Patterns and trends of malaria morbidity in western highlands of Kenya

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Abstract
A study of patterns and trends of malaria morbidity was conducted in Kericho district in Kenya western highlands prone to occurrences of malaria epidemics. Kericho district supports small scale and large scale tea farming, sugarcane, horticulture, maize, wheat, potatoes, beans and vegetables besides livestock keeping. Results has shown that malaria hospitalization cases grew by 111.13% and 109.52% per annum in 1988-2002 and 1998-2005 respectively. Hospital records in the district showed a total of 814364 outpatient malaria cases(1988-2002) or average range of 1230 to 15277 per 100000 or 7.4% of the population annually was diagnosed and total hospital malaria admissions were 70511 or annual average of 4701 cases (range 3439 to 12088 cases per 100000). Malaria morbidity cases (1998-2005) were 566160 (average annual range of 3733 to 9105 cases). Malaria epidemics occurred seasonally each year between May and July after long rains (157mm-250mm in April-May) followed by high temperatures >18^{o}C). Overall the level of positive malaria cases is high with seasonal predictable patterns of occurrences in western highlands of Kenya. Consequently control measures according to the National Malaria Control Strategy Framework of 2001-2010 and malaria education and improvement of environmental sanitation should therefore be provided to the communities in western Kenya highlands so as to reduce the problem of malaria morbidity in the region.

Key words: Patterns, Trends, Malaria, Epidemics, Morbidity, Highlands, Kericho, Kenya

1. Introduction and literature review

Malaria occurrence in tropical and sub-tropical developing countries has become a paradox in these regions because the disease has defied sophisticated technological initiatives for its control. The increasing trends and patterns of the disease burdens; morbidity, abortion, still birth, mental disorder and death continue to cause a lot of suffering and impoverishment of many people particularly in Sub-Saharan Africa (SSA).

Malaria morbidity is the most important component of the disease burden in terms of the number of occurrences annually and is associated with the burdens, human sufferings, hospital admissions and economic costs in malarious tropical and sub-tropical regions of the world. Globally the number of malaria clinical cases is estimated at 500 million cases resulting in 1 million deaths (WHO, 1998). Africa accounts for 90% of these deaths where 1 child (< 5 years old) dies from malaria in every 20 seconds (WHO, 1996; WHO, 2001). In Sub-Saharan Africa (SSA) more than 92 million malaria incidences occur every year and prevalence of infection is estimated to be over 275 million malaria parasite carriers (WHO, 1993: 1996) and the disease cost Africa an estimate of over 4 billion USA dollars in 2001 (WHO, 2001).

In Kenya malaria is a leading cause of health problem and is endemic in Coast, Nyanza, Eastern and Western provinces. In the high attitude (1600m-3000m Above sea-level (Asl)) parts of central and western Kenya highlands occurrence of malaria epidemics have been reported since 1940's, 1980's late 1990's and in the millennium (Garnham, 1945; Garnham, 1948; Some, 1994; WHO, 1998; WHO, 2001; Hay *et al*.,2002; Shanks *et. al.,* 2005; Tonui, 2008).In these highlands fatal malaria epidemics have assumed seasonal character in occurrence with peak occurrence between April and July each year (Hay *et al*., 2002; Shanks *et al.,* 2005; Tonui, 2008) and overall malaria is major cause of morbidity and mortality among infants and children in these areas where it causes at least deaths of 58 infants per 1000 life births due to the disease and an estimate of 12 children of ages (1-4 years) per 1000 die of the disease annually (Snow *et al.*, 1994). In Kenya more 20 million people are at risk of contracting malaria yearly and the number of deaths due to the disease is estimated at 40000 yearly and the country looses 170 million working hours annually due to malaria (GOK, 2001).

Malaria is a protozoan disease and in humans the disease is caused by protozoan species of genus *Plasmodium (P); P.falciparum, P. malariae, P. vivax* and *P. ovale* (Giles, 1995). *P. falciparum* malaria is the most important of them all and is predominant in tropical regions and responsible for at least 85-90% of all malaria cases, and is the main cause of malaria burdens in non-immune individuals in these areas (Shililu *et al.,* 1996; Lieshout *et al.,* 2004) The main vector of malaria transmission in humans in tropical, areas is *Anopheline(A)* mosquitoes. In Kenya more than 90% of malaria is caused by P. *falciparum* (Khaemba *et al.*, 1994) and *A mosquitoe* species *A gambiae* is the main vector of malaria transmission in Kericho district (Garnham, 1945; Garnham 1948, Malakooti *et.al.*, 1998; Coetze *et. al*., 2000).The *A*. mosquitoes are also transmitters of *Plasmodia* in rodents, birds and monkeys and malaria has been reported in reptiles (Bruce-Chwatt, 1980). The occurrence of malaria burdens is on increasing trend annually in Sub-tropical Africa and is blamed on lack of access to health services and malaria education, parasite resistance to anti-malaria drugs, vector resistance to insecticides such as DDT, civil wars, poor governance, poverty and environmental changes (Kokwaro, 1999; Sachs and Malaney, 2002; Lieshout, *et. al*., 2004; Tonui, 2008; Tonui, *et. al*. 2010).

