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Influence of Socio-Economic and Cultural Activities on Vector-Host Interaction and Risk of Rhodesian Sleeping Sickness at Busia and Nguruman Areas of Kenya

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Abstract: This study assessed the influence of socio-economic, cultural and demographic variations on human-fly contact i.e. interaction between human beings and tsetse flies and their potential role in transmission risk of rhodesian sleeping sickness among the Teso and Maasai communities of Kenya. Results indicated that farming was the economic activity with the highest risk, exposing 84% males and 75% females to tsetse bites at Busia. Level of formal education influenced choice of occupation, with farming absorbing 85% of those with primary education. Ritual bathing was the riskiest cultural activity exposing 45.97% of the population into contact with tsetse flies. Grazing pattern favoured contact avoidance thus minimizing risk of disease trypanosomiasis to livestock. However at Nguruman, livestock keeping was the riskiest economic activity exposing 60% of the population to tsetse flies. Level of formal education did not influence choice of occupation and over 90% of the land was under bush and was tsetse infested. *Olpul* and *Moranism* were the most important cultural activities exposing 85.7% of the population into contact with tsetse flies. Vector-host contact was highest at watering points and men and women were at risk with risk indices of 47.73 and 26.5%, respectively. Management of transmission risk in both Busia and Nguruman would therefore be partly aided by conducting socio-cultural practices in tsetse free areas and scheduling economic activities such as herding as to avoid intense contact with the tsetse flies.

Key words: Vector host interaction, rhodesian sleeping sickness, socio-economic risk factors, tsetse flies

INTRODUCTION

Rhodesian sleeping sickness is restricted to western part of Kenya despite widespread distribution of the vector, tsetse flies (*Diptera*: *Glossinidae*). The socio-economic, cultural and demographic variations of the communities occupying the sleeping sickness focus and the other tsetse infested but sleeping sickness free areas of Kenya have not been assessed. Socio-economic and cultural practices of communities living within tsetse-infested areas have been reported to influence human-fly contact i.e., the interaction between human beings and tsetse flies (Leak, 1999) and human-fly contact plays fundamental role in determining disease transmission and incidence in sleeping sickness foci (Page and McDonald, 1959). The nature and duration of the contact determines the intensity of transmission to humans. Mulligan (1970) identified two forms of contact as personal (intimate) or impersonal (casual) and noted that the form and duration of contact determine incidence and intensity

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of infection. He further related the contact phenomenon to the observation in certain instances where prevalence of human sleeping sickness in an area might bear little relationship to tsetse fly density. In Nigeria, for instance, Page and McDonald (1959) observed that sleeping sickness was localised, occurring only in the North, despite the presence of *G. palpalis* throughout the country. Comparison of the degree of human-fly contact between the Northern and Southern explained the phenomenon. According to Gouteux (1985) high intensity of human-fly contact may also occur where human habitation is dispersed among plantations that are harboring tsetse flies. Snow (1984) reported that watering sites for humans and their livestock, mainly at wells, are major foci for transmission of sleeping sickness in Sudan. In Cote d'Ivoire, transmission of sleeping sickness occurred mainly at the boundary of plantations and forests. Encroachment within tsetse habitats with extended duration of human-fly contact increasing the risk of contracting the disease in such places (Hervouet and Laveissiere, 1987). According to a WHO (1986) report, for *T. b. rhodesiense* disease transmission, the high-risk groups include hunters, poachers, honey gatherers and firewood collectors. Epidemiological studies of *T. b. rhodesiense* infection in humans in lower Kitete, northern Tanzania, similarly showed that the disease was occupational in nature (Tarimo, 1980). Factors favouring infection, in this case, were the herding of animals, *olpul* feast for males, firewood collection, water drawing and collection of building materials by women. This study therefore aimed at estimating the influence of socio-economic and cultural practices on human-fly contact and quantifying the contribution of such contacts in terms of trypanosomosis risk among the Maasai of South Western Rift Valley and the Teso of Western Kenya. The two communities exhibited contrasting socio-economic, cultural and demographic diversity among the communities living in *G. pallidipes* infested areas in Kenya. While Nguruman is sleeping sickness free despite the presence of *G. pallidipes*, Teso is a sleeping sickness endemic area. Attempts are made to explain the disease endemicity in one area and its complete absence in the other area.

