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High prevalence of anaemia in pastoral communities in Kilimanjaro region: malnutrition is a primary cause among Maasai ethnic group

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Abstract

Burden of anaemia is widespread, and more pronounced in the sub-Saharan Africa. Malaria has for so long been associated with the prevalence of anaemia in most of the areas in Tanzania. Understanding the disease distribution and associated risk factors are important for interventional planning. Haemoglobin assessment was done during the four cross section surveys from June 2006 to March 2008 in which 2434 participants from two villages were examined. All households in the villages were mapped by the use of global position system. Multivariate and univariate regression analyses were used for evaluation of ecological factors for anaemia. Anaemia prevalence was heterogeneous between ethnic groups found in the village (Maasai being mostly affected OR= 2.58; CI $_{95\%}$ 1.91 – 3.47, P< 0.001). Anaemia affected mostly the young ages and female residence. Malnutrition was a major problem affecting this population as evidenced by the low body mass index (BMI) in majority of the residents. Due to the low prevalence of malaria in the study area (1.5%), the contribution of malaria to the prevalence of anaemia was considered insignificant. Socio-economic and cultural factors are important factors that can lead to high anaemia prevalence rates among pastoral communities, in particular the Maasai ethnic group. Apart from the immediate, disease mediated anaemia, these socio-economic factors should be well considered as fundamental when planning for interventions in the area, if such interventions are to be successful.

Keywords: Anaemia, Maasai, Body Mass Index, Malnutrition.

INTRODUCTION

Anaemia is a public health challenge in Tanzania. Disease is associated with morbidity of up to 66 % of pregnant women [1], 50 % - 62 % of children under 5 years of age [2] and is one of the leading causes of mortality in children [3]. Poverty, disease manifestation and poor health delivery systems and infrastructure in most of African countries have aggravated the problem. The results has been high morbidities and mortalities related to anaemia as reported in many African health facilities [4-6].

The prevalence of anaemia differs in different epidemiological and socio-economical settings. In some settings malaria is an important cause[7-11] while in others intestinal worms plays the main important role as the causative factor [12] which results into blood loss and malnutrition. Chronic illnesses and socioeconomic status have an important role to the development of anaemia by increasing problems of affordability of food and accessibility of preventive and curative measures [13].

Within an area, there may be specific risk groups due to social, environmental or genetic factors. Interventions to treat most affected groups commonly used in public health campaigns include iron supplementation by using iron pills, together with food based approaches by increasing the intake of meat, fish, eggs, vegetables and vitamin C which enhances the absorption of iron. However, a study carried in Zanzibar showed that an iron supplementation treatment group had a higher risk of mortality**,** compared to controls, whereas in a similar study in Nepal, iron supplementation had no effects on mortality [14]**.** Intermittent preventive treatment (IPT), insecticide treated materials (ITM), and patient management have been established as simple and cost-effective strategies to reduce both malaria and anaemia [15, 16].

Simple tools are available to relieve the burden of anaemia among the risk groups. With introduction of the Integrated Management of Childhood Illness (IMCI) strategy developed by the World Health Organization, where by health workers are taught on how to recognize and promptly treat anaemia, malaria and other infection symptomatically. This intervention has been implemented successfully in Kenya [17], Gambia [18], and Malawi [19] and in Tanzania [20, 21].

Majority of the high risk groups live in the rural areas. It is in these rural residences where basic public health needs such as safe drinking water, improved personal and environmental sanitation and health care are limited [22]. It is of paramount importance that high risk groups be identified in the community in order to design integrated control strategies to control anaemia. Such strategies could include improvement of nutrition education on child feeding practices, training on relevance some food taboos, improvement of regimes of feeding, prevention and treatment of the diseases that lead to anaemia. Here, we determined factors that are associated with anaemia in relation to predisposing factors as well as recommendations for preventive measures in this micro-geographical area with low and seasonal malaria endemicity in Tanzania.