The present study investigated the trends and seasonal patterns of malaria morbidity in malaria epidemic prone area of western highlands of Kenya where fatal malaria epidemics have been reported (Some, 1994; Malakooti *et.al.,* 1998; Oloo *et.al.,* 1996; Hay *et al.,* 2002; Shanks *et.al.,* 2005; Tonui, 2008).

2. Materials and methods

2.1 Study area

Patterns and trends of malaria morbidity was conducted in Kericho district, Fig. 1 in western highlands of Kenya, in SSA. Kericho district lies between longitudes 35^{o} 02'E and 35^{o} 40'E and between equator and 0^{o} 23'S lies at an altitude between 1600m and 3000m Asl which characterizes epidemic malaria prone highlands (GOK, 2001; Hay *et al.,* 2002: Shanks *et al.,* 2005) covers an area of 2111.6 Km^{2} and receives fairly high rainfall throughout the year. The main soils distributed in the district are fertile loam, volcanic and clay soils. The district had a population of 456768 inhabitants in 1999 (CBS, 2001) with a population density of 216 people per Km^2. Most of the population (80%) lived in rural areas in scattered villages and practiced cash crop growing, tea, sugar-cane and pyrethrum whereas dairy cattle, sheep and goats are also kept for meat while, maize, beans, potatoes and vegetables are widely grown as food crops and for sale. In the district are large scale tea plantations in the form of 18 large estates with a total of 100000 workers are owned by multinational companies. Each estate covers an area of more than 1000 acres. Approximately 32% and 37% of the workers originate from Kericho district and the neighboring holoendemic malaria Lake Victoria region to the west respectively. This predisposes the district to malaria transmission as a result of peoples'mobility/travel, back and forth from this region due to employment opportunities in tea estates.

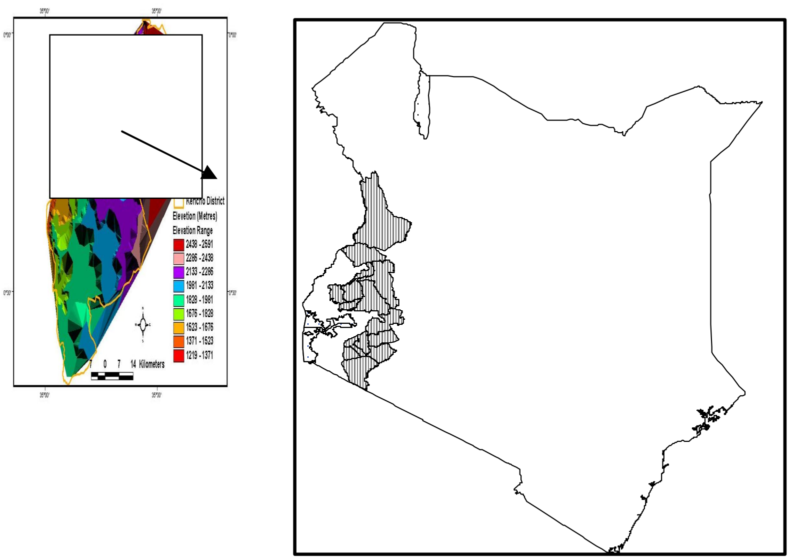

Fig 1: The study area: Kericho district in malaria epidemic prone highlands of western Kenya
Source: GOK, 2001

2.2 Sources and methods of data collection

The retrospective health data for the study were obtained from Kericho district main hospital records for the period 1988-2005 while climatic data temperature, rainfall and relative humidity were obtained from Kericho meteorological station for the same synoptic period(1988- 2005)

2.3 Data analysis

Data were analysed using standard statistical methods, tables, means, time series graphs and t-test. Time series graphs were used to determine emerging seasonal patterns and trends of malaria morbidity and climatic data and t-test was used to test the significance difference in sample means of malaria hospital admission cases for the periods 1988-1995 and 1995-2002.