MATERIALS AND METHODS

Study Areas

This study was conducted at Busia and Nguruman between January and September 2005. Busia study area lies between latitude 0°136' South and 0° North and longitudes 33°54' east and 340 25' 24'' East (Fig. 1). The area is infested with *G. f. fuscipes* along the riparian forest patches and *G. pallidipes*, which has patchy distribution, associated with woody hillside vegetation (Ford, 1971). Nguruman lies at latitude 1° 55' S and longitude 35° 25' E on the floor of the rift valley in southern Kenya (Fig. 2). The area is infested by *G. pallidipes* and *G. longipennis* within the woodlands and *G. swynnertoni* on the adjoining escarpments (Brightwell *et al*., 1997).

Sampling Frame

Based on household data obtained during the preliminary collection, a two stage-sampling frame was used at Busia area. In the first stage, households were clustered within local administrative sub-locations while in the second stage, the selected households were assigned to random numbers, ordered and each of the ten enumerators assigned households randomly for questionnaire administration. About 10% (138) of the 1341 households were interviewed. At Nguruman, about 77% (40) of the 52 Manyattas (Maasai homesteads) were sampled. Although each homestead had varying number of households between (4 and 12), the livestock were grazed together and the socio-economic activities were finely knit across households within each homestead that it was practically not meaningful using a household as a unit of sampling.

Focused Group Discussion (FGD)

In gathering preliminary information on the selected locations at Busia, two separate FGD were held. The first FGD comprised Location chief and four assistant chiefs, Division livestock officer and

