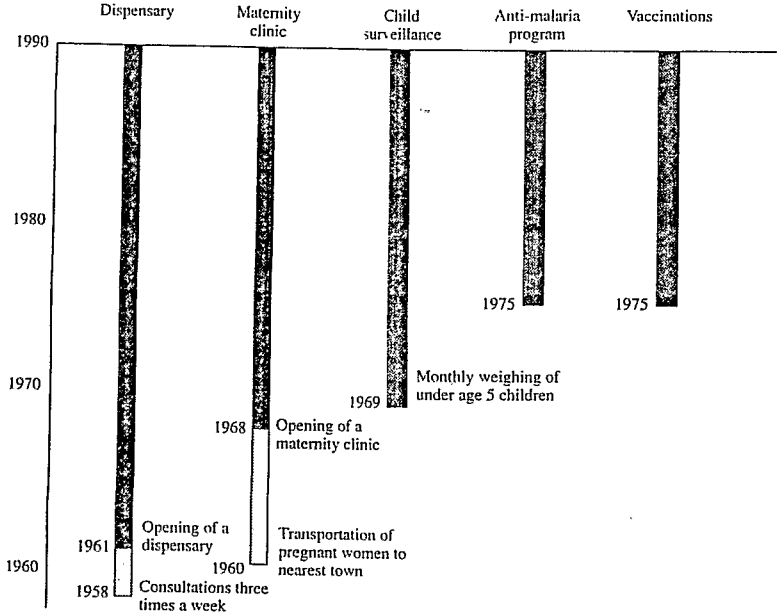

FIGURE 1 *Evolution of health services and programmes in Mlomp since 1958*

gressively encouraged by missionaries and health workers to abandon the kalambas and use modern maternity clinics. Before 1968, there was no maternity clinic in the area of Mlomp but some women used to deliver at the closest maternity clinic, 10 km away, or if necessary, at the maternity hospital 50 km away. During the period from 1960 to 1968, the nurses working at the dispensary systematically offered to take pregnant women to those places. In 1968, a maternity clinic opened in Mlomp. It is located in the centre of the study area and no houses are more than 3 km away from it.

The proportion of deliveries occuring in a maternity clinic was calculated from pregnancy histories collected in 1984–1985 (Figure 2). It was very low before 1945 (3%). However, after 1970, most women gave birth in maternity clinics, (≥95%). Birth weights were available for 694 liveborn singletons born in the study area during the period 1985–1989. The mean birthweight was 3160 g with 6.6% of children with a low birthweight (<2500 g).

Vaccination programmes started in 1971 and 1972 (measles, diphteria-pertussis-tetanus, polio), but until 1975 services were irregular and vaccination coverage was low. The situation improved after 1975 and after 1980 most children were correctly vaccinated. For example, 99% of the children born in Mlomp in 1988 and still living in the area at the end of 1989 had received measles, yellow fever, BCG, diphtheria-pertussis-tetanus-polio vaccines (as recommended by the Expanded Programme of Immunization).

A national growth surveillance programme with monthly visits for children <5 years of age was introduced in 1969 in the area. The age limit was reduced to 3 years in 1985. After the monthly weight measurement participating mothers receive supplementary food for themselves and their children, however food distribution was stopped in 1989. Most children are enrolled in the growth surveillance programme (94% in 1989).

An antimalaria programme was started in 1975. In particular it promotes regular intake of chloroquine for everyone during the rainy season (May–November). The dose given is ½–2 pills a week for children, and 3 for adults which corresponds to 5 mg/kg. Chloroquine is distributed monthly and free of charge for young children (<5 years, or <3 years since 1985) and pregnant women when they come to the health centre for growth surveillance or antenatal visits. It is sold at the dispensary for others. Families are also encouraged to keep a stock of chloroquine at home and treat any case of fever with this drug.