3. Results and discussions

3.1 Trends and seasonal patterns of malaria morbidity

Tables 1, 2 and 3 and Figs. 2,3,4,5 and 6 summarize trends and patterns of malaria morbidity burdens in Kericho district in 1988 – 2002 and 1998 – 2005 surveillance periods. The period 1998-2005 was chosen for the study because in 1998/1999 Kenya experienced malaria epidemics in the highlands and in semi-arid North-Eastern province which were associated with El-Nino weather (Najera *et al.*,1998) and widespread chloroquine treatment failure and Kenya was implementing a change of first-line treatment policy from chloroquine to Sulfodoxine/pyrimethamine (GOK, 2001; Akhwale *et al.*, 2004).

Table 1: Trend of malaria morbidity burdens, Kericho district main hospital, 1988-2002

Year	Out patient morbidity	Malaria hospital admissions	Positive slides malaria morbidity
1988		2425	**1075**
1989	19643	2856	**1260**
1990	10014	5757	**2603**
1991	11240	4604	**2120**
1992	93232	3210	**1461**
1993	40792	2669	**1107**
1994	124408	3670	**1891**
1995	114408	2449	**856**
1996	80158	3096	**1217**
1997	53775	6835	**2795**
1998	44808	8523	**4597**
1999	49667	6340	**1335**
2000	48491	4718	**841**
2001	55875	5648	**777**
2002	87853	7711	**1682**
Total	814364	70511	**256**
Mean	58169	4701	**1708**

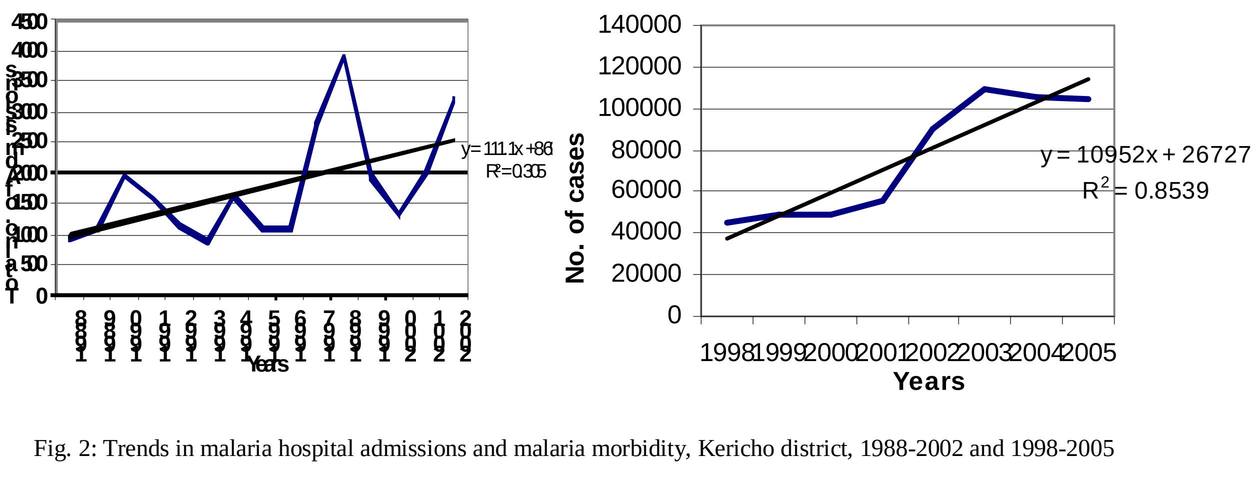

Fig. 2: Trends in malaria hospital admissions and malaria morbidity, Kericho district, 1988-2002 and 1998-2005

Table 2: Patterns and trends of malaria morbidity in Kericho district; 1998-2005

Year	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**Total**	**Mean**
Jan	1951	4005	2765	4834	4262	9833	6593	9544	43784	5473
Feb	3974	276	3338	4801	4507	10818	6688	9226	46112	5764
March	2587	3683	4112	7547	3202	11339	8205	7514	48184	6023
April	6318	3147	4168	3387	3932	7030	7701	6318	42000	5250
May	5493	5537	7283	3337	5425	6696	10248	10078	54096	6762
June	5000	6489	6290	5188	18080	14688	16656	9028	81416	10177
July	4155	8591	3354	5643	23616	18712	15158	12184	91408	11426
Aug	1753	4738	4296	5124	11923	8285	8355	11357	55824	6978
Sept	3071	2236	3916	4528	4996	5706	7491	10807	42744	5343
Oct	4057	2766	3461	4451	4321	6716	7150	8212	41128	5141
Nov	2314	2663	2899	3990	2704	4237	6215	5837	30856	3857
Dec	4156	1870	2874	3046	3617	5196	6344	4203	31272	3909
Total	44796	48492	48756	55872	84600	72840	106800	104304		
Mean	3733	4041	4063	4656	7050	9105	8900	8692		

