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NEONATAL TETANUS MORTALITY IN KILIFI DISTRICT, KENYA: RESULTS OF A COMMUNITY SURVEY, 1989

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SUMMARY

In a house-to-house survey in Kilifi District, Kenya, mothers of 2556 live born children were interviewed and data collected on neonatal mortality, especially from neonatal tetanus (NNT). The crude birth rate was 60.5 per 1,000 population, the neonatal mortality rate 21.1 per 1,000 live births, and the NNT mortality rate 3.1 per 1,000 live births. The neonatal mortality and NNT mortality rates were higher in boys than in girls. There was no geographical or seasonal variation. NNT was not associated with mother's age, parity, or history of previous child death. 72% of the children were adequately protected at birth against NNT; in those with documented protection NNT mortality was 0, in those with undocumented protection 1.2 and in other children 8.5 per 1,000 live births. Other risk factors for NNT included home delivery, untrained assistance during delivery, unclean cord cutting and application of potentially infectious substances on the umbilical stump. The survey and additional data indicate that over the past decade Kilifi District has greatly reduced NNT incidence and overall neonatal mortality. Policies and strategies have been identified by the survey for accelerated NNT control.

INTRODUCTION

In 1984-85, house-to-house neonatal tetanus (NNT) mortality surveys were conducted in three districts of Kenya using the standard WHO 30-cluster survey methodology (1). Estimates of neonatal tetanus mortality ranged among the three districts from 6 to 15 per 1,000 live births (2,3). It was inferred that 8,000 to 12,000 newborns die annually in Kenya from this preventable disease. Although the Kenya Expanded Programme on Immunization (KEPI) has been considerably strengthened in all parts of the country in the past few years, it was felt by the KEPI management unit that the control of NNT needed increased attention. Since only an unknown, but probably small, proportion of cases are reported through routine disease surveillance systems, the NNT mortality survey in Kilifi District was performed in 1989 to determine the magnitude of NNT as a public health problem in the district, alert decision-makers about its importance, and initiate a discussion on future TT immunization policies and other NNT control activities. The survey was conducted by the Ministry of Health, Kenya with the technical and financial support of the U.S. Agency for International Development through its Resources for Child Health Project (REACH/John Snow, Inc.).

MATERIAL AND METHODS

Based on the last national census in 1979, clinical experience and the results from the previous NNT surveys, the coastal area was presumed to have a high incidence of NNT. Kilifi District (see map) was chosen among the six districts in Coast Province for logistic reasons. Using 1979 census data, 30 of the smallest administrative units (sublocations) in

Kilifi District were selected with probability proportional to population size. In each of these sublocations, a cluster of 85 live births in 1988 was identified by starting in a randomly selected household and proceeding to the next nearest household until the required number of live births had been identified.

For each live birth, the mother or another close relative was interviewed and a questionnaire was completed with information on the biodata of the child and the mother, the delivery, and whether or not the child was still alive. If the child was found to have died during the first 28 days of life (days 0-27), an additional questionnaire was completed with open-ended questions followed by more specific questions on symptoms of disease prior to death. A neonate was determined to have died from NNT if it was able to suck soon after birth, stopped sucking, and died with rigidity and convulsions. This questionnaire on neonatal death was reviewed independently by two medical doctors and, in case of doubt, the household was visited again by one of these or the diagnosis was confirmed in a hospital or health center where the child had been treated.

The data were collected by ten interview teams each consisting of two people, one from the Ministry of Health (MOH) Division of Health Information Systems in Nairobi, experienced in field surveys, and one local health worker or school graduate able to communicate with the mothers in their vernacular. Teams consisted of male and female interviewers and were accompanied in each cluster by a local guide known by the community. The teams received 4 days of intensive theoretical and practical training in the survey technique. Training and supervision stressed the importance of <u>not</u> looking for living children, but inquiring as to the outcome of any pregnancy during the past two years. In the field, the interview teams were closely supervised by five senior health workers. The survey took place from 10 February to 5 March, 1989, and the target group was live births during 1988. The maximum recall period was thus 14 months.