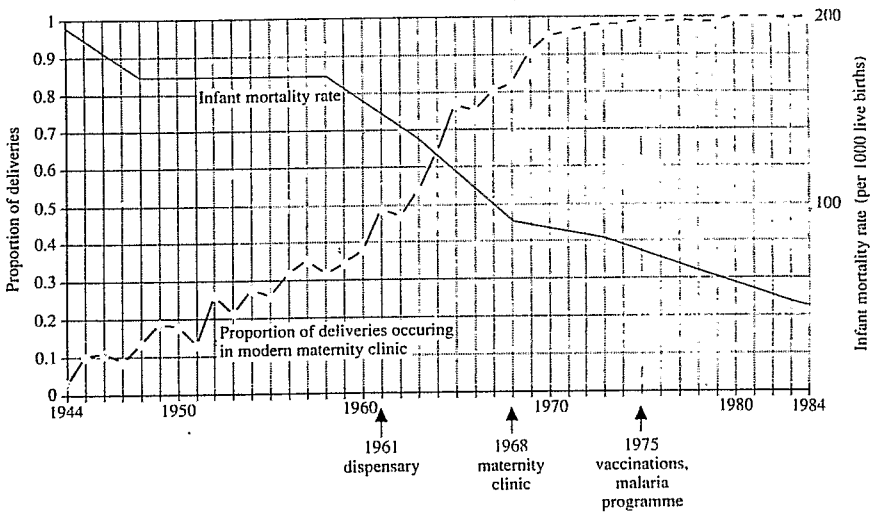

FIGURE 2 *Annual proportions of deliveries occurring in modern maternity clinic and infant mortality rate (probability of dying before age 1 for a child born alive). Mlomp 1944–1984*

No assessment of malaria prevalence was made at the beginning of the antimalaria programme. However, a survey carried out in 1963 in Mlomp showed a parasite rate of 50% in children (SLAP, unpublished data). In 1989, the prevalence of malaria parasitaemia was 3% among young children (0–6 years) and 5% among children 7–14 years in March, at the end of the dry season, and 3% and 10% respectively in October, at the end of the rainy season. Prevalence in adults in March was not measured, but in October it was 12%. Morbidity from malaria was studied in patients attending the dispensary with fever. The proportion of patients whose blood films were positive was 10% (6/58) in March–April 1989 and 43% (168/391) from July to October, during the following rainy season.

Evolution of Child Mortality Since 1930

Almost all the women aged ≥15 years present in the study area (1834 women) were interviewed in 1984–1985 about their pregnancy history. Information on the survival status of their 6703 children born alive (only those born after 1930) was analysed to estimate the probability of a newborn child dying before his fifth birthday (5q0) per 5-year cohort (Table 1, Figure 3). For the more recent period (1985–1989), the death risks were estimated from information on births and deaths during that period (809 births and 75 deaths of children <5 years old).

For the cohorts born in 1930–1934 through 1960–1964, 5q0 was nearly constant, varying between 350 and 400 deaths per 1000 livebirths. The situation changed with the cohort born in 1965–1969: 5q0 was only 228 per 1000 for that cohort and subsequently decreased regularly to 159 per 1000 for the cohort 1975–1979 and to 81 per 1000 for the period 1985–1989.

Because in such surveys we can only interview surviving mothers, there is a selection effect inherent

TABLE 1 *Evolution of childhood mortality since 1930 in Mlomp from maternity history data collected in 1984–1985 (interviews of 1834 women aged ≥ 15 years)*

Year of birth (group of 5 years)	Number of children	Probability of dying × 1000 (standard deviation)			
		1q0	4q1	5q0	5q5
1930–1934	133	150 (31)	257 (41)	368 (42)	71 (28)
1935–1939	248	210 (26)	189 (28)	359 (30)	75 (21)
1940–1944	347	210 (22)	197 (24)	366 (26)	73 (18)
1945–1949	406	170 (19)	250 (24)	378 (24)	71 (16)
1950–1954	556	171 (16)	221 (19)	354 (20)	61 (13)
1955–1959	793	170 (13)	220 (16)	353 (17)	78 (12)
1960–1964	906	137 (11)	234 (15)	339 (16)	72 (11)
1965–1969	927	90 (9)	152 (12)	228 (14)	42 (7)
1970–1974	870	82 (9)	130 (12)	201 (14)	32 (7)
1975–1979	812	65 (9)	101 (11)	159 (13)	
1980–1984	705	47 (8)			

1q0: probability for a child born alive to die before age 1
4q1: probability for a child alive at exact age 1 to die before age 5
5q0: probability for a child born alive to die before age 5
5q5: probability for a child alive at exact age 5 to die before age 10