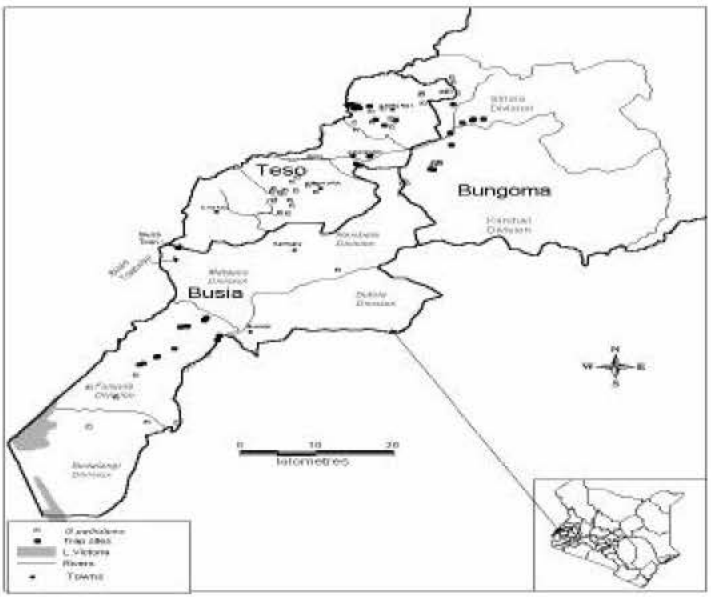

Fig. 1: Map of Westerns Kenya showing the study area

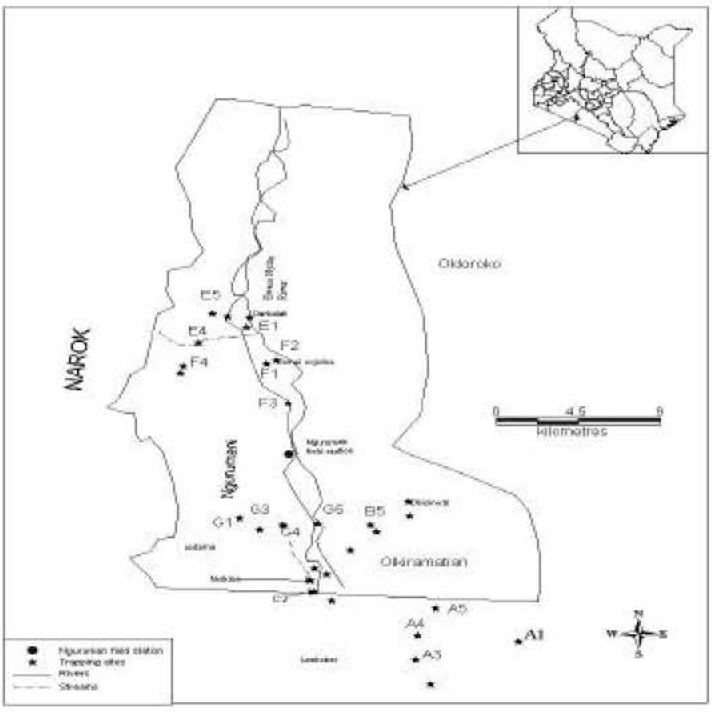

Fig. 2: Map of Nguruman showing the study area

the division Agricultural Officer. At Nguruman, on the other hand, secondary data from a study that was on-going was used. Five opinion leaders (sub locational assistant chiefs) and four village elders were selected for the FGD. In both cases the discussions were base on:

- Experiences on tsetse and trypanosomosis problem in Angurai location
- Population pattern, socio-economic and cultural activities in the area
- Modalities of assistance in case the project may need their help
- Suitability of the draft questionnaire for use within the community

The discussions were interactive and the draft questionnaires were pre-tested on the opinion leaders. Issues that arose were captured in the revised draft to make it applicable to respondents.

The second FGD at Busia comprised District Cultural Officer (DCO), District Assistant Education Officer (DAEO), Chairman of Chamasiri Location Cultural committee, Chief of Chamasiri Location and four Location cultural assistants. The discussions were based on questionnaire themes, with emphasis on socio-cultural aspects that influence the vector and human interaction. At Nguruman, socio-cultural aspects that influence the vector and human interaction were discussed with individual elders whose homesteads were visited on different days since it was difficult to bring them all at one place given their nomadic lifestyle.

Recruitment and Training of Enumerators and Questionnaires Administration

Ten enumerators were recruited from all the villages in Angurai location, while four were recruited at Nguruman. The minimum requirement was a C+ grade at Kenya Certificate of Secondary Education. A one-day induction course was conducted for the recruited enumerators. The questionnaire was pre-tested on village elders first, as part of enumerators training. This was also aimed at determining the accuracy of questions in eliciting relevant responses. Relevant modifications were carried out on ambiguous questions and the resulting final draft questionnaire was administered.

Data Management

Data was initially entered into Microsoft Access® (Microsoft Co-operation, Redmond, WA, USA). It was verified for outliers and missed entries before analysis. Analysis was carried out in Excel® 2000, Minitab® 13.0 and SPSS® 9.0 for Windows. Gender, level of education, land size, land use patterns and occupation were compared statistically using cross tabulations, summary tables and Chi-squared analysis. The relationship between age, sex and village on the occurrence of diseases was initially investigated through a table of proportions. Analysis of variance (ANOVA) was used to determine percent risks of exposure of gender and economic activities.

RESULTS

Gender, Level of Formal Education and Occupation

Out of the 138 households head earmarked for questionnaire administration at Busia, 95 (68%) complied. The rest either declined to participate or were uncooperative in giving responses. Majority of respondents were within age groups 30-39 (26.3%) and 40-49 (24%) years, while respondents below age 29 and above age 50 years were less than 16% each. Males headed 78.9% of the households while females headed 21.1% of the households and the mean age of respondents was 44.1 years. Farming was the main occupation, engaging 84% of the males and 75% of the females. It was observed that 85% of those who attained primary and 69.2% of those who attained secondary education engage in full time farming (Table 1) and the illiteracy level was low (5.26%).