Data were entered on the computer using SPSS/PC+ Data Entry with double entry validation. The validity of data was further checked by the valid values and rules utility of the data entry program and by appropriate frequency analyses and cross-tabulations of the data file. Analyses were performed with SPSS/PC+, Lotus Symphony and Epiinfo.

Differences in mortality between population subgroups were evaluated statistically by Fisher's test or a modified chi-square test. The variance assumption of the chi-square test is the binomial model. Due to the cluster sampling, the neonatal deaths in the present survey did not occur independently and their variance must be expected to be larger than the variance of a binomial distribution. A design effect due to the cluster sampling method was calculated as the observed variance of the cluster means divided by the expected variance if the sample had followed the binomial distribution. For NNT mortality the design effect was 1.03, for total neonatal mortality 1.72 and for tetanus toxoid immunization 5.30. It can be shown that the chi-square for comparison of subgroups in this case equals the usual chi-square divided by the design effect. Due to the very small design effect for NNT mortality, this correction was not done for NNT mortality. Confidence intervals of NNT mortality rates were estimated from

tabulated values of the Poisson distribution, while other confidence rates were calculated from the binomial distribution taking the design effect into account.

RESULTS

1. Neonatal and infant mortality

In the 30 clusters, 5154 households with a total population of 42,252 persons were visited. The average household size was 8.2 compared with 5.6 in the 1979 census, and the crude birth rate 60.5 compared with 55 in the same census. A total of 54 neonatal and 48 post-neonatal deaths were found in a population of 2556 live births, 49% of which were males. The neonatal mortality rate was estimated as 54/2556 = 21.1 per 1,000 live births (95% confidence interval 13.8 - 28.4). The neonatal mortality rate was 28.7 in boys and 13.8 in girls (p=0.052). In the 1984-85 NNT surveys in Kenya, neonatal mortality in three districts ranged from 10 to 23 per 1,000 live births with the highest mortality in South Tana Division (Tana River District), which borders the northern part of Kilifi District. Neonatal mortality did not vary with the age or parity of the mother. It was slightly higher for children whose mothers had previously lost a child, but the difference was not statistically significant.

An estimation of infant mortality is more complicated as the observation periods ranged from 1 to 12 months. Using the lifetable method (4), infant mortality was estimated at 49.6 per 1,000 live births (Fig. 1). Neonatal mortality was accordingly 43% of the total infant mortality, which is comparable to the 40% reported nationwide from the Kenya Fertility Survey 1977-78 (5) and to a study in Machakos District in the late 1970's which reported 47% (6). Experience from other developing countries indicates considerable variation from one country to another in the proportion of infant mortality occurring in the neonatal period.

2. Neonatal tetanus mortality

Eight deaths due to neonatal tetanus were observed. The overall neonatal tetanus mortality was thus 3.1 per 1,000 live births (95% conf.int. 1.4-6.2). This is low compared with the results from previous surveys in Kenya (Table 1). The mothers attributed the death of their child to one or more of the following diseases: Kusaga, Lalwa, Nyago and Kafulo, which all describe the symptoms of NNT.

The age distribution of neonatal deaths followed the typical pattern with highest overall mortality during the first few days of life and a clustering of neonatal tetanus deaths from day 3 to 11 (Fig. 2). The symptoms preceding death from tetanus were compared with those of other neonatal deaths in Table 2. The mean age at onset of NNT was 3.9 days, duration 2.3 days and age at death 6.1 days (range and median are found in Table 2). Typically, a child who had been able to suck after birth stopped sucking and died with rigidity and convulsions. It should be noted, however, that most children who died of other causes during the neonatal

period also stopped sucking, so this symptom was not a good discriminator. All children who died from NNT had received treatment prior to death, either from a health professional or from a traditional healer, while almost half of the children who died from other causes did not receive any treatment. This probably reflects the fact that NNT has a longer duration than most other fatal neonatal diseases and that the majority of children dying from other causes died shortly after birth.

Geographically, the deaths from NNT were evenly distributed. There was no seasonal pattern of neonatal mortality or NNT mortality. Neither for NNT mortality nor for other neonatal mortality was there any difference between long and short recall periods. Although all three NNT cases in female children occurred within the last 7 months before the survey, this difference was not statistically significant.