MATERIALS AND METHODS

Study site and population

This study was conducted in Kiruani and Majengo villages. These villages are situated in Lower Moshi area that lies on the plains beneath Mount Kilimanjaro in northern Tanzania (3° 38'39 S; 37° 20'25 E - 3° 39'25 S; 37° 21'52 E). The annual rainfall is 650mm. The long rains start in May to July and unpredictable short rains in October and November. Sometimes, due to climate changes the area experiences no rains at all in this period of the year. The remaining time of the year is dry and sunny. The area is characterized by low transmission intensity [23] of 2.5 infectious bites per person per year with *An. arabiensis* as the only identified malaria vector [24, 25]. Malaria incidence in this study area of was estimated at ~38 episodes per 1000 person years at risk [25].

Data were collected in cross sectional surveys done in 2006 to 2008. Which were in wet and dry season and just before the start of rainy season in October 2007 and March 2008. Families were selected using village census and computer-randomized tables. A central point in each village was identified and villagers attended the survey on a first come first served as illustrated in a previous published paper [23]. Free medical care and malaria treatment was available for all study participants. Kikuletwa swamp, which is situated in the lower lands, is considered the main breeding site for Mosquito.

Sample collection and laboratory methods

Informed consent to take part in the study was obtained from all study participants. During these cross sectional surveys, both thin and thick blood smears and stained with 10% Giemsa were collected for microscopic detection of the parasites. Parasite density was estimated by counting the number of sexual parasites per 200 white blood cells (WBC) and number of sexual forms per 500 WBC. A slide was judged negative if no parasite were seen after inspection of 100 high power fields. For quality control, a second microscopist was unaware of the results from the first reading, evaluated all the slides. At each cross sectional survey, participant's body temperature was measured through tympanic temperature by electronic thermometer. A blood sample from a finger prick was furthermore used to measure haemoglobin using a HaemoCue photometer (Angelholm, Sweden). Copack colour scale and conjunctivae colours were used as alternative methods to determine anaemia to complement the HaemoCue method.

Definition of anaemia and body mass index (BMI) categories

The different categories of anaemia status were defined as shown below;
Normal haemoglobin concentration (Hb > 11 g/dl), Mild anaemia (Hb = 8 – 11 g/dl), Moderate anaemia (Hb = 5 – 7.9 g/dl) and Severe anaemia (Hb < 5 g/dl).
In addition BMI was divided into four categories; underweight (≤ 18.5 kg/m^2); normal (18.5-24.9 kg/m^2); Overweight (25-29.9 kg/m^2) and obesity (≥30 kg/m^2).

Statistical Analysis

Statistical analysis was carried out using SPSS 15.0 for windows (SPSS Inc., Chicago, USA). Participants were divided into three-age groups (< 5 years, 5 – 15 years and > 15 years). Chi-squared analysis was used to determine differences in anaemia prevalence by age and by distance of residence from bushes or water bodies (swamps). Multivariate logistic regression models were used to construct a complete model aiming to include all factors related to the presence of anaemia, a stepwise-descending selection procedure was used. All variables with p-value <0.10 in univariate analysis were included in multivariate analysis. Adjusted Odds Ratios (aORs) and 95% Confidence Intervals were reported and P-value <0.05 was considered significant.

Ethics

Ethical clearance was granted by the Ethical board of the Tanzanian National Institute of Medical Research, NIMR, (NIMR/HQ/R.a8/Vol.IX/491).

RESULTS AND DISCUSSION

Baseline characteristics

In the cross-sectional surveys done in 2006 - 2008, 2434 participants were enrolled. The median age was 13 (IQR 5-32) years old. Majority of the population were female participants, 42.4 % (1431/2434). The population mean haemoglobin concentration level was 13.4 g/dL (SD=5.59). The characteristics and measurements of anaemia of the study participants are shown in Table 1.

Prevalence of malaria and anaemia

Microscopic analysis of blood smears showed that the prevalence of malaria in the study area was 1.5% [23]**.** The overall prevalence of anaemia (haemoglobin concentration, less than or equal to 8 g/dL) was 9.6%. A significantly greater proportion 20.1% of children under 5 years of age were anaemic compared to the other categories (X^2 =98.35, P<0.001), followed by the group of individuals aged 15 years and above with a prevalence of 6.9% (X^2 =17.41, P <0.001). The lowest prevalence of anaemia 5.3% was observed in the category aged between 5 and 15 years old (X^2 =22.24, P <0.001). There was no significant difference in anaemia prevalence between males and females (X^2 =0.01, P = 0.912). Results are presented in table 1. Body Mass Index (BMI) was available for 96.4% subjects of whom 50.5% had BMI<18.5 kg/m^2, 36.2% had BMI 18.5-24.9 kg/m^2, 8.9% had BMI 25-29.9 kg/m^2 and 4.4% had BMI ≥ 30 kg/m^2.

