

Malaria specific mortality in lowlands and highlands of Muheza district, north-eastern Tanzania

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Abstract: Vital registration of causes of death in Tanzania is incomplete and many deaths occur outside health care settings. Verbal autopsies (VA) are used to determine the underlying cause of death, and the probable diagnosis helps to estimate reasonably cause-specific mortality. In this paper, we report findings of a verbal autopsy survey which involved eight villages in both low and highlands of Muheza district, north-eastern Tanzania. The survey was conducted following a rapid census, which was done to identify households that had lost one or more members within a period of two years from the date of census. Trained research assistants administered VA questionnaires to parents/close relatives. Two physicians reviewed each report independently and a third opinion was sought where there was discordant report between the two. A total of 9,872 households were surveyed and 134 deaths were recorded. A total of 96 (71.6%) deaths were from lowland villages representing high malaria transmission. Majority (72.4%) of the reported deaths occurred at home whilst 32.1% occurred at health facility settings. Overall, severe malaria was the leading cause accounting for 34.3% of all deaths. Infants were most affected and accounted for 43.5% of the total deaths. Pulmonary tuberculosis ranked second (8.2%) cause of deaths and was exclusively confined to individuals ≥ 15 years. Probable cause of death could not be determined in 13.4% of deaths. In conclusion, majority of deaths in rural north-eastern Tanzania occur at home and the immediate causes are usually unknown or not documented. These findings indicate that the verbal autopsy is a useful tool for detecting leading causes of death at community level in the absence of health facility-based data.

Key words: verbal autopsy, malaria, mortality, lowland, highland, Tanzania

Introduction

Worldwide, one out of three deaths is due to an infectious or communicable disease, majority of which occur in developing countries (Gajalakshmi & Peto, 2004). Globally, information on the cause of death has been useful in supporting the development of evidence-based decision making and in guiding priority setting intervention in public health (Ruzicka *et al.*, 1990). This means, proper estimation of mortality is one of the pre-requisite in understanding the actual picture or determining the magnitude of disease burden (Sankaranarayanan *et al.*, 1996) at the community level especially in rural poor settings. Many deaths in developing countries occur outside health care settings (Lopez, 1990) as a consequence of limited access to health services. Estimation of cause of death becomes more difficult in developing countries because neither health-facility-based information system nor vital registration provides adequate data on the cause of mortality (Gajalakshmi & Peto, 2006).

Despite high mortality due to infectious diseases in developing countries, the cause of such deaths often goes unrecorded due lack of complete vital registration systems as establishment and maintenance of such systems are always difficult and expensive (Gonghuan *et al.*, 2005; Mathers *et al.*, 2005). According to the World Health Organization, lack of these data hinders the whole process of assessing the global situation on disease specific mortalities as well

as monitoring their trends in the most affected countries (WHO, 2004).

In sub-Saharan Africa malaria is the leading cause of morbidity and mortality, especially in children under five years and pregnant women. There are estimated to be 300-500 million clinical cases of malaria each year, about 80% in tropical Africa (Snow *et al.*, 2005). Coupled with malaria, the situation is worsened further by the upsurge of HIV/AIDS and related opportunistic infections, especially in the adult population (Korenromp *et al.*, 2005; Suri *et al.*, 2006). For various reasons including local beliefs, poor access to health facilities and self-medication practices, many deaths in Africa occur outside the health care systems (Lopez, 1990; de Savigny *et al.*, 2004; Rafael *et al.*, 2006). Most of the information on mortality estimate therefore, emanates from data collected from health facilities which is always an underestimate.

In many of the developing countries verbal autopsy may be a surrogate for death certificates in ascertaining causes of death (Gajalakshmi & Peto, 2006). Such information may be used to complement the health-facility-based data. Verbal autopsy is a systematic retrospective inquiry of the family members about the circumstances, events, symptoms, and signs of illness prior to death to help determine the underlying cause of death and to classify the broad patterns of mortality.

Malaria is the leading cause of morbidity and mortality in Tanzania. Health facility data indicates that about 19% of all hospital deaths are due to malaria

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(Kitua, 2003). It is estimated that 11.9% of deaths occurring at home in Tanzania never consulted health facility for help in the course of their illness (de Savigny *et al.*, 2004). As a result of poor registration systems of vital events, it is often difficult to ascertain reliably the rates and causes of deaths prevailing in developing countries (Gonghuan *et al.*, 2005; Mathers *et al.*, 2005).