Table1: Percent involvement of those with various levels of formal education in farming activities

Formal education	No. of respondents (N)	Involvement in farming (%)
None	5	80.0
Primary	61	85.2
Secondary	26	69.2
Post secondary	3	33.0

Table 2: Percent involvement of respondents with various levels of formal education in livestock keeping

Formal education	No. of respondents (N)	Involvement in livestock keeping (%)
None	16	66.70
Primary	7	29.10
Secondary	1	4.17
Post secondary	0	0.00

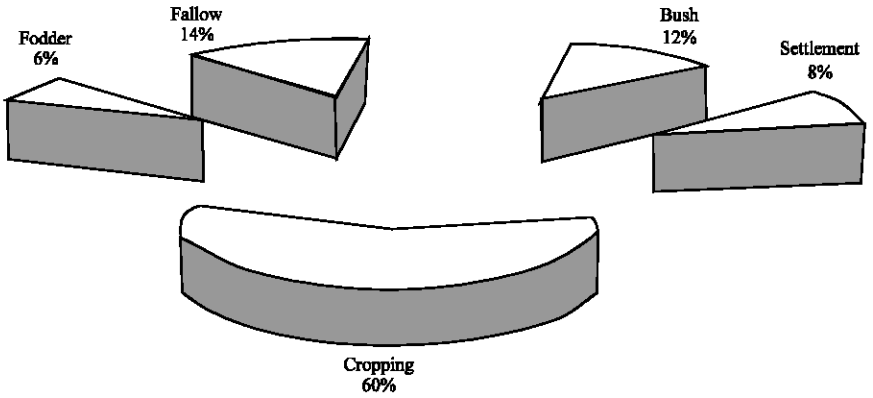

Fig. 3: The land use pattern at Angurai location, Teso District

At Nguruman, questionnaires were administered on 40 respondents, 97.5% of whom were males and only 2.5% were female. Most respondents were not aware of their exact chronological age and they estimated their ages using community age sets. Correspondingly, the most predominant age set was *Majeshi* (35-45 years), which formed 37.7% of respondents followed by *Ilkiseiya* (31.7%). Illiteracy level was high (60%). Livestock keeping was the main economic activity engaging 60% of the respondents followed by livestock trade (22.5%) and crop farming (15%). Level of education seemed to influence involvement in livestock keeping (Table 2). Chi square analysis of cross-tabulations indicated no significant difference between level of education and primary economic activity ($\chi = 3.796$, df = 6, $p<0.704$). However, respondents with no formal education formed the bulk of each of the three economic activities, livestock keeping (66.7%), livestock trade (55.5%) and crop farming (50%). Male household heads controlled (98.9%) of the three important economic activities.

Land Ownership and Land Use

Land ownership was principally individual (93.7%) at Busia. Other forms of ownership were communal (5.3%) and ranching (1.1%). Mean land size per household was 5.38 hectares. Activities on land at Angurai location indicated that land use is inclined towards agriculture with cropping taking up 60% while fallow and bush areas together took up 26% of the land. The area of land under fodder was the least at 6% while homestead took up 8%. The pie chart below shows land use pattern at Angurai location of Teso District (Fig. 3). The respondents listed three major crops grown at their farms as cassava (16.5%), beans (14.3%) and bananas (11.6%). The rest such as avocado, cotton, maize, millet, peas, potatoes, sisal, sorghum, soybeans, kale, sweet potatoes, tobacco and tomatoes took up the remaining 57.6%. However, the percent composition of crops grown varied with the

Table 3: Tsetse density and percentage of respondents grazing their livestock under respective vegetation types during dry and wet seasons at Nguruman

	Dry season		Wet season	
Vegetation type	Tsetse density*	Grazing (%)	Tsetse density*	Grazing (%)
Swampy area	+	4.2	+	16.0
Forested area	+++	29.2	+++	8.0
Riverine vegetation	+++	20.8	+++	4.0
Shrub/bush area	++	45.8	+	72.0

