Original article

Community-based malaria control programme in Tigray Region, Northern Ethiopia: Results of a mortality survey of rural under-five children

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Abstract: A mortality survey of children under five years of age was undertaken in Tigray Region, in rural areas covered by a community-based malaria control programme. A multistage cluster sampling technique was used to define the sample. Trained Malaria Control Programme personnel conducted interviews in 4660 households. Total under-five population sampled was 7335, in which 190 deaths were reported in one year. Median duration of illness before death was 14 days, mean age at death 1.5 years, and 53% of those who died were male. Forty five percent died without being taken to a Community Health Worker (CHW) or to a health facility before death, and 92% of the deaths occurred at home. Overall, 12% of deaths were reported by families due to fever or malaria. Death rate (age 0-4) was 25.9%. Estimated age specific mortality rate (age 0-4) was 26.3%, underfive mortality rate (U5MR) was 163%, and malaria-specific mortality rate based on lay reporting was 3.3%. Two districts were found to have very high mortality with estimated U5MRs of 372% and 290%.

Based on these findings, increased efforts are being made in the Community-Based Malaria Control Programme to educate families about the importance of early diagnosis and treatment and the use of CHW services for ill children. Areas for investigating the determinants of the marked district mortality differentials are discussed. [*Ethiop. J. Health Dev.* 1998;12(3):203-211]

Introduction

Because of the importance of malaria as a public health problem in Northern Ethiopia, the Malaria Control Department of the Tigray Region Health Bureau initiated a community-based malaria control programme in 1992. The long term objective is to control malaria through community participatory efforts in a primary health care setting. The design and initial assessment of the Programme are described elsewhere(1). Programme activities include early diagnosis and treatment of clinical malaria at the village level by Community Health Workers (CHWs),provision of chloroquine prophylaxis to pregnant women, and community participation in environmental management for vector control.

Although it is postulated that Programme interventions will have a favourable impact on the health of the general population, the health of especially vulnerable groups, including children under-five years of age and pregnant women is of particular concern and interest. Both groups, by virtue of having lesser immunity to malaria(2), should benefit most from programme interventions. The group in which deaths due to malaria are expected to be highest and in which

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the impact on mortality of programme interventions would be greatest is the under-five year age group.

At the time of programme implementation, the Region's official death reporting system recorded only deaths that occurred at health institutions. Because death data from health institutions are not reported by age or sex, and because only 25-30% of the population had access to health institutions (as defined by distance from residence to health institution of less than 10 kilometres), existing

mortality data were inadequate to serve as baseline. An attempt to collect mortality data from routine CHW reports proved ineffective as reporting was incomplete. It was thus decided to undertake a baseline mortality survey with the aim of evaluating the impact of rogramme interventions on mortality in under-five year children. The specific objectives of this survey were 1) to estimate mortality rates in the under-five age group, 2) to estimate malaria-specific mortality rates based on lay reporting, and 3) to determine pattern of utilization of community-based and health institutionbased services before death.

Methods

Study area and population: The Community-Based Malaria Control Programme covers all rural malarious areas in Tigray. According to the administrative structure at the time of Programme implementation, malarious areas included 60 of 81 districts (74%) and 681 of 1136 localities (61%). Each locality is formed by 3-5 villages. The target population was the under-five year age group. Using formulae from other malaria-control intervention trials with correction for the effect of cluster sampling(3,4), it was estimated that study of at least 4655 children under-five years was required to document a 15% decrease in deaths between years at a power of 0.9.

estimated under-five mortality rate = 233 per thousand[5]
y = sample size of under-5s required for each survey r1 = expected mortality rate at baseline r2 = expected mortality rate after 5-year intervention design effect = 1.26
$y = (10.5 (r1+ r2) / (r1 -r2)^2$ X design effect) = 4655

A multistage cluster sampling technique was used to define the sample. Ten districts (primary sampling units) were chosen using probability proportional to size (PPS). The chosen districts were in Adua, Enda-Selassie, Maichew, Makalle, and Tembien areas. Within the selected districts, 85 localities (secondary sampling units) were then selected using PPS. Within each locality, one village (the ultimate sampling unit) was chosen by lottery. The first household within each village was selected randomly: a pen was spun at the centre of the village and all houses located in a line from the pen point to the edges of the villages were numbered, then one was randomly selected as the first survey household. Subsequent households were chosen by serial proximity. If a house were locked the next closest house was selected. Hundred percent of the planned sample was eventually seen. The survey questionnaire was administered in a mean of 52 (±2) households in each of 90 villages.