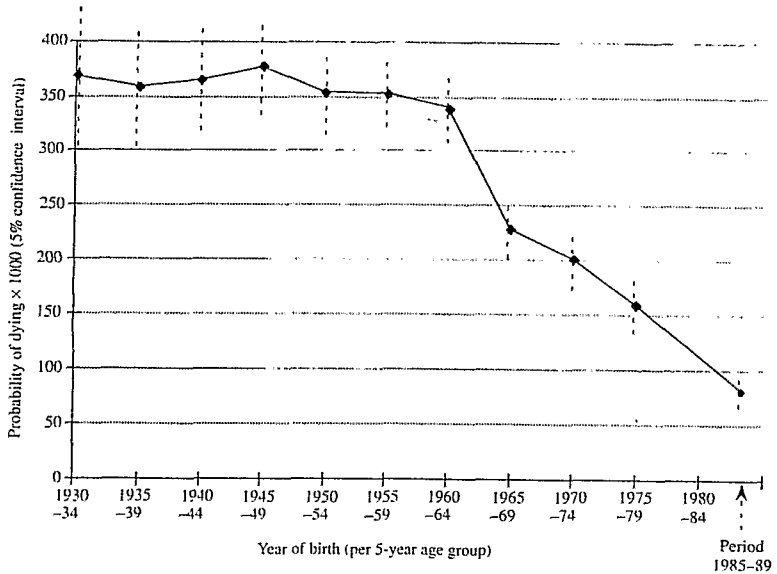

FIGURE 3 *Probability of dying before age 5 for a child born alive. Mlomp. (1930–)*

Sources: maternity histories collected in 1984–1985 (period 1930–1979) and prospective demographic survey (period 1985–1989)

in retrospective information for the distant past; for periods long enough ago that few mothers have survived to interview, child mortality is likely to be underestimated (assuming a positive relationship between child and mother mortality risks) and the trend slightly sharper than the data show.

The infant mortality rate or risk of dying during the first year of life (1q0) and the risk of dying during the 4 subsequent years, for those who reach age 1 (4q1) evolved differently (Table 1, Figure 4): 1q0, which was between 150 and 200 per 1000 until the 1955–1959 cohort, started to decline with the 1960–1964 cohort and has decreased regularly since then to slightly less than 50 per 1000 for the period 1985–1989; 4q1, which was between 200 and 250 per 1000, started to decline later than 1q0, with the 1965–1969 cohort, but once the decline had started its rate of progress was more rapid than that of the infant mortality rate. Thus 4q1 caught up with 1q0 and both risks were approximately equal in 1985–1989.

The mortality risks for the period 1985–1989 are presented by age intervals from birth to age 5 in Table 2. As previously mentioned, the risk of a child born alive dying before age 5 (5q0) is 81 per 1000. Mortality is concentrated in the first year of life (49 per 1000), and within it, in the neonatal period, from birth to 28 days (36 per 1000), with most deaths occurring during the first week. In comparison, mortality between ages 1 and 5 is now low (34 per 1000).

Causes of Child Death in 1985–1989

The number of deaths and their causes during the period 1985–1989 are shown in the first columns of Tables 3 (neonatal period) and 4 (postneonatal period). Congenital malformations caused nearly one third of neonatal deaths. Deaths from complications of labour, prematurity or neonatal tetanus were few. For older children, aged between 1 month and 5 years, the first cause of death was gastrointestinal diseases, with nearly one-third of deaths caused by these diseases (Table 4). The second cause of death was lower respiratory infections, which were responsible for about one-sixth of the deaths. There were no measles deaths and only one death from whooping cough.

Malaria mortality was remarkably low. During the 5-year period 1985–1989 only four deaths were probably attributable to malaria, two in children aged less than 3 years and two in children aged 5. The probability for a child alive at age 1 month of dying from malaria before reaching age 5 years was 2 per 1000 (the risk for all causes combined was 46 per 1000) (Table 4).