NNT mortality was estimated in various subgroups of the population. It was neither associated with the mother's age nor her parity. Mothers who had previously experienced the death of a child did not have greater risk of losing a child from NNT than those mothers whose children were all alive. As was the case for total neonatal mortality, boys were at greater risk of dying from NNT (4.0 per 1,000 live births) than girls (2.3 per 1,000 live births), but due to the small number of NNT deaths (5 and 3 respectively) this was not statistically significant ($p=0.34$).

For 21 neonatal deaths, pediatricians revisited either the household or the health facility where the newborn had been treated in order to re-confirm the diagnosis. Two newborns, who were originally recorded by surveyors to have died of NNT, were subsequently determined by the pediatricians to have died from other causes. One of these, according to hospital records, had not developed convulsions and died at 14 days of age with a diagnosis of sepsis. The other child had not been seen by a health worker and died at 6 days of age with symptoms of sepsis and/or jaundice. Pediatric investigations, however, uncovered two additional cases of NNT which had originally been attributed to other causes.

3. Tetanus toxoid (TT) immunization

The mothers were asked how many TT injections they had received during the index pregnancy and the previous pregnancy. TT immunization cards as part of antenatal care are not commonly used in Kenya, so few TT injections were documented. The anatomical site of TT injections is, however, unique to the Kenyan context, and a careful interviewer is able to assist the mother to distinguish between different types of injection given during pregnancy. The recall period was very long, one year or more for the index pregnancy and several years for the previous pregnancy. This invariably renders the data relatively unreliable.

Children were classified as protected if their mother had received two or more doses of TT during the index pregnancy, or one dose during the index pregnancy and at least one dose during the previous pregnancy. If the doses given during the index pregnancy were documented, the protection was regarded as documented. Children were classified as having uncertain

TT status if their mothers had received 2 or more doses during the previous pregnancy and none during the index pregnancy. Children of mothers who had received less than two doses in total with none during the index pregnancy were classified as unprotected.

72% were classified as protected (8% with documentation), 3% were uncertain and 16% unprotected, while the status of 9% was unknown due to missing information. Mothers less than 20 years old were more often unprotected than mothers more than 20 years old (25% versus 14%; p=0.015), and women were more often unprotected during their first pregnancy (28%) than during subsequent pregnancies (13%)(p=0.0005).

Table 3 shows neonatal mortality according to TT protection status. No NNT deaths occurred in children with TT protection documented by an immunization card. In children of mothers who reported being protected, but who were unable to produce documentation, two died from NNT, while three NNT deaths occurred in unprotected children and three in children with unknown status. Combining all protected children in one group, whether protection was documented or not, gives a NNT mortality rate in protected children of 1.0 per 1,000 live births (95% conf. int. 0.1-3.9) and 8.5 per 1,000 live births (95% conf. int. 3.1-18.6) in all other children (p=0.007). Vaccine efficacy was calculated as 0.87. The NNT mortality rate in the unprotected population was at the same level as that found during the previous NNT surveys in Kenya. There was no association between TT status and neonatal mortality from other causes.

4. Delivery practices and antenatal care

Questions were asked regarding place of delivery, attendant at delivery, how the umbilical cord was cut and what was applied to the cord after cutting. Furthermore, the number of antenatal visits and other visits to health clinics during the index pregnancy were recorded.

The majority of mothers (79%) delivered at home and the rest in a hospital or health center. A trained nurse, midwife or medical doctor attended 21% of the mothers, 4% were attended by a trained TBA (traditional birth attendant), 30% by an untrained TBA and 44% by another untrained person.

The umbilical cord was cut aseptically in 89% of cases, most often with a new, unused razor blade taken directly from its original wrapping. After cutting, however, potentially infectious material was applied in 62% of the cases, while 21% had an aseptic dressing and 15% were left without any dressing.

Table 4 shows the distribution of live births according to delivery practices, i.e. birth at home or in a health facility, trained or untrained birth attendant and clean or potentially infected cord treatment (cutting and dressing). The majority of children were born at home with the assistance of an untrained attendant, and in most of these cases the cord was potentially infected. All NNT deaths occurred in children born at

home, with untrained assistance and potentially infected cord treatment. Calculated from the mortality rates in Table 4, the vaccine efficacy of TT, which was thus standardized for differences in birth practices, was 0.86.