*+ = Low; ++ = Medium; +++ = High

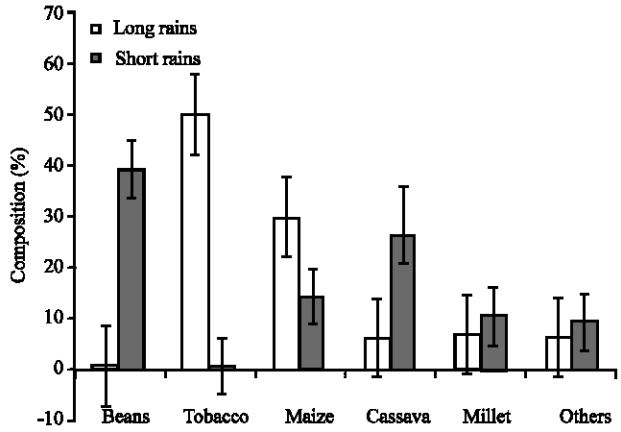

Fig. 4: Percent composition of crops grown during the long and short rain seasons at Angurai location

seasons as shown below (Fig. 4). While tobacco and maize were the most grown crops during the long rains, cultivation of beans and cassava dominated the short rain. Millet was however grown equally in both seasons.

At Nguruman, the community owns grazing land jointly and the community determines grazing pattern. Most of the land had not been adjudicated. However, limited subdivision into individual ownership had bee carried out within the richer agricultural lands around Oloibortoto and Nguruman Township. Over 90% of the land is under bush and open grassland and barely 1% of the land is under crop agriculture while the rest is occupied by homesteads. Part of the land is owned by Kenya Wildlife Service (KWS) as a game reserve. Horticulture is practiced to a limited extent on the upper part of Nguruman using irrigation.

Seasonal Grazing Patterns of Livestock and Vector Contact

Livestock population at Busia was low. Livestock keeping was highly constrained by tsetse and trypanosomiasis problem. Goats composed the highest proportion of livestock in the area (36.7%), followed by cattle (25.1%), sheep (17%), dogs (12.5%), pigs (4.9%) and donkey (3.7%). Most livestock were of local breeds (86.47%). Cattle had the highest number of exotic breeds followed by goats and sheep, although the proportions in each case were negligible. Significantly higher proportion of farmers grazed their livestock in open grassland (29.5%) and shrub/bushy areas (23.5%) than swampy (13.9%) and other areas (11.7%) during the dry season as indicated by the standard error bars. However few respondents grazed along the rivers (3%) and in forested areas (0.6%). Similar trend of grazing is evident during the wet season although much higher proportion of respondents shifted grazing to the open grassland (44.6%) and bushy areas (45.6%). Riverine and forested areas were completely avoided while very low proportion of respondents (1.5%) takes their animals to swamps during the wet season (Fig. 5).

At Nguruman, most respondents (45.8%) indicated that they graze their livestock in shrub and bush areas followed by forested areas (29.2%) and riverine vegetation (20%) as shown in Table 3.

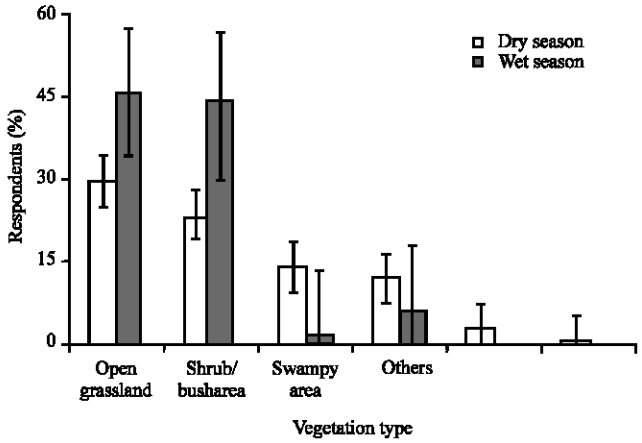

Fig. 5: Proportion of respondents using various vegetation types as grazing areas for their livestock during dry and wet seasons at Angurai location, NB: Error bars are for SE