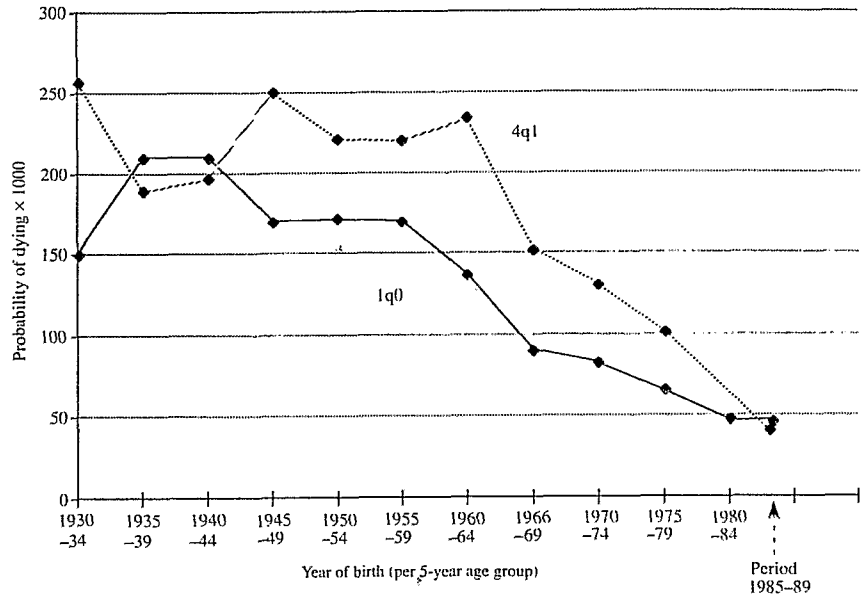

FIGURE 4 *Probability of dying from birth to age 1 (1q0) and from age 1 to age 5 (4q1) in Mlomp. (1930–)*
Source: maternity histories collected in 1984–1985

TABLE 2 *Probability of dying (× 1000) from birth to age 5 by age intervals. Mlomp, Senegal, 1985–1989*

Age interval	Number of deaths	Probability for a child alive at the beginning of the age interval to die before the end (× 1000)	SD[b]
0–6 days	25	28	(6)
7–27 days	8	9	(3)
28–365 days	10	13	(4)
0–1 year	43	49	(7)
1–4 years	32	34	(6)
0–4 years	75	81	(9)

[a] The exact period is from 30th October 1984 to 22nd February 1990.
[b] SD = standard deviation.

The annual mortality rate from malaria was 0.4 per 1000 in children aged 0–4 years and 0.5 per 1000 in children aged 5–9 years.

DISCUSSION

Our data show that child mortality declined sharply during the last 25 years in the Mlomp area. The probability for a child born alive of dying before his fifth birthday fell fourfold, from 350 to 81 per 1000. The level of child mortality is now low compared to the national levels for Senegal which are three times higher for rural zones and twice as high for the entire population, rural or urban.[10,11]

Socioeconomic changes have taken place in the area during the last 25 years. Their influence on child mortality may have been limited, however. Although schooling has increased, the evolution is recent and has only affected young generations: during the period 1985–1989, only 26% of the births occurred to women who had been to school (who had completed at least 1 year of schooling). The educational level of the women does not explain the rapid drop of child mortality in the years 1960–1974 since only 2% (years 1960–1969) and 6% (years 1970–1974) of the mothers of the children born in those years had been to school. Furthermore, for most of the women, the number of years of schooling was <3 years. Transportation has only improved over the last 10 years, whereas child mortality began its decline more than 10 years ago. Lastly, economic conditions have changed in the area, but only slowly and probably no more than in most rural areas of Senegal.

The drop in child mortality in Mlomp probably results mainly from improved health services (dis-

TABLE 3 *Neonatal mortality (probability for a child born alive of dying before age 28 days) by cause. Comparison between Mlomp (Senegal) (1985–1989) and two other rural African areas*

Cause of death	Mlomp (Senegal) 1985–1989[a]		Niakhar (Senegal) children born between April 1983 and October 1986		Machakos (Kenya) 1975–1978	
	No. of deaths	Probability of dying (x 1000)	No. of deaths	Probability of dying (x 1000)	No. of deaths	Probability of dying (x 1000)
Congenital malformations	9	10	–[b]	–	7	2
Complications of labour	3	3	–[b]	–	22	5
Prematurity	2	2	64	15	24	5
Tetanus	1	1	66	16	0	0
Other cause	11[c]	13	71	17	38	8
Undetermined	1	1	–[b]	–	16	3
No information	6[d]	7	11	3	0	0
Total	33	36	212	51	107	23