Questions were asked on ear-piercing and circumcision but none of the children who died during the neonatal period had any of these procedures performed.

In 10% of the cases, there was no information on the use of antenatal care, in most instances because information was not accepted from a respondent other than the mother. Of the remaining mothers, 92% had visited an antenatal clinic at least once during the index pregnancy, while 38% of the mothers had visited a health facility for other reasons during the index pregnancy. 268 mothers (12%) had paid at least two visits to an antenatal clinic during the index pregnancy and yet had not been protected during the last two pregnancies with two doses of TT; these included 3 of the 8 mothers whose children died from NNT.

DISCUSSION

As of 1988, NNT surveys had been carried out in 16 countries in Africa. Survey results regularly indicate that NNT is grossly under-reported by routine disease surveillance systems. The disease occurs primarily at home in rural areas and is frequently not seen by health workers. Among the EPI-target diseases, NNT is the second leading cause of mortality after measles in many countries. WHO estimates that each year in Africa 210,000 neonates succumb to the disease (7). KEPI has set a target to reduce the level of NNT to less than 5 per 1,000 live births by 1993. The NNT mortality rate of 3.1 per 1,000 live births in the present study indicates that this target has already been achieved in Kilifi District.

Rates of NNT or neonatal mortality in Kilifi District at the time of the national census in 1979 are unavailable. With an infant mortality rate of 149 per 1,000 live births in 1979, and applying national averages concerning the proportion of infant mortality occurring during the neonatal period (5), it is estimated that the 1979 neonatal mortality rate was 60 per 1,000 live births. The Kilifi District survey found a greatly reduced neonatal mortality rate of 21.1. The fact that the crude birth rate and the male:female birth ratio were as expected supports the validity of the survey data.

Although the possibility exists that some neonatal mortality was missed, the survey and additional data indicate that Kilifi District represents a major success story in lowering NNT incidence and reducing overall neonatal mortality.

In the past decade, immunization services have been greatly improved in Kilifi District. The reported number of second or booster doses of TT immunizations increased by 35% from 1982-85 to 1986-88. Since KEPI began in the District in 1982, the percentage of fully immunized infants increased from 27% to 52% in 1987 according to coverage surveys (8).

Access to childhood immunization is now very high with 95% of infants receiving DPT1 according to documentation or history and a BCG scar rate of 90% in 1987.

From 1982-85 to 1986-88, fatal NNT cases seen at Kilifi District Hospital decreased by 42% from a yearly average of 38 to 22, while NNT cases as a proportion of all pediatric admissions fell from 2.8% to 1.5%. (9) Hospital records for 1988 from both Kilifi and Malindi Hospitals, which cover approximately 80% of the population of Kilifi District, indicated that 49 NNT deaths occurred. The estimated number of births in 1988 was 34,761 (Central Bureau of Statistics), and the adjusted NNT mortality rate was thus 1.8 per 1000 live births. This rate corresponds to the NNT mortality rate of 3.1 on the present study, considering that half of the NNT deaths were seen at a health facility - as with the small sample on the present survey.

Although baseline data at the time of the 1979 census are unknown, an antenatal care coverage in Kilifi District of 85% for first visits in 1987 was the highest of all six districts in Coast Province (10). There were an additional 2.8 antenatal revisits on average for each registered first visit. The present NNT survey found that 92% of mothers had at least one antenatal visit. The 1987 coverage survey found TT coverage to be 84%, based primarily on maternal recall of TT received during the last two pregnancies. Using a stricter definition of adequate coverage, the present NNT survey found 72% of newborns were delivered with protection against tetanus.

As expected, the survey found independent and incremental risks associated with various factors but the few NNT cases made a detailed analysis impossible. Children with a combination of several risk factors, including no TT protection, home delivery by untrained attendants and application of septic dressings, had a NNT mortality rate of 14.1 per 1,000 live births which accounted for 51% of all neonatal deaths in this group. The NNT mortality rate and the proportion of neonatal deaths due to tetanus in the unprotected population were thus at the same level as in the entire survey population of the previous NNT surveys in Kenya.