Table 1: Characteristics and measurements of anaemia in the study population

Characteristics	Measures
Gender, Female % (n/N)	9.9% (142/1431)
Age group, % (n/N)	
< 5 years	20.1% (118/586)
5-15 years	5.3% (38/721)
> 15 years	6.9% (78/1126)
Anaemia Status, % (n/N)	
Normal (Hb > 11 g/dl)	65.4 % (1593/2434)
Mild (Hb = 8 – 11 g/dl)	25 % (608/2434)
Moderate (Hb = 5 – 7.9 g/dl)	8.8 % (213/2434)
Severe (Hb < 5 g/dl)	0.8 % (20/2434)

Data are based on cross sectional surveys conducted in 2006 and 2008

Table 2: Presence of anaemia in the study population according to univariate and multivariate logistic regression model (N=2434)

Variable	Prevalence %(n/N)	Univariate Analysis			Multivariate analysis		
		Odds Ratio	95% CI	P= Value	Odds Ratio	95% CI	P= Value
Age group							
5-15 years	5.3% (38/721)	1.00	-	-	1.00	-	-
< 5 years	20.1% (118/586)	3.77	2.86-4.96	**<0.001**	4.58	3.11-6.75	**<0.001**
> 15 years	6.9% (78/1126)	0.55	0.41-0.73	**<0.001**	-	-	-
Sex							
Male	9.2% (92/1003)	1.00	-	-	-	-	-
Female	9.9% (142/1431)	1.09	0.83 – 1.44	0.536	-	-	-
Fever							
Without	9.3% (212/2281)	1.00	-	-	-	-	-
With	15.4% (20/130)	1.77	1.08 – 2.92	0.024	-	-	-
Ethnic group							
Others	0.1% (60/1136)	1.00	-	-	1.00	-	-
Maasai	13.2% (170/1287)	2.58	1.91-3.47	**<0.001**	2.51	1.85 - 3.41	**<0.001**

Risk of anaemia in relation to age group, gender, fever and ethnicity

In the univariate logistic regression analysis, participants < 5 years old had 3.77 times the odds of having anaemia compared with participants between 5 and 15 years old ($CI_{95\%}$ 2.86-4.96; P<0.001). Furthermore, participants above 15 years old were less significantly likely to have anaemia, they had 0.55 times the odds of having anaemia compared with participants between 5 and 15 years old ($CI_{95\%}$ 0.41-0.73; P<0.001) [Table 2]. By comparison, gender did not significantly influence the presence of anaemia. Female participants had 1.09 times the odds of having anaemia compared with male participants ($CI_{95\%}$ 0.83 – 1.44; P=0.536) and the participants with fever were more likely to have anaemia, they had 1.77 times the odds of having anaemia compared with participants without fever ($CI_{95\%}$ 1.08 - 2.92; P=0.001). [Table 2]

In the multivariate regression analysis, there was a strong relationship between young age (< 5 years old) and anaemia. Anaemia was observed to be age dependent as low haemoglobin concentration level is predominant early in the young age in comparison to the older age (OR=4.58; $CI_{95\%}$ 3.11 – 6.75 ; P<0.001) [Table 2]. Age above 15, sex and fever were not included in the multivariate model due to the fact that they did not had any significant effect in univariate model. So in multivariate model only the significant ones were included. However, in the multivariate regression analysis, Maasai emerged also as a significant predictor of anaemia (OR= 2.51; $CI_{95\%}$ 1.85 – 3.41; P<0.001)] [Table 2]

Haemoglobin estimation

The haemoglobin was measured using three different methods HaemoCue, Copack colour scale and conjunctivae colour scale. All results were recorded for accuracy. HaemoCue was used as the gold standard [Table 1]. Seven hundred and six children's haemoglobin were measured using Copack colour scale and 700 among them were tested for haemoglobin levels using conjunctivae colour scale. Both results were compared to those using HaemoCue machine and were found to be in agreement. This was done in order to ensure accuracy of the prevalence estimation in the study area.