Sources:
Niakhar: Leroy and Garenne, 1989
Machakos: van Ginneken and Muller, 1984

[a] The exact period is from 30 October 1984 to 22 Februay 1990.
[b] This category is absent from the published table.
[c] Other specific infection: 5, neonatal haemorrhage: 2; perinatal icterus: 2; other cause: 2.
[d] In five cases out of six, the mother was on migration and delivered outsided the Mlomp area.

pensary and maternity clinic) and programmes (growth surveillance, vaccination, malaria control) which began in the 1960s and 1970s and were accompanied by intensive health education. Their efficiency, as shown by coverage rates for recent years, is unusually high. The specific impact of each health activity is difficult to estimate, as each was progressivley introduced at about the same time and synergistic effects may have occurred.

Infant mortality (1q0) started to decline before mortality in the 1–4 year age group (4q1). It is not surprising that these two risks evolved separately since the underlying causes of death are different in infants and in older children. In high mortality populations, deaths occurring at age 1–4 years are mostly caused by infectious diseases, while those occurring in the first year of life are frequently due to poor conditions during pregnancy and delivery. Usually, 4q1 declines earlier than 1q0, and Mlomp is a rare example of the opposite situation.

The rapid decline in infant mortality since 1960, the unusually small proportion of babies born with low birthweight for a rural African population and the low number of deaths attributed to neonatal tetanus, prematurity and delivery conditions in 1985–1989 suggest that the improvement in delivery conditions and ante- and postnatal health care started earlier in Mlomp than in most rural areas in Senegal and that programme development was more intensive than normal for the country. By 1970 and thereafter, more than 95% of the women gave birth in a maternity clinic (during the period 1981–1986 only 28% of deliveries in rural areas of Senegal and 41% in the whole country occurred with the assistance of health services).[10] It is important to note that the use of maternity facilities was already well established in Mlomp by 1967 although there was no local maternity clinic and women still had to travel 10 km to deliver. Hence, the new maternity clinic which opened in 1968 did not initiate the change in delivery conditions, it just contributed to it. Indeed, a few years before the opening of the clinic in Mlomp, the proportion of women delivering in clinics had greatly increased (Figure 2), probably in relation to the opening of the dispensary and to the policy of providing transportation for pregnant women from Mlomp to nearby maternity clinics.

Though the early and rapid success of maternity clinics among the Mlomp population largely results

TABLE 4 *Probability of dying before age 5 years for a child alive at age 1 month, by cause. Comparison between Mlomp (Senegal) (period 1985–1989) and three other rural African areas*

Cause of death	Mlomp (Senegal) 1985–1989[a]		Niakhar (Senegal) 1983–1985		Farafenni (Gambia) 1982–1983		Machakos (Kenya) 1975–1978	
	No. of deaths	Probability of dying (x 1000)	No. of deaths	Probability of dying (x 1000)	No. of deaths	Probability of dying (x 1000)	No. of deaths	Probability of dying (x 1000)
Gastroenteritis	14	15	259	91	25	53	62	16
Pneumonia	8	9	104	37	26	55	47	12
Measles	0	0	82	30	5	11	49	12
Whooping cough	1	1	42	15	0	0	7	2
Malaria	2	2	63	23	24	51	14	4
Other infections	3[b]	3	17[c]	6	19[d]	40	6[e]	2
Congenital malformations	3	3					2	1
Prematurity							1	0
Malnutrition			25	9	4	8	20	5
Accident	2	2					4	1
Other	2	2	29	11	11	23		
Undetermined	7	8	209	74	15	32	12	3
Total	42	46	830	264	129	228	224	56