In the 1984-85 surveys, 67% (range 59% - 71%) of neonatal mortality was due to tetanus. WHO notes that in many countries up to 50% of neonatal mortality may be due to NNT (11). In the present survey the figure was only 15%, while the overall rate of neonatal mortality remained as high as in the neighboring Tana River District survey. It is unlikely that the Kilifi survey teams would have elicited a similar rate of neonatal mortality and selectively missed NNT mortality.

Nearly all of the drop in neonatal mortality in Kilifi from the assumed 60 per 1000 live births in 1979 to 21.1 in 1989 was likely due to a reduction in NNT (Table 5). Replacement mortality did not occur. Assuming a neonatal mortality rate in Kilifi District of 59.6 per 1,000 live births in 1979 (0.4 x 149), and assuming that 69% (41.1) was due to tetanus as on the 1984-85 survey in neighboring Tana River District, then the mortality rate from other neonatal conditions would have been 18.5 per 1,000 live births in 1979. This is similar to the non-tetanus neonatal mortality rate

of 18.0 per 1,000 live births, which was found on the present survey. Neonatal mortality attributable to causes other than tetanus is generally less amenable to rapid reduction in the short term.

CONCLUSION

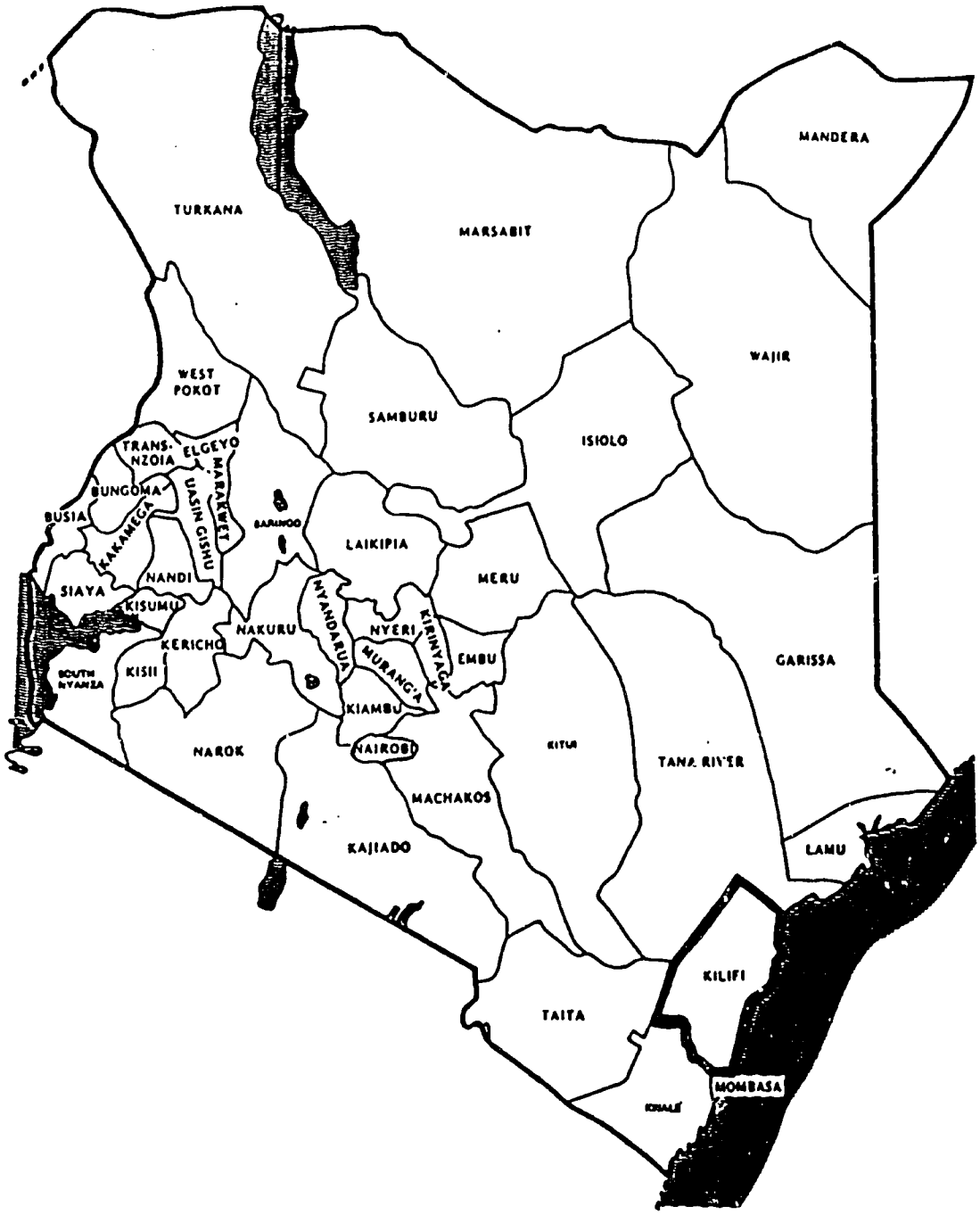
The survey has identified three areas where improvement in services is especially needed. Missed opportunities for TT immunization must be reduced. 12% of the mothers had not received TT during their last 2 pregnancies despite having attended antenatal clinics at least twice during the index pregnancy. These 12% contributed half of the 8 cases of NNT found on the survey. The introduction of durable tetanus protection cards for recording all TT doses and the strengthening of screening, referral and immunization at every antenatal contact would reduce the level of missed opportunities. In other districts where antenatal services are less developed or utilized, screening and immunization of all women of childbearing age at every contact with the health services will be needed.