Trained Department personnel carried out the survey from May 23 through June 30, 1994. The survey was administered only in households living permanently in the locality during the survey period. Standard forms with precoded variables were used to collect data from each household. Information collected included household size, deaths in under-five children from April 9, 1993 through April 8, 1994, age and sex of children who died, health service utilization before death, and family report of cause of death. Inadvertently, numbers and dates of births during the survey period were not recorded.

Data analysis: The following formulae were used to calculate rates:

death rate age 0-4=# deaths in children <5 years/<5 year population age specific mortality rate age 0-4=# deaths in children <5 years/midyear <5 year population cause specific mortality rate=# cause reported deaths in children <5 years/midyear <5 year population under 5 mortality rate=# deaths in children <5 years/# live births.

As numbers and dates of births during the survey period were not recorded, the following formulae were used to estimate denominators:

midyear <5 year population=((# children <5 years in household at time of survey)+(# deaths in children <5 years the second half of the survey period year)-(# estimated live births the second half of the survey period year)
estimated live births during survey period year=Crude Birth Rate[8] X household population at time of survey.

The Epi Info statistical programme (version 5) was used for data analysis. Comparison of multiple groups was made using chi-square test for categorical variables, and parametric and nonparametric

analysis of variance (ANOVA) for continuous variables. Statistical significance is defined as a p value of less than 0.05.

Results

Household characteristics are shown in Table 1. Household size, number of under-five children per household, and duration of residence in locality differed significantly between areas. However, except for duration of residence, the magnitude of difference is small and has doubtful demographic significance for the purposes of the survey. Overall, mean number of persons per household was 5.2; mean number of under-five children per household was 1.6, and mean years of residence in the locality was 32 years.

Table 1: **Characteristics of survey households**

Area	Number of Districts Sampled	Number of Localities Sampled	Number of Villages Surveyed	Number of Households	Total Household Population	Persons per Household Mean±1SD	Total Under-5 Household Population	Under 5 Children per Household Mean±1SD	Years Locality Residence Mean±1SD
p value							p<0.0001	p=0.0001	p<0.0001
Adua	3	25	27	1396	7390	5.3±1.9	2211	1.6±0	34±15
EndaSelassie	2	16	18	935	5020	5.4±1.9	1399	1.6±0.6	30±16
Maichew	2	17	18	938	4849	5.2±1.9	1482	1.5±0.6	25±16
Makalle	2	18	18	924	4363	4.7±1.8	1475	1.6±0.7	32±15
Tembien	1	9	9	467	2595	5.6±1.7	768	1.6±0.6	42±10
SUBTOTAL	3	85	27	4660	24217	5.2±1.9	7335	1.6+0.6	32±16

Number of deaths and characteristics of those dying are shown in Table 2. Mean age at death and distribution of deaths by sex and age group did not differ significantly between areas. Overall, deaths in children less than one year accounted for 30% of all deaths; mean age at death was 1.5 years, and 53% of those dying were boys. Median duration of illness before death ranged from one to more than four weeks and differed significantly between areas, with shortest duration of illness in the more malarious areas of Maichew and Tembien.

Causes of death reported by families were categorized as shown in Table 3. Analysis for differences in proportionate mortality by area was not done because of the small number of deaths per category. Malaria was considered the cause of death in children whose parents reported death due to malaria or fever. Malaria thus accounted for 12% of deaths, and malaria-proportionate mortality was highest in the more malarious areas of Maichew (22%) and Tembien (38%). Causespecific mortality rates based on lay reporting are shown