In Muheza district, Tanzania, malaria is a leading cause of hospital attendances, admissions, and deaths, and is holoendemic in the lowlands with a prevalence of over 75% (Lyimo *et al.*, 1991; Ellman *et al.*, 1998). In the highland, on the other hand there is a modest varied level of malaria transmission whereby in some cases a prevalence as low as 33% has been reported (Ellman *et al.*, 1998). In both zones, malaria transmission is highest during and following the long rainy season, which usually extends from March through July. The average numbers of infective bites per person per year i.e. mean annual entomological inoculation rates; have previously been shown to be about 405 and 34 in the lowlands and highlands, respectively (Ellman *et al.*, 1998). Point prevalence of malaria cases as estimated from community surveys range from 7.4–9.9 in high malaria transmission lowlands, and 2.4–7.4 in the highlands (Ellman *et al.*, 1998).

The aim of this study was therefore, to establish malaria specific mortality at different endemicity in Muheza District, north-eastern Tanzania. This was part of a larger study aimed at establishing an epidemiological map of malaria in north-eastern Tanzania.

Materials and Methods

Study area and population

This study was carried out in Muheza District, north-eastern Tanzania. The district covers an area of about 4,992 km² and an estimated human population of 279,473 (URT, 2002). The district is topographically divided into highland and lowland zones. The district is divided into six divisions, 35 wards 175 villages, and 44,124 households. The district is served by 54 dispensaries, four health centres, and one district hospital. Most dispensaries have a catchment population of between 4,000 and 5,000. The major ethnic groups in the district include the Wasambaa (in the highlands) and Wabondei (in the lowlands). The majority of the inhabitants are small-scale farmers of maize, cassava, oranges, coconut, rice and banana.

Study design

The verbal autopsy survey was carried out in both the highland and lowland villages. Kizerui, Shambangeda, IBC Msasa and Kwelumbizi were selected from the highland zone and were considered to be moderately endemic for malaria. In the lowlands, village selected were Moa, Mwandusi, Jirihini and Kwangena. Selection of the study villages was based on pre-defined criteria such as proximity to health facility and absence of other malaria intervention activities.

Community meetings were conducted in the selected villages during which the aim and study procedures were explained and discussed with the local population. During these meetings community willingness to participate in the study was also sought. Prior to the verbal autopsy surveys, a quick population census was conducted in all selected villages to establish the sampling unit for the malariometric indices and also for tracing out households with deaths within 2 years from the date of the census. Specially designed population census questionnaires were used to collect the information. The entries included the date of census, name of head of household, tribe, and names of household members, sex, and age, level of education, occupation and history of death in the household within the previous two year from the date of the census. All households with the history of death within the specified 2 year period from the census date were identified.

Data collection

The WHO standard verbal autopsy questionnaires (WHO, 1999) was adopted and utilised with minor modifications. The modified questionnaires were translated into Kiswahili and back-translated into English to ensure that there was no loss of meaning of information collected as a result of the translation. Three questionnaires were developed which included tools for collecting information on neonatal deaths, post-natal childhood deaths and adults and maternal deaths. The tools contained sections which included background information on the deceased individual and household, and history of illness before death, duration of symptoms and health care seeking including treatment received before death. A team of four field assistants with experience in conducting interview were trained for a period of seven days on how to carry out a verbal autopsy survey. The tools were pre-tested in a pilot survey before they were used in the actual field survey.

Trained research assistants visited the household of the bereaved families to administer a verbal autopsy questionnaire to parents/close relative that were around at the time of the illness that led to death of their beloved ones. Two physicians reviewed each report independently and a third opinion was sought where there was discordant report between the two.

Results

A total of 9,872 households were surveyed and 134 deaths were recorded. However, probable cause of death could not be determined in 13.4% of deaths reported. Significantly more deaths 71.6% were recorded in the lowland villages (representing high malaria transmission) than in the highland villages. Majority (72.4%) of the reported deaths occurred at home, whilst 27.6% occurred at health care facilities. However there was no variation in proportions of deaths, which occurred at home between lowland and highland areas ($P=0.5$). Moreover, the proportion of death by gender in both strata was not significantly different ($P=0.3$) (Table 1).