Tsetse densities were shown to be moderate in shrub and bush, but high in forests and riverine vegetation. Therefore, 49.2% of respondents exposed their livestock to high tsetse challenge. Under severe drought most livestock, especially cattle, are moved to the highlands and some cross over into the Republic of Tanzania. Small ruminants such as goats and sheep normally graze with cattle but are left behind while cattle move far a field in search of pastures. Significantly high proportion of respondents (72%) indicated that they graze their livestock in shrub and bush, while 16% graze in swampy areas during the wet season. This implies low challenge as the two vegetation types were shown to have low tsetse densities during the wet season.

Tsetse and Livestock Interaction at Watering Points

Four major watering points for the animals were identified at Busia. These included streams, rivers, boreholes and within homesteads. Fifty percent of respondents indicated that they water their animals at the streams, 25% at the dams, 17.3% at the river and 7.7% at home. The tsetse densities at the various watering points were given as high near the streams and rivers, medium near the dams and low near homes. This means that 75% of livestock interacted with tsetse flies at high densities areas near watering points, while only 7.7% of livestock were at low risk of interaction with the tsetse flies as they were watered at low-density neighbourhoods.

At Nguruman, dry season watering points included River Ewaso Ngiro and River Entasopia among other small streams from the adjacent hills. Tsetse densities at these watering points were indicated as high by 68.75% of respondents during the dry season. The chances of tsetse interacting with livestock at such watering points are therefore high. During the wet season, majority of livestock are watered in swamps as reported by 100% of respondents. The vegetation type at swamps is shrub/bush and tsetse density in such areas was indicated to be low by 96% of respondents. The risk of tsetse flies transmitting trypanosomes to livestock at the watering points during the wet season is therefore low.

Drug Use in Livestock

Frequency of use of trypanocidal drugs was viewed as indicative of the risk of exposure to infection given the grazing pattern and watering points. The most commonly used trypanocides at Busia were Samorin (11.5%) followed by Trizan (2.1%) and Veriben (1.1%). Eighty one point three percent of respondents indicated that they use trypanocides once a month on each animal, 6.3% twice

a month, 2.1% thrice a month and 10.4% more than thrice a month. Respondents also indicated frequent use of dewormers and antibiotics (85.3%). Livestock and tsetse interaction related well to treatment frequencies such that high treatment frequencies occur in those livestock grazed or watered in high tsetse density areas. Livestock grazed near rivers where interaction was highest, for example, were treated more than thrice a month as indicated by 40% of respondents. Those grazed in low challenge areas were treated only once per month as indicated by 66% of respondents.

In the case of Nguruman, the commonly used drugs for trypanosomiasis treatment were listed as Veriben and Samorin. However the respondents were unable to quantify amount of drugs used per year given the low literacy level and the high number of livestock they own. Dry season was cited to be more stressful to livestock given high treatment frequency and less pastures. Besides tick borne diseases and worms came out strongly as major constraints to both cattle and small ruminants. Because of worm infestation, farmers often used dewormers such as Nielsen.

Wildlife, Livestock and Human Interaction

Respondents at Busia ranked baboons and monkeys as the most abundant (56%) wildlife followed by foxes (11%), mongoose (8.8%), squirrel (6.6%) and rats (6.6%). The respondents listed the abundance of monitor lizard, which is a well-known reservoir host of *Trypanosoma brucei rhodesiense*, at 3.3%. Sixty five point two percent of wildlife were said to be migratory while 34.8% were resident and the migration pattern closely follows availability of food resource. Most wildlife (75%) shared watering points with humans and livestock.

At Nguruman, zebra was ranked as the most abundant wildlife species composing 53.8% of total wildlife in the area followed by wildebeest at 20%. Other species included gazelle (7.7%), hyena (7.7%), lion (5.1%) and impala (2.6%) in that order. Among the wildlife listed 72% were said to be migratory. The animals migrate to Maasai Mara Game Reserve and Serengeti in Tanzania during the dry seasons. Ninety percent of the wildlife share watering points with livestock at sources indicated to be harboring high tsetse density by 53% of respondents.