Table 2: **Numbers of deaths and characteristics of children who died**

Area	Number of Deaths	Male Sex Percent	Age in Years Mean±1SD	<1yr	Distribution of Deaths By Age Group Percent			4-<5yr	Days Ill Before Death Median
					1-<2yr	2-<3yr	3-<4yr		
		X^2=6.91 p=0.14	p=0.62			X^2=20.46 p=0.20			p=0.03
Adua	71	54	1.5±1	34	28	15	13	10	14
EndaSelassie	25	44	1.8±1.4	32	20	12	20	16	30
Maichew	23	35	1.5±1.0	22	43	22	9	4	7
Makalle	50	56	1.6±1.2	22	32	28	6	12	30
Tembien	21	71	1.4±1.3	43	5	33	14	5	7
TOTAL	190	53	1.5±1.2	30	27	21	12	10	14

Table 3: **Family report of cause of death***

Cause of Death	Number (percent) of Deaths					
	SUBTOTAL	BY AREA				
		Adua	Enda Selassie	Michew	Mekalle	Tembien
Unknown	35 (18)	17 (24)	16 (64)	2 (9)	0 (0)	0 (0)
Diarrhoea	35 (18)	8 (11)	2 (8)	5 (22)	19 (38)	1 (5)
Measles	24 (13)	8 (11)	2 (8)	2 (9)	9 (18)	3 (14)
Other1	22 (12)	10 (14)	0 (0)	4 (17)	7 (14)	1 (5)
Pertussis	20 (11)	7 (10)	0 (0)	2 (9)	10 (20)	1 (5)
Respiratory	17 (10)	11 (15)	0 (0)	1 (4)	0 (0)	5 (24)
Fever	13 (7)	0 (0)	3 (12)	5 (22)	1 (2)	4 (19)
Malaria	10 (5)	6 (9)	0 (0)	0 (0)	0 (0)	4 (19)
Sudden Death	8 (4)	4 (6)	1 (4)	2 (9)	0 (0)	1 (5)
Malnutrition	4 (2)	0 (0)	0 (0)	0 (0)	4 (8)	0 (0)
Perinatal	2 (1)	0 (0)	1 (4)	0 (0)	0 (0)	1
TOTAL	190	71	25	23	50	21

* Statistical analysis of differences by area not done because of small numbers of deaths per category. 1 OTHER includes abdominal pain, abdominal swelling, anaemia, anthrax, burn, chicken pox, circumcision, delirium, edema, epilepsy, heart disease, hypertension, kidney disease, polio, skin disease, and weakness.

in Table 4. The risk of dying from perceived malaria was highest in the more malarious areas, although the magnitude of difference in risk was greater between Maichew and Tembien than between the less malarious areas and Maichew. In the malarious areas, deaths from malaria were reported more frequently than deaths from other causes.

General mortality rates are shown in Table 5. A large mortality differential is apparent both between and within areas, with very high mortality rates in Adiet district and Hintalo district.

Pattern of health service utilization before death and site of death are shown in Table 6. In all areas, large proportions (45%) of children who died were taken neither to a CHW nor to a health institution before death, and most children died at home. No difference between areas was shown in the proportion of patients receiving no care (p=0.27). Overall, the median duration of illness of seven days for those receiving no care was significantly shorter than the median of 30 days of illness for those receiving care (p<0.0001).

Table 4: **Estimated cause specific mortality rates based on lay reporting***

	Cause specific mortality rates per thousand BY AREA					
Cause of Death	Adua	Enda Selassie	Maichew	Makalle	Tembien	SUBTOTAL
Unknown	8.2	12.3	1.5	0.0	0.0	5.1
Diarrhoea	3.9	1.5	3.6	13.6	1.4	5.1
Measles	3.9	1.5	1.5	6.4	4.2	3.5
Fever or Malaria	2.9	2.3	3.6	0.7	11.2	3.3
Other1	4.9	0.0	2.9	5.0	1.4	3.2
Pertussis	3.4	0.0	1.5	7.0	1.4	2.9

Respiratory	5.3	0.0	0.7	0.0	7.0	2.4

* Statistical analysis of differences by area not done because of small numbers of deaths per category.
1 OTHER includes abdominal pain, abdominal swelling, anaemia, anthrax, burn, chicken pox, circumcision, delirium, edema, epilepsy, heart disease, hypertension, kidney disease, polio, skin disease, and weakness.