Whereas 89% of the mothers had their umbilical cord cut aseptically, in most cases at home with a clean unused razor blade, potentially infectious material was applied to the stump in 62% of the cases. Suitable messages will need to be formulated and communicated to mothers.

Young mothers having their first pregnancy were found to be significantly less well protected by TT than other women; however, given the small number of NNT deaths, this did not constitute a risk factor. It is therefore necessary to design immunization strategies and messages specifically aimed at increasing TT coverage in this high-fertility group. This could be done by introducing a 5 dose TT schedule for all women of childbearing age and starting TT immunization in schools and on contacts with the health services before the age of first pregnancy.

Further surveys may be needed in other parts of the country to assess NNT mortality, but an analysis of hospital records gives relevant information on NNT mortality and can be used to make a low-cost, nationwide assessment of NNT. Although tetanus is a notifiable disease in Kenya, NNT is not yet reported separately from other tetanus. Surveillance of NNT cases and trends will need to be strengthened as a prerequisite for improved control.

The 38th Session of the Regional Committee for the WHO Regional Office for Africa in 1988 called for NNT elimination in Africa by 1995. With the good start towards NNT control in Kilifi District providing encouragement, Kenya should now take up this challenge by designing a NNT elimination strategy tailored to the operational, epidemiological and social realities in each district.