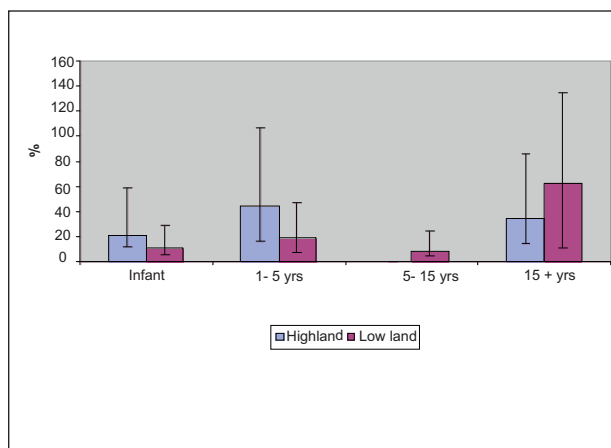


Figure 1: Proportion of deaths by age group with 95% level in highlands and lowlands

A slightly high non-significant proportion of 31.6% of deaths occurred at health facility in areas with low malaria transmission as compared to 26.0% of deaths, which occurred in high transmission areas ($P=0.5$). Of all deaths that occurred at home, 85.2% (69/81) were in individuals ≥ 5 years old as compared to 52.8% (28/53) deaths in < 5 years old ($P=0.001$).

Table 1: Proportion of deaths by sex, age group and place of death in the highland and lowland villages in Muheza District

Variables	Proportion of deaths		
	Highland (n=38)	Lowland (n=96)	P-value
Sex			
Male	57.9 (22)	49.0(47)	$P=0.3$
Female	42.1(16)	51.0(49)	
Age groups			
< 5 years	65.8(25)	29.2 (28)	$P=0.001$
≥ 5 years	34.2 (13)	70.8 (68)	
Place of death			
Health facility	31.6 (12)	26.0(25)	$P=0.5$
Home	86.4(26)	74.0(71)	

A total of fifty-three (39.6%) deaths were recorded in children under five years old. A significantly high proportion of deaths that occurred in highland areas were observed among children under the age of five years (65.8%) as compared to lowland areas where children under this age category accounted for only 29.2% of all deaths ($P=0.001$) (Table 1).

Deaths were distributed unevenly among the age groups (Figure 1). The 1-5years and ≥ 15 years age groups were mostly affected. Whereas the largest proportion of deaths among ≥ 15 years was observed among those living in the lowlands, most deaths among the 1-5 years olds were from the highland villages.

Table 2: The percentage (number) of identified causes of death

Causes of Death	Proportion of death per Strata		
	Highland (N=38)	Lowland (N=96)	Total deaths (N=134)
Communicable diseases/conditions	°	°	°
Severe malaria	36.8(14)	33.33(32)	34.33(46)
Pulmonary Tuberculosis	2.63(1)	10.41(10)	8.21(11)
Severe anaemia with malaria	7.9(3)	3.13(3)	4.48(6)
HIV/AIDS	2.63(1)	4.17(4)	3.73(5)
Severe anaemia	2.63(1)	3.13(3)	2.99(4)
Meningitis	°	3.13(3)	2.24(3)
Neonatal septicaemia	2.63(1)	2.08(2)	2.24(3)
Severe pneumonia	2.63(1)	1.04(1)	1.49(2)
Malaria and severe anaemia in pregnancy	2.63(1)	°	0.75(1)
Severe malaria and pneumonia	°	1.04(1)	0.75(1)
Non - communicable diseases/conditions	°	°	°
Congestive cardiac failure	5.26(2)	7.29(7)	6.72(9)
Renal failure	2.63(1)	6.25(6)	5.22(7)
Cancer	°	3.13(3)	2.24(3)
Diabetes mellitus	°	3.13(3)	2.24(3)
Severe prematurity	5.26(2)	1.04(1)	2.24(3)
Stroke	2.63(1)	1.04(1)	1.49(2)
Embolism	2.63(1)	°	0.75(1)
Animal bite (crocodile)	2.63(1)	1.04(1)	1.49(2)
Drowning	°	1.04(1)	0.75(1)
Birth trauma	°	1.04(1)	0.75(1)
Motor traffic accidents	°	1.04(1)	0.75(1)
Spinal injury	°	1.04(1)	0.75(1)
Cause was not determined	18.42(7)	11.46(11)	13.43(18)