Table 5: **Mortality rates in children under-five years by area and district***

	Death Rate Age 0-4	Estimated Age Specific Mortality Rate Age 0-4	Estimated Under 5 Mortality Rate
SUBTOTAL	**25.9/1000**	**26.3/1000**	**163/1000**
AREA			
Adua	**32.1/1000**	**34.5/1000**	**200/1000**
Adi Abun district	21.2/1000	22.7/1000	138/1000
Adiet district	51.4/1000	55.0/1000	290/1000
Edaga Arbi district	23.7/1000	25.6/1000	140/1000
EndaSelassie	**16.9/1000**	**19.3/1000**	**104/1000**
Lalay Koraro district	14.8/1000	15.9/1000	93/1000
Tadj Koraro district	19.2/1000	20.8/1000	114/1000
Maichew	**16.4/1000**	**16.7/1000**	**99/1000**
Chercher district	24.6/1000	26.4/1000	151/1000
Mohoni district	8.4/1000	9.2/1000	50/1000
Makalle	**33.7/1000**	**35.8/1000**	**239/1000**
Hintalo district	55.5/1000	57.9/1000	372/1000
Wajirat district	14.1/1000	15.0/1000	105/1000
Tembien	**27.3/1000**	**29.5/1000**	**169/1000**
Ambera Meteka district	27.3/1000	29.5/1000	169/1000

* Statistical analysis of differences by district not done because of small numbers of deaths per category.

Discussion

General Mortality: This survey is the first large scale community-based study of childhood mortality in Tigray Region for many years. The overall estimated U5MR of 163 puts the Region in UNICEF's very-high-U5MR category(5). Mortality figures are most meaningful when viewed as trends, but Tigray Region was a major site of conflict during the 20 year civil war which ended only in 1991, and the lack of regional mortality data for comparison precludes analysis of mortality trends within the Region. However, examination of such trends in Ethiopia and sub-Saharan Africa is instructive, and helps put into perspective the first Tigray Region report in several decades. While in most African countries during the 1950's, 30-40% of children died before age five, by the mid1970's in many countries fewer than 22% of children died before age five(7). From the mid-1970's to the early 1980's, Ethiopia was one of six countries identified in an analysis of changing patterns of mortality in Sub-Saharan Africa as showing persistent stagnation or an increase in mortality in children under-five, a fact ascribed to the prolonged civil war and a general lack of socio-economic development (7). For the period of the last 15 years, reports of under-five mortality in Ethiopia vary by source. The Ethiopian Central Statistical Authority reports declining mortality, with U5MR decreasing from 219 (1970-1979) to 199 (1980-1984)(8). Other sources report national U5MR estimates of 252 (1985-1990)(8), 233 (1989)(5), and 220 (1993)(9). Recent figures from the Central Statistical Authority estimate U5MR for 1990-1995 to be 152(9). Despite this reduction, Ethiopia remains in the category of very high U5MR countries. National mortality rates can conceal substantial variations between and within regions. The Tigray Region U5MR of 163, though higher than the latest national estimates, is within range of regional variation that might be expected.

The overall mortality estimates in Tigray conceal variation within the Region. U5MR showed wide variation, with disturbingly high mortality rates ranging from two to four times the national rate in some districts. Such intra-regional mortality differences have been reported elsewhere in Ethiopia. In the Butajira Health Project area the mortality rate was 209 but ranged from 105 per thousand in the urban highlands to 299 per thousand in the rural lowlands(10). The marked differences in mortality rates by district calls for further investigation. In attempting to account for such mortality differentials, consideration must

Table 6: **Health service utilization before death and site of death***

	HEALTH SERVICE UTILIZATION BEFORE DEATH NUMBER (PERCENT)			SITE OF DEATH NUMBER (PERCENT)		
	Taken Only To Health Facility	Taken Only To CHW	Taken To Both CHW and Health Facility	Taken to Neither CHW nor to Health Facility	En route to or at Health Facility	Home
All Causes by Area						
Adua	4(6)	5(7)	24(34)	37(53)	7(10)	63(90)
EndaSelassie	1(4)	2(8)	12(48)	10(40)	1(4)	24(96)
Maichew	7(30)	1(4)	6(26)	9(39)	1(4)	22(96)
Makalle	3(7)	6(14)	19(43)	16(36)	1(2)	48(98)
Tembien	0(0)	2(10)	8(38)	11(52)	5(24)	16(76)
TOTAL, All Causes	15(8)	16(9)	69(38)	83(45)	15(8)	173(92)
SUBTOTAL, Malaria1	1(4)	3(13)	3(35)	11(48)		

* Statistical analysis of differences by area not done because of small numbers of deaths per category.