Sources:
Niakhar: Leroy and Garenne 1989
Farafenni: Greenwood *et al.* 1987 and personal communication
Machakos: van Ginneken and Muller 1984
[a] the exact period is from 30 October 1984 to 22 February 1990.
[b] one death was caused by meningitis
[c] 17 deaths were caused by cholera
[d] 13 deaths were caused by meningitis
[e] six deaths were caused by tuberculosis

from the efforts of missionaries and health workers to encourage people to use them, the tradition of delivering in *kalambas* may have had some influence. For generations women have been used to leaving their homes and going to a special place to deliver. The women's associations of the village financed the building of the modern maternity clinic (as they had built the *kalambas* in the past). Customs such as removing all clothing on arrival at the clinic, staying there 5 days or more, and forbidding men from entering, have been maintained with the collaboration of health personnel. This has facilitated the transition. Undoubtedly change would have been slower if the tradition had been to deliver at home, as is the case in most areas of Senegal and the rest of Africa.

Diseases preventable by vaccination are now very rare in Mlomp—a consequence of the high vaccination coverage rate. They remain important causes of death in other rural areas, as shown by similar studies in Niakhar,[12] Senegal and Farafenni, The Gambia[13] (Tables 3 and 4). The last epidemics of measles occurred in Mlomp in 1972 and 1974. About 1000 children contracted the disease and several dozen died. Among diseases not preventable by vaccination, gastrointestinal diseases and lower respiratory infections are the most important causes of death in children aged 1 month to 4 years. However, as shown by Table 4, the risk of dying from such diseases is approximately five times lower in Mlomp than in Niakhar or Farafenni. Malaria mortality is also remarkably low in Mlomp. Although chemoprophylaxis has considerably reduced the level of endemicity, malaria remains the most frequent cause of fever. That nearly all the clinical cases survive in that population with low immunity can only be explained by rapid presumptive treatment facilitated by the habit of keeping chloroquine at home. The two components of the malaria programme, chemoprophylaxis and presumptive treatment, have been promoted in close association and probably both played a role in the fall of malaria mor-

tality. In Farafenni, malaria mortality has also been significantly reduced by a combination of chemoprophylaxis and treatment.[14]

The drop in child mortality in Mlomp is reminiscent of that which occurred in Machakos, Kenya.[15] The Machakos area had benefitted from an important programme aimed at enhancing the health of mothers and children. Child mortality had reached very low levels by African standards; proportions of low birthweight babies and causes of death were very similar to those observed in Mlomp (Tables 3 and 4). Another example of rapid drop in child mortality was seen in Keneba, The Gambia.[16] Ten years after a new outpatient clinic, run by a qualified physician and full-time midwife, began providing a wide variety of health services, with a research laboratory nearby, infant mortality fell from 148 to 24 per 1000 and mortality in children aged 1–4 years from 109 to 13 per 1000 although the population remained poor and largely illiterate. By contrast with Keneba which had a professionally run upcountry outpatient clinic, and like most dispensaries, Mlomp has no physicians or midwives, but is run by nurses (just one for the first 15 years). But, as in Keneba, and in contrast with most public dispensaries in Africa, health activities were well coordinated, drugs were always available thanks to non-governmental assistance, and personnel were available 24 hours a day. Furthermore, in the case of Mlomp, there was little change of personnel throughout the whole period and consequently continuity in service implementation was high.

Mlomp is one example of an African rural area where the provision of well-organized health services at a reasonable cost has produced a dramatic decline in child mortality.

ACKNOWLEDGEMENTS

This study was supported by several French institutions: Institut National de la Santé et de la Recherche Médicale (contract No. 858028), Institut National d'Etudes Démographiques, Muséum National d'Histoire Naturelle, Centre National de la Recherche Scientifique (URA 49) and Institut Français de Recherche Scientifique pour le Développement en Coopération (ORSTOM). Thanks are due to the Ministère du Plan et de la Coopération and to the Ministère de la Santé, Senegal, for their interest and help. We are indebted to Jeanne-Marie Rousset, Monique Bailly-Maître, Thérèse Jullia, Patrick Dujarric, Assane Badji, Henriette Diatta, Constance Sambou, Agnès Senghor, Antoinette Senghor and Cécile Senghor, who participated or assisted in the collection of the data and to Anouch Chahnazarian, Vincent Fauveau, Brian Greenwood, Alice Greenwood, Kenneth Hill and Henry Mosley for their comments and suggestions.

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(Revised version received July 1992)