KILIFI DISTRICT, ONE OF THE SIX DISTRICTS OF KENYA'S COAST PROVINCE

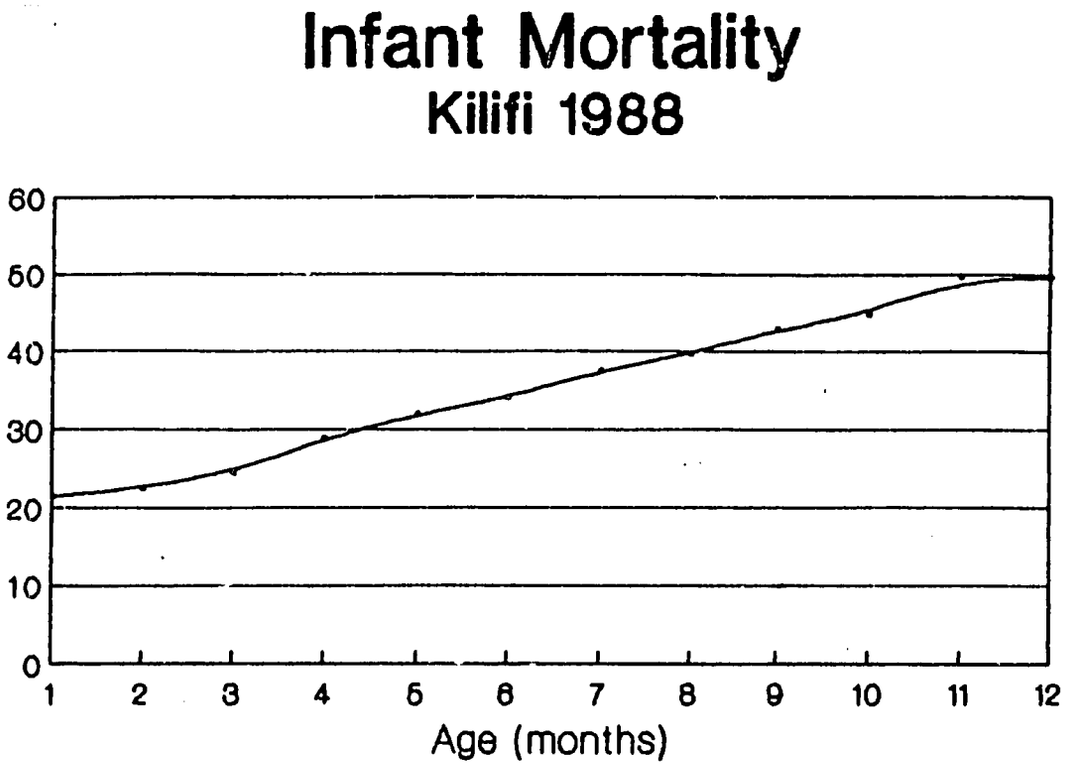


Fig. 1. Cumulated mortality per 1,000 live births by month during infancy. Calculated from survey data using the life table method. Kilifi District, 1989.

Table 1. Neonatal tetanus surveys in Kenya, 1984-89.

	1984-85			1989
District	Meru	Tana River	Kisii	Kilifi
Live births	2132	2133	2301	2556
Neonatal deaths	34	48	22	54
Rate/1,000 live births	16 (9-23)*	23 (16-30)	10 (5-15)	21.1 (16-28)
Neonatal Tetanus Deaths	24	33	13	8
Rate/1,000 live births	11 (7-16)	15 (11-21)	6 (3-9)	3.1 (1-6)
% of neonatal mortality due to tetanus	71%	69%	59%	15%