1 Malaria includes children whose cause of death was reported by family as malaria or fever

be given to errors in survey administration. However, survey teams received detailed orientation and used standardized forms which should minimize inter-observer error. Apart from possible survey errors, other factors to consider include differing levels of socioeconomic development, environmental characteristics, including altitude and number of rainy seasons, population density, and accessibility of preventive and curative services(11).

Overall sex distribution of deaths in this survey is the same as that reported in the Butajira Project(10). However, the age distribution of deaths, with 30% occurring in children under one year, differs from previous reports in which 50% to 60% of under five deaths occurred during the first year of life(9,10). Direct techniques of estimating mortality by asking date of death of children have been reported to be subject to several specific errors and biases, including selective omission in reporting deaths of children who die shortly after birth, and misreporting of age at death. Both errors result in a general upward bias in age reported(11). The older age at death in this survey may have resulted from such errors, or may represent a true regional difference. In the two year longitudinal study of childhood deaths in the Butajira Project, though 50% of deaths occurred in children under one year, trend in under-five mortality at six-month intervals over two years showed a significant increase in mortality during the second year of life: children 1-4 were more at risk of dying than infants(10). Similarly, in an analysis of Gondar and Hararge regional data from the 1981 Ethiopian Rural Demographic Survey, an increase in mortality in children between ages one and four was noted over several years(12).

Cause-Specific Mortality Based on Lay Reporting: Ethiopian national and regional cause-specific under 5 mortality figures are not available for comparison, but the major causes of infant and childhood deaths are relatively few and similar in most African countries and include diarrhoea, acute respiratory infections (including pertussis), measles, malnutrition, malaria, tetanus, and other neonatal infections(7). The probable causes of death in under-five children in the Butajira Project have been reported as other (40%, mainly meningitis and malaria), acute respiratory infection (18.5%), measles (13.8%), diarrhoea (8.4%), perinatal (6.1%), pertussis (4.7%), accidents (4.3%), and malnutrition (4.3%)(10). The higher percentage of deaths reported due to diarrhoea and pertussis in Tigray and the lower percentages due to respiratory infections and perinatal causes could

be due in part to the technique used to classify cause of death (verbal autopsy in Butajira, family report of cause of death in Tigray). Both techniques are limited by relatively low sensitivity and specificity. Although verbal autopsy has been found valuable in some studies, recent reports suggest that its usefulness may be limited to diseases with specific symptoms(13-15). Another possible explanation for the proportionate mortality differences is that a large percent age of deaths in this survey was reported as unknown; further questioning may have elucidated specific causes resulting in a different distribution. Finally, regional variation in such factors as level of nutrition, availability of clean water, immunization, and accessibility of antenatal care, and general health services may also partially explain the differences.

Malaria Specific Mortality Based on Lay Reporting: Malaria accounted overall for 12% of deaths based on family report of death. However, marked variation was noted by area, and the most malarious areas had the highest malaria proportionate mortality, ranging from 22% to 38%. In The Gambia, in an area highly endemic for malaria, malaria has been identified as the probable cause of 4% of infant deaths and of 25% of deaths in children aged 1-4, while in less highly endemic areas in Kenya, malaria was responsible for 3% of infant deaths and 10% of deaths in children aged 1-4 years(16). In the Butajira Project, malaria and meningitis accounted for almost 40% of childhood deaths, but epidemics of both diseases were recognized during the survey period(10). Cause specific mortality figures in Tigray must be considered only rough estimates because of the limitations inherent in the lay report technique for classifying cause of death. Even with verbal autopsy the positive predictive value for the diagnosis of malaria may be only 46%(14).

Pattern of Health Service Utilization Before Death: Forty-five percent of children who died were taken neither to a CHW nor to a health facility before death; those who did receive medical care before death were ill significantly longer than those who died without care. While inaccessibility of institutional facilities may have been important in some areas, CHWs were accessible in every locality surveyed. The possibility that families take children to a CHW only when they feel an illness is malaria must be considered. However, utilization of health services by children with malaria deaths showed the same pattern: overall, more than 45% of children who died with malaria as the probable cause of death, died without being taken to a CHW or health facility.