Overall communicable diseases accounted for 70.7% of all deaths (Table 2). Severe malaria was the leading cause of deaths accounting for 34.3% of the total deaths. Infants were the most affected age group accounting for 43.5% of all deaths due to severe malaria. Moreover, 92.9% (13) of all deaths in <15 years old children that occurred in highland villages were due to severe malaria ($P=0.02$). Pulmonary tuberculosis ranked second (8.2%) and was exclusively in the ≥ 15 years old age group. The proportion of deaths due to pulmonary tuberculosis was significantly higher in the lowlands than highlands ($P<0.05$). Congestive cardiac failure and renal failure were the most frequent causes of deaths among the non-communicable diseases.

Discussion

In this study, verbal autopsy method was able to identify leading causes of death among rural communities of north-eastern Tanzania. Similarly, in a recent study in China, verbal autopsy technique was found to perform reasonably well in identifying several leading causes of adult death (Yang *et al.*, 2006). However, in the study in China, the sensitivity of the technique was found to be less satisfactory in detecting deaths from causes of some important diseases. Data from a multi-centre validation study

carried out in Tanzania, Ethiopia and Ghana have shown that sensitivity and specificity of verbal autopsy differ between the three study sites depending on the distribution of the causes of death (Chandramohan *et al.*, 2001).

Our findings have shown that deaths occurring at home are a common phenomenon in rural communities in northern eastern Tanzania. The fact that so many deaths in adults individuals occurred at home suggests for variation in health seeking among different age groups. It is possible that most of the deaths in the underfives were due to delay in health seeking. The reasons for such a trend are many, but may include lack of community knowledge on signs and symptoms of malaria which may provoke health care seeking outside the formal channel which might result into delay in case detection and prompt treatment. Other reasons included poverty, preponderance for traditional healers, lack or poor health care services, long distances to the nearest health facility as well as cost sharing scheme. In many cases, the use of self medication using wrong or counterfeit drugs sold by drug vendors and in kiosks is also likely to exacerbate the delay in health seeking behaviour (Alilio *et al.*, 1997).

The observed differences in mortality due to severe malaria among children below five years between the two strata might be accounted for by the

low immunity in individuals living in areas with low to moderate transmission in the highland. There is consistent evidence that shows that immunity against malaria results from cumulative exposure to malaria parasite leading to acquired immunity at younger age for residents of high transmission intensity. The observed pattern could be explained by extended risk for severe *Plasmodium falciparum* infection toward older age for residents of low transmission due to delay in attaining immunity against severe malaria. The relatively high proportion of death due to tuberculosis is of great concern. The prevalence of tuberculosis is high, especially during this era of HIV/AIDS (Ministry of Health, unpubl.). Similar observations have been reported by AMMP (1997).

From the VA survey, it is clear that early health seeking behaviour in these communities must be emphasized. This should always focus to the most vulnerable groups, the underfives and pregnant women. It is crucial for the health authorities in the area to make sure that frequent appropriate health educations aimed at changing individual health seeking behaviour is promoted. Training of mothers on detection of danger signs and management of malaria is likely to reduce the mortality among the children (Frank *et al* 2006; Makundi *et al.*, 2006). Emphasis should also be given to women attending antenatal clinics for the importance of seeking medical attentions for their children and this should go hand in hand with giving proper education to traditional birth attendants.

In order to have proper surveillance, and generate accurate data on malaria disease burden and related morbidity and mortality in areas with limited access to health care facility, VA surveys is likely to act as an important complement in portraying the accurate picture of the case specific mortality provided that those involved are well trained and have all the necessary data collection tools and availability of physicians to verify the probable cause of deaths for the reported mortalities.

The fact that non-communicable accounted for about a third of the total causes of death indicates an increase in the burden of such conditions, which have received little attention by health authorities. There is therefore need for urgent measures to intervene on this growing public health problem.

In conclusion, the majority of deaths among rural communities in Tanzania still occur at home and usually the immediate cause is usually unknown. This study has shown that verbal autopsy technique may be utilized to bridge the gap in the establishment of

probable cause of deaths that occur outside health care facilities.

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