*95% confidence intervals in parentheses

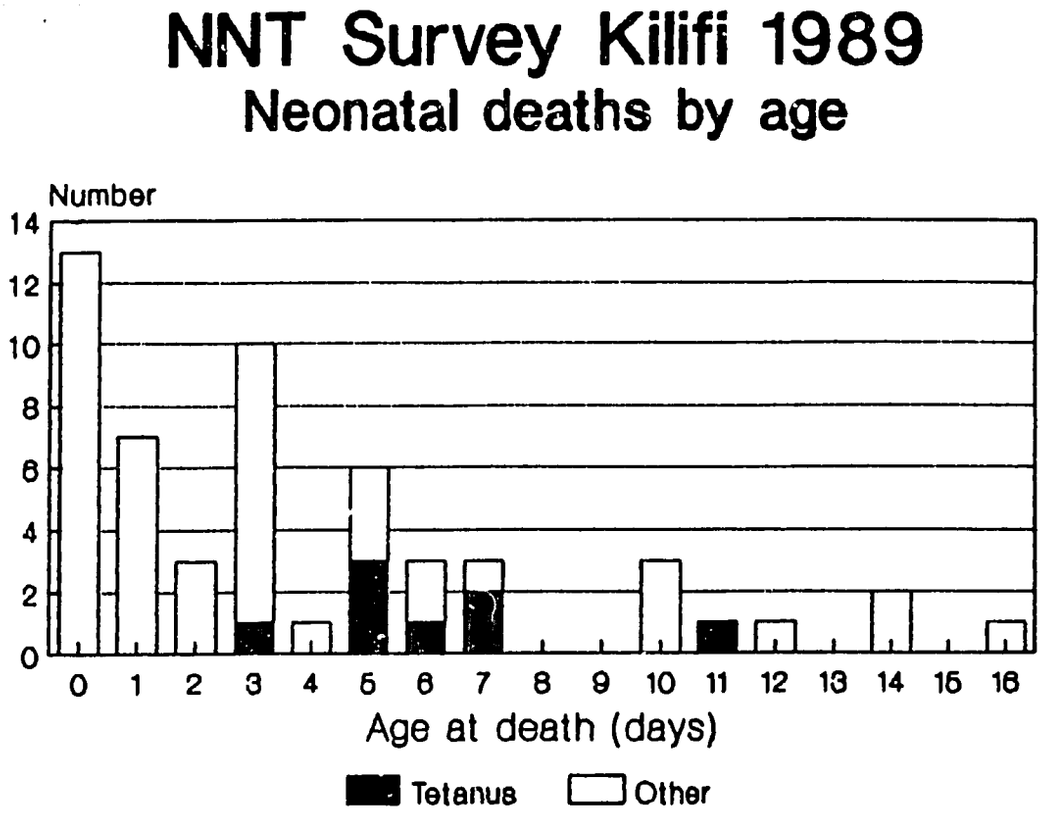


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Fig. 2. Neonatal deaths due to tetanus and other causes by age in days. Kilifi District, 1989.

Table 2. Age, duration, symptoms and treatment prior to death from neonatal tetanus and other neonatal diseases. Kilifi District, 1989.

	Neonatal tetanus (n=8)	Other neonatal diseases (n=46)
Age at onset	0-7 days median=4	0-7 days median=1
Duration	0-4 days median=3	0-13 days median=1
Age at death	3-11 days median=5.5	0-16 days median=2.5
Sucked at birth	88%	35%
Stopped sucking	86%	88%
Rigidity	100%	15%
Convulsions	100%	20%
Treatment		
Health professional	50%	41%
Traditional healer	50%	9%
No treatment	-	50%

Table 3. Neonatal mortality and TT immunization status.
Kilifi District, 1989.

TT Status*	Neonatal tetanus mortality		Non-tetanus neonatal mortality	
	Deaths	Rate/1,000 live births	Deaths	Rate/1,000 live births
Protected with documentation (n=207)	0	0 (0-17.8)**	5	24.2 (0-51.4)
Protected without documentation (n=1645)	2	1.2 (0.1-4.4)	25	15.2 (7.5-22.9)
Unprotected (n=405)	3	7.4 (1.5-21.6)	10	24.7 (5.0-44.4)
Uncertain status (n=75)	0	0 (0-49.2)	2	26.7 (0-74.2)
Unknown status (n=224)	3	13.4 (2.8-39.1)	4	17.9 (0-40.5)
TOTAL	8	3.1 (1.4-6.2)	46	18.0 (11.3-24.7)

*See text for definitions

**95% confidence intervals in parentheses

Table 4. Neonatal mortality according to birth practices and TT protection
Kilifi District, 1989.

Birth practices	TT status	Live births	Neonatal tetanus		Non-tetanus	
			Deaths	Rate/1,000	Deaths	Rate/1,000
Home delivery, untrained assistant, infected cord	Protected	1021	2	2.0 (0.2-7.1)		
	Unprotected*	426	6	14.1 (5.2-30.7)	20	13.8 (6.0-21.7)
Home delivery, untrained assistant, clean cord	All	390	0	0 (0-9.5)	9	23.1 (3.6-42.5)
Delivery in health facility, trained assistant, clean cord	All	398	0	0 (0-9.3)	13	32.7 (9.9-55.4)
Other and unknown	All	321	0	0 (0-11.5)	4	12.5 (3.4-31.9)

*Unprotected includes children with unknown TT status

Table 5. Mortality Rates in Kilifi District
According to 1979 Census and 1989 Survey

Mortality rate per 1000 live births	1979 census	1989 survey	Mortality reduction per 1000 live births
Infant mortality rate	149.0	49.6	99.4
Neonatal mortality rate	59.6	21.1	38.5
Neonatal tetanus mortality rate	[illegible].1	3.1	38.0
Non-tetanus neonatal mortality rate	18.5	18.0	0.5

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