Source: Kericho district main hospital statistics, 1998-2005

From Tables 1 and 2, total outpatient malaria morbidity cases during the period 1988-2002 was 814364 cases or a mean annual rate of 58169 cases (range 1230 to 15277 per 100000) this imply that each year malaria was diagnosed in 7.4% of the population. Total malaria hospital admissions were 70511 or a mean annual of 4701 cases (range 3439 to 12088 cases per 100000). In hospitalized malaria patients malaria diagnosis was laboratory confirmed. Table 3, as total number of positive slides of 25617. Out of a total malaria hospital admissions 1476 died from malaria thus representing 30% of all deaths of hospital admissions for all causes in Kericho district main hospital. Malaria morbidity cases were on increase yearly with annual average range of 3773 to 9105 cases in 1998-2005. malaria epidemic occurred seasonally each year between May and July, the peak occurrences occurred in 2003 when 9105 cases were reported.

Table 3: Average monthly laboratory confirmed diagnosis of malaria and climatic elements, 1988-2002

Month	**Jan**	**Feb**	**Mar**	**April**	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
Average number of positive slides	113	125	132	234	192	231	227	126	81	67	61	86
Average temperature (^{0}C)	18	18.6	18.6	18	17.5	17.2	16.8	17.1	17.4	17.4	17.35	17.8
Average rainfall (mm)	118	93	179	233	250	158	157	182	149	184	153	96

The laboratory confirmed diagnosis of malaria morbidity cases, Table 3 above shows seasonal patterns of high levels occurred between the month of March and July each year (1988-2002) when average monthly number of positive cases ranged between 132 and 234 corresponding to average monthly range of temperature and rainfall of 16.8^{o}C – 18.6^{o}C and 157mm- 250mm respectively. The peak occurrences of malaria cases occur between May and July, after the long rains (April-May) and when temperature fall below 17^{o}C in July the number of malaria cases declined. The average monthly rainfall and temperature ranges of 157mm-250mm and 17^{o}C-18.6^{o}C respectively influences the seasonal occurrences of malaria morbidity because these factors provide pools of water and temperature > 18^{o}C which are conducive for breeding sites for *A. gambiae* mosquitoes responsible for transmission of malaria in Kericho district.

To test whether the means observed in malaria hospital admissions (1988-2002) for two sample periods 1988-1995 and 1995-2002 t-test was conducted and results depicted in Table 4 which shows that the difference in means in malaria hospital admissions for the sample periods was significant at

0.05 level of significance (t statistic=2.87, t critical =2.4 at 0.05 level of significance). Thus the hypothesis that there is no temporal trend in malaria hospital admissions is rejected.

Table 4: Results of t-test for two sample periods (1988-1995 and 1995-2002) for malaria hospital admissions

Period	Sample mean	Standard deviation
1988-1995	2934.4	1238.5
1995-2000	5561.2	2398.9
t statistic	2.8	
Degrees of freedom	7	
t critical at 0.05 significance level	2.4	

Figs 2,3,4,5 and 6 show overall summary of emerging patterns and trends of malaria hospitalizations and morbidity cases. Trends (Figs, 2 and 4) of malaria hospital admissions was on upward trend at a growth of 111.13% (1988-2002) and malaria morbidity (1998-2005) grew at 109.52% per annum and R^2 =0.4734,0.8539 or 47.34% and 85.39% respectively of the variations of malaria hospital admissions were accounted for by passage of time (1988-2002) and (1998-2005) respectively. Figs 3, 5 and 6 show seasonal patterns of a malaria morbidity cases which increased from average of 5600- 4450 cases (April- July) each year and corresponds to rainfall and temperature monthly ranges of 158-250mm and 17.2 ^{o}C-18.6^{o}C respectively.