Gender Roles and Risk of Sleeping Sickness

Socio-cultural activities were found to contribute varying risks by creating contact between various gender and tsetse flies. Analysis of exposure to tsetse flies by gender through involvement in cultural activities using two-way analysis of variance (ANOVA) showed significant differences ($F_{5,18} = 9.03$; $p<0.001$). Separation of mean percent exposure using Least Significant Difference (LSD) showed that ritual bathing exposes gender significantly more than all the other cultural activities. Ritual bathing was also scored as the highest risk associated cultural practice with a mean risk of 45.97%. Exorcism posed the second highest risk for girls (30.8%), while for boys and for men it was circumcision with risks of 36.8% and 25% respectively as shown in Table 4.

At Nguruman, cultural practices exposed gender differently to the risk of contact with tsetse flies. Among the men, *Olpul* was cited by 85.7% of respondents as the main risk associated cultural activity. This cultural activity was also indicted for boys (27.5%). *Moranism* was indicated as another cultural

Table 4: Percent exposure of gender to tsetse bites through cultural activities at Busia

	Percent exposure by gender				
Cultural activities	Men	Women	Boys	Girls	Mean risk
Ritual bathing	40.0	44.1	42.1	57.7	45.97[a]
Circumcision	25.0	11.8	36.8	0.0	18.40[b]
Appeasing spirits	11.7	17.6	10.5	11.5	12.83[b]
Exorcism	1.7	2.9	10.5	30.8	11.48[b]
Baptism	16.7	17.6	0.0	0.0	8.58[b]
Exhumation	5.0	5.9	0.0	0.0	2.73[b]

Means followed by the same letters within the same column are not significantly different at p = 0.05 (LSD)

Table 5: Percent exposure of gender by involvement in economic activities at Nguruman

	Percent exposure by gender			
Economic activities	Men	Women	Boys	Girls
Grazing livestock	22.90	0.00	77.10	0.00
Watering livestock	25.70	5.70	68.60	0.00
Fetching water	8.60	77.10	0.00	14.30
Collecting firewood	2.90	65.70	31.40	0.00
Trade	42.90	51.40	2.90	2.90
Charcoal burning	93.80	6.30	0.00	0.00
Harvesting honey	97.10	2.90	0.00	0.00
Land clearing	87.90	3.00	9.10	0.00
Mean risk	47.73[a]	26.51[a]	23.63[a]	2.50[b]

Means followed by the same letters within the same row are not significantly different at p = 0.05 (LSD)

activity exposing boys to tsetse contact (7.5%). *Olpul* is a fattening ceremony among the Maasai where a number of bulls are driven into the bush and slaughtered for meat and blood. The participants stay in seclusion, spending the nights and days in the bush without going back home, until they clear the entire meet from the bulls. The ceremony usually takes between 3 and 4 weeks. *Orititi,* a prayer session where women visit shrines usually associated with specific trees in the wild, was cited by 68.42% of respondents as the major cultural activity exposing women to tsetse bites. No specific cultural activity of significance was identified for girls, although a few respondents indicated that girls occasionally participate in *Olpul*. Major economic activities were indicated to expose gender to tsetse contact. The risk of men being bitten by tsetse flies stood at 47.73% followed a distance by women at 26.51% and boys at 23.26%. Girls were the least at risk (2.5%). Charcoal burning, honey harvesting and land clearing are the most risky economic engagements for men while for women it was water fetching, firewood collection and trade (going to the market). Boys were most exposed by grazing and watering of livestock while girls had no significant exposure by any of the economic engagements. Analysis of percent risks of exposure of gender by economic activities using one-way unstacked ANOVA was significant ($F_{3,28} = 3.04$; $p<0.046$). When mean percent exposure were separated using LSD, only girls were found to be significantly less exposed than men while all the other gender categories were not (Table 5).