Comparative data on use of CHW services during fatal childhood illnesses are not available for review, but pattern of utilization by age group in the Community-Based Programme has been previously assessed and shows under-utilization of treatment services by under-five children relative to their proportion in the population. Reasons for this pattern of under-utilization were sought during focus group discussions with community members in June 1994 and the major contributing factors reported were 1) the heavy work load of women which left them limited time to attend to the health needs of their young children, 2) distance to the CHW village which, when combined with heavy work responsibilities, proved a barrier to utilization, 3) waxing and waning of children's symptoms which lead to a delay in seeking care, and 4) inadequate knowledge about the need for early diagnosis and treatment(1).

It is not unreasonable to assume that these cultural and structural factors determine utilization of services in fatal as well as non-fatal illness. Structural barriers to care of ill children have been previously demonstrated. The association between malaria knowledge and practice was investigated in 1992 in Central Ethiopia in a survey of rural women who were mothers of children less than 10 years. While 95% knew that malaria could be treated with modern medicines and 85% believed that untreated malaria could be fatal, 84% waited a few days before taking their sick children for care. Severity of illness, cost of care, distance, transportation, and the presence of someone to assume household duties were factors considered in the decision to seek care(17). In a study of utilization of Ethiopian hospitals, health centres, and health stations, low utilization rates by rural sick children were noted, with a rapid decrease in utilization rates with distance. Duration of illness was strongly associated with distance travelled, those with more chronic illness more likely to travel farther to health facilities(18). In a recent report of care seeking for fatal illness in young children in Indonesia, although 80% of homes where a child died were within two kilometres of a health post, no care was sought for 22% of under-five children who died from natural causes, and 42% of children who died were taken only to a traditional healer or to other non-medical care givers. Reliance on traditional

remedies or traditional healers, belief that it was "God's Will" when a child died, and lack of realization that illness could be life threatening were found important determinants of non-use of modern medical services(19).

The reasons for death when malaria was the probable cause and the child had been taken to a CHW are not clear but could be late presentation, inadequate treatment, late or no referral, chloroquine resistance, or misdiagnosis as malaria of a non-malarial illness. The same factors could contribute to the deaths of children taken only to health facilities or to both a CHW and health facility.

Survey limitations

Because numbers and dates of births were not recorded, calculations of mortality rates required denominator estimates from national crude birth rates. Birth rates may differ by area, or may be higher in the population with under-five children than in the general population. If the latter were true, the U5MR estimates in this survey are high. On the other hand, in estimating number of live births the household population at the time of the survey was used. Out-migration or death of family members older than four years during the later part of the survey period could mean a lower household population at survey time than at mid-year thus number of live births may be underestimated. As lay reporting of cause of death is neither a sensitive nor a specific technique, cause specific mortality rates must be considered only estimates.

When calculating the required sample size a design effect of 1.26 was used. Given the larger population of 7335 children actually surveyed, design effect was, in effect, 1.99. Based on actual survey data, using number of localities as the number of communities, design effect was recalculated(4) and found to be 2.94. Thus, 10,860 children should have been surveyed to minimize bias introduced by cluster sampling. Subsequent surveys will use a larger sample.

This survey, carried out as part of operational evaluation of the Community-Based Malaria Control Programme, is the first large mortality survey in children undertaken in Tigray for many years. The findings are important for the Regional Malaria Control Programme and also for those responsible for programmes to improve child health in Tigray. The findings will also be of value at the national level.

1. Intensify community education about the importance of early diagnosis and treatment of febrile illnesses in children.
2. Intensify community education about availability and use of CHW services.
3. Consider training more community-based personnel to increase accessibility to early diagnosis and treatment of febrile illness.
4. Investigate factors contributing to district mortality differentials.
5. Promote and undertake training of CHWs and traditional birth attendants in the prompt recognition, immediate care and referral of patients with life-threatening diseases.
6. Strengthen the capacity of peripheral health services to manage life- threatening diseases including malaria.

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