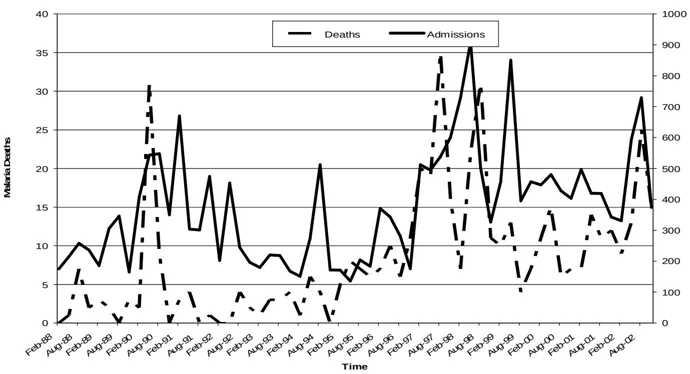

Fig. 3: Patterns of malaria hospital admissions, 1988-2002

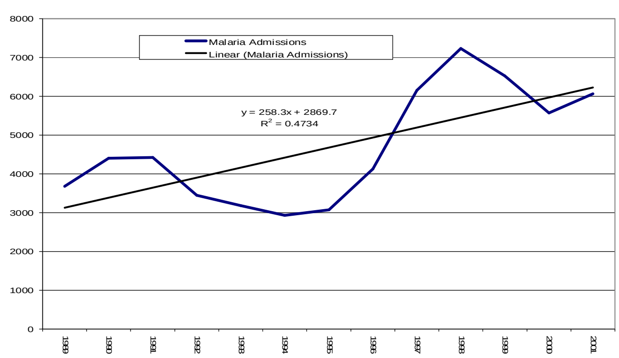

Fig 4: Trend of malaria hospital admissions 1988-2002

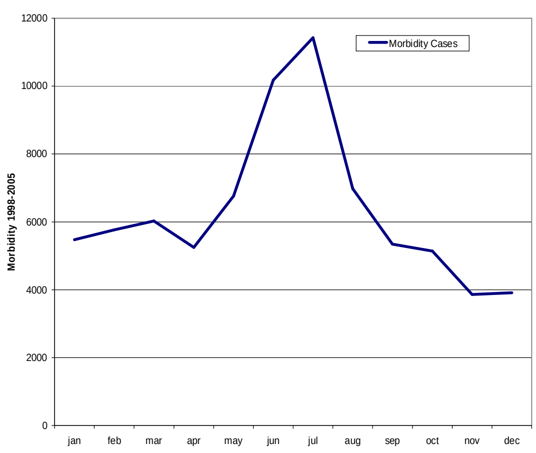

Fig 5: Patterns of monthly malaria morbidity cases, 1998-2005

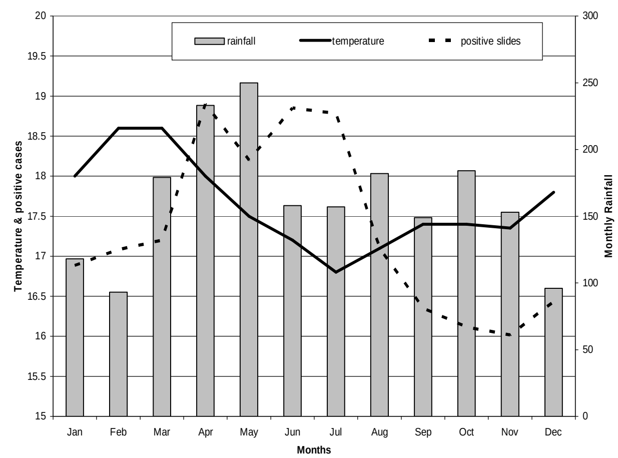

Fig 6: Patterns of average monthly positive slides, rainfall and temperature, 1998-2005

3.2 Conclusions and recommendations

Our results showed that morbidity due to malaria occurred all year round and seasonally in occurrence during the surveillance period 1998-2005 and trends were on the increase in the former malaria 'free highlands' of western Kenya. An important demonstration of this study is that temperature and rainfall have not significantly changed over the last 17-20 years in the study area (Tonui, 2008) to influence malaria transmission as an indicator of climate change. This observation indicates that other factors such as micro-climate change due to deforestation, people mobility (to and from malaria holoendemic areas, socio-economic changes, deterioration of environmental sanitation, resistance phenomenon of *Plasmodia* and A. mosquitoes and inefficiency in the district health delivery systems may have contributed to upsurge in malaria transmission in the district hence increase in malaria morbidity burdens. This underscores the need to step up control strategies of the disease occurrence that addresses implementation of National Malaria Strategy, 2001-2010 and up to 2030. Effective malaria control programmes need to address local environmental factors that lead to the reduction of malaria transmission in the district. In addition there is a need for further research.

- on modelling malaria at local and national level with validated models.
- to address environmental sanitation, climatic, population at risk and socio-economic changes in relation to malaria morbidity patterns.
- on environmental mapping, remotely sensed by satellite sensors and prediction, velocity and dynamics of malaria morbidity.

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