DISCUSSION

In this study, it was realized that level of formal education influenced choice of occupation, especially among the illiterates and those with primary education, in both study areas. Livestock farming was found to be a higher risk activity, exposing more people to tsetse fly infested areas than crop farming. Since majority of inhabitants of Busia (84%) were crop farmers while those of Nguruman (60%) were livestock farmers, it may therefore be postulated that livestock keeping would pose more serious risk of disease transmission to humans at Nguruman than at Busia. This would further be exacerbated by high illiteracy level since majority of those without formal education were found to be basically involved in livestock keeping. Tarimo (1980) reported similar findings while doing epidemiological studies on *T. b. rhodesiense* infection in humans in lower Kitete area of northern Tanzania where he showed that the disease was occupational in nature. He listed herding of animals as one of the factors favouring transmission to humans. Land use pattern determine the availability or lack of suitable tsetse habitats. About 60% of the land in Busia was under crop agriculture, largely maize and cassava plantation, which are poor habitats for tsetse flies. This confirms the finding by Ottichilo (1985) who reported that most natural vegetation at Busia had been cleared for agriculture and secondary bush encroachment of *Tithonia diversofolia* and *Lantana camara* predominate fallow

land, hedges between fields and watercourses. In contrast, 90% of land in Nguruman was under bush and shrub, providing good habitat for tsetse flies. The importance of bush and shrub in the sustenance of disease transmission cycle has been reported in Nigeria (Omoogun *et al*., 1991).

It has been observed that seasonal grazing patterns played a significant role in tsetse-livestock contact and therefore disease prevalence in cattle irrespective of the tsetse fly density (Leak, 1999). In Busia the grazing pattern favoured contact avoidance, this in essence minimized risk of trypanosomiasis to livestock. This was possible due to low stocking levels resulting in less strain on pastures and farmers therefore had a choice to pastures away from tsetse-infested areas. However, contact was higher during the wet season. Unlike in Busia, risk of trypanosomiasis to livestock in Nguruman was higher during the dry season as search for pasture and water brought livestock into close contact with wildlife and tsetse flies. Tarimo (1980) similarly observed that the impact of trypanosomes appears to be largely dependent on animal movement during grazing and watering practices and this he said was possibly as a result of frequent contact with cattle host at the communal pastures and water points. Snow (1984) also reported that watering sites for humans and their livestock are major foci for transmission of sleeping sickness in Sudan.

Rhodesian sleeping sickness is anthropozoonotic and therefore the interaction among vectors, wildlife and livestock is a key factor in the sustenance of its transmission. In Both Busia and Nguruman, most wildlife shared watering points with humans and livestock. A large number of livestock also migrate to either Uganda or Tanzania and back, exposing them to risk of infection with rhodesiense trypanosome. Cases of rhodesian sleeping sickness have been reported in Serengeti in Tanzania and Western part of Uganda (Tarimo, 1980; Angus, 1996; Bourn *et al*., 2001) and some of the wildlife are reservoir hosts *Trypanosoma brucei rhodesiense*. Gender played a major role in determining risk of sleeping sickness transmission to humans. Ritual bathing and exorcism were the highest risk associated cultural practice among the Busia population and boys were the most at risk. At Nguruman, *Olpul*, *Orititi* and *Moranism* were the risk associated cultural practices exposing men, women and boys to vector contact and therefore to transmission. Charcoal burning, honey harvesting and land clearing were noted as the most risky economic engagements for men while water fetching firewood collection and trade were for women. World Health Organization (WHO, 1986) reported hunting, poaching, honey-gathering and firewood collection as the high-risk economic activities associated with transmission of rhodesian sleeping sickness. The report further linked infections to occupation. Tarimo (1980) similarly reported that rhodesiense sleeping sickness was occupational in nature and listed herding of animals, *olpul* feast for males, firewood collection and water drawing as factors favouring transmission among the Maasai of Tanzania.

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