DISCUSSION

In our study done in an area of low transmission intensity, we observed a high prevalence of anaemia among the young children below five years of age and to lesser extent those above 15 years. Females were more affected than males. Our findings support the existing general knowledge about group specific anaemia prevalence rates [26]. This study was community based, including a heterogeneous mixture of community member parameters. Therefore, results reported here provide clear reflection of the status of anaemia in a typical pastoral and rural community, composed of a complex mixture of feeding taboos, ages and socio-economical status.

BMI measurements of the participants indicated that slightly more than half (50.5%) of participants had BMI<18.5 kg/m^2, which is indicative of malnutrition. This proportion is highly suggestive that malnutrition could have an immense contribution to the observed prevalence of anaemia in the study area. Previously, in a study conducted by our group in the same study area in 2007 [23], the prevalence of malaria in the study was reported to be 1.9% by microscopy. These factors compared, it implies that the role of malnutrition in the observed prevalence of anaemia is the major contributor to the observed prevalence.

The traditional diet of pastoralists and the Maasai in particular in Kenya and Tanzania is derived mostly from their cattle. It is interesting that despite the huge herds of cattle and sheep pastoralists keep, they do not often eat beef but rather, they drink milk and usually mixed with blood which is harvested directly from the cattle. Frequent meat eating is taboo as it endangers stock levels and is considered unwise because it is seen as a form of poor spending. Livestock is the equivalent of a modern savings bank account.

Studies have indicated that infants who drink cow's milk in the first year of life are at risk for iron deficiency anaemia [27] because cow’s milk does not have enough of the iron infants need to grow and develop. Cow’s milk has been reported to be the most common dietary cause of iron deficiency in infants [28]. It contains less iron than many other foods and also makes it more difficult for the body to absorb iron from other foods. It is generally known that babies only absorb about 10% of the iron they eat, most children need to receive 8-10 mg of iron per day. Breastfed babies need less, because iron is absorbed 3 times better when it is in breast milk [27]. The high prevalence of anaemia observed in this community could have resulted from the predominance of cow’s milk as the main diet including children less than five years old. A much more complex interaction could exist to explain our results.

Majority of Maasai are cattle keepers; spend most of the time looking for the good pasturing ground. Children who are not enrolled for school get only their morning meal and the evening meal with a skip of lunch when they accompany the elders in the field-grazing cattle. Since elders and older children spend their time grazing, school children from the study community usually go to school without breakfast and lunch. As most schools do not provide meals, such children get a single meal a day. This could explain the dietary inadequacy that is likely to worsen the situation of malnutrition and subsequently of anaemia. A previous school-based study in northern Tanzania reported similar findings [30].

Eating fish, chicken and game meat is a taboo in Maasai culture. The interrelationship of these factors makes a clear explanation of the observed consequences of poor nutrition in the study community. Since the taboos include pregnant women, the consequences are usually passed from generation to the next with poor growth, anaemia in childhood and adolescence [29]. There is no documentation regarding other biological or genetic factors that could account for the high prevalence of anaemia among the Maasai and not the other ethnic groups.

Ash [33] and Mulokozi [31] reported on higher prevalence of iron deficiency anaemia and vitamin A deficiency among schoolchildren and pregnant women especially those living in semi-arid regions and coastal area. Our results extend these findings by including, not only school children, but also other groups of the community. Previously, anaemia was associated with ability to purchase the nutritional necessities (family per capita) [32]. Social economical factors that lead to inability to purchase the necessary food items for the children left at home or those going to school add on top of the list of factors that have lead to the high anaemia frequencies in the study area.

CONCLUSION

In conclusion, the present results demonstrate socio-economic status and cultural habit of the Maasai group being associated with the anaemia in the micro-geographical area.

Socio-economic and cultural factors are important factors that can lead to high anaemia prevalence rates among pastoral communities, in particular the Maasai ethnic group. Apart from the immediate disease mediated anaemia, these socio-economic factors should be well considered as fundamental when planning for interventions in the area, if such interventions are to be successful. Nutritional status assessment of the population need further review as different ethnic groups have variety of foods and feeding habits. Pregnancy women are more prone to malnutrition under circumstances prevalent in study area. Future efforts towards control of anaemia in similar set-ups should therefore take into account and target high-risk and most vulnerable groups in the population, i.e. children and pregnant women.

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