Participatory Epidemiology of Coenurus Cerebralis Infections in Goats and Sheep kept by Pastoralists in Ngorongoro District, Tanzania

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Abstract

Livestock diseases are among the most important causes of poverty in Ngorongoro district since such diseases deteriorate the livelihoods of local people. Participatory Epidemiology (PE) study was conducted in ten pastoralist villages in Ngorongoro district to determine morbidity, case fatality rates and their impact on livelihoods of the livestock keepers. PE tools that were used included simple ranking, proportional piling, seasonal calendars, timelines and probing. Goats were perceived as the most abundant among livestock species kept followed by sheep and cattle in that order. However, cattle with an average score of 51.6 were perceived as the most important for their livelihood.The importance of other animals in descending order was goats, sheep, donkeys, poultry and pigs being the least that scored 22.9, 16.7, 6.2 and 2.6 respectively. For goats the mean flock morbidity and case fatality rates for major diseases were 58.7% and 35% respectively while in sheep it was 61.5% and 24.5%. For the goats the overall score for morbidity rates for nervous signs/gid (ormilo in Maasai), pest des petites ruminants, pox, contagious Caprine pleuropneumonia and other diseases were 12%, 13.6%, 7.5%, 19.3%, and 7.3% while their respective mean score for case fatality rates were 100%, 48.5%, 33.3%, 34% and 38.3% respectively For sheep diseases, the overall score for morbidity for gid (ormiloin Massai tribe) pest des petites ruminants, pox, mange and other diseases were 12.5%, 12.4%, 8.7%, 20.1%, and 7.8% while the respective mean scores for case fatality rates were 100%, 48.3%, 26.4%,

5.4% and 33.3% respectively. The clinical signs of gid (omilo in Massai tribe) included unidirectional cycling, frequent abnormal noise, staggering, head tilting, difficult to chew and swallow and eventual death. Large cysts (up to 6cm in diameter) that were confirmed parasitologically to be Coenuruscerebralis were found mainly embedded between the different parts of brain lobes under the meninges. The present study confirms the debatable aetiology of CNS syndrome (Omillo in Massai tribe) for small ruminants in Ngorongoro district to be Coenurouscerebralis and validates development of strategies to control the disease that at present its case fatality rate issalarming and is a major threat to livestock health and Maasai pastoral community livelihood.

Key words: central nervous system, gid, *Taeniamulticeps*, ormilo, participatory epidemiology, Ngorongoro, Tanzania

Introduction

In spite of the large number and economic importance of small ruminants in developing countries in the tropics including Tanzania, productivity is often low owing to diseases, inadequate feed resources and poor management. Losses from disease alone reduce productivity by 50-60% (Pritchard, 1988; ILCA, 1992). The recurrent losses in productivity and profit are often due to parasitic infections, particularly helminths which are common and a major problem for small ruminant production in most parts of the tropics (Ibrahim, 1998). Ngorongoro district is estimated to have a livestock population of 1,284,567 with small stock accounting for 73.9% of this figure. Virtually all animals kept are local breeds whose main attribute is physiological adaptation to harsh environment of climate variability, seasonal shortage of feed and high disease challenge (Ole-Nesselle*et al.,* 2008). A vast majority of livestock keepers practice transhumance as part of strategy to exploit temporal and spatial variation in range resources as well to minimiz (*ibid*.) Although livestock production remains the basis of food security and a mainsource of livelihood for the majority of the population of Ngorongoro district, it is now estimated that more than 60% of the

food intake of the pastoralists consists of grain most of which is bought against the sale of livestock. The situation is partly a result of the poor performance of the pastoralists' economy caused by structural and environmental factors (Loomu, 2005). Among manyfactors two are particularly important in depressing the performance of the pastoralists' economy, namely livestock diseases and recurrent drought (*ibid*.). Ngorongoro district in general has a very complex disease situation, which is perhaps unique in the country. This is a result of the diverse eco – climatic conditions found in the district and cross – border livestock movements (Ole-Neselle*et al*., 2008). Eco-climatic conditions which favour survival and multiplication of disease vectors, close interaction between livestock and wildlife as well as semi-nomadic mode of livestock production are some of the factors contributing to high disease transmission (Swai *et al*., 2006)

Generally, there has been a growing threat of livestock diseases with several impacts in Ngorongoro district. Some of these impacts include; diminished herd size due to increased mortality, direct financial losses from low market value, destabilization of the traditional setup resulting from the migration of labour force, and poor health status especially in children (Bakuname *et al*., 2002) and other direct losses due to death, emergency sales and slaughter. Although there has been some and broad intervention strategies in the efforts of trying to reduce livestock mortalities from diseases (through improved disease preventive measures) in Ngorongoro district, these have largely focused on cattle and to some extent neglecting small stock (sheep and goats). As a result, this category of stock has been suffering more from almost all natural calamities despite their food security value and economic importance to the community. For example, following the severe droughts of 2003/04 and 2005/06 that hit the country, contrary to expectations, small ruminants suffered higher levels of mortalities compared to cattle which physiologically are less suited to drought conditions. During 2003/04 drought, goats and sheep suffered average mortality of 37% compared to cattle which experienced mortality of 31% (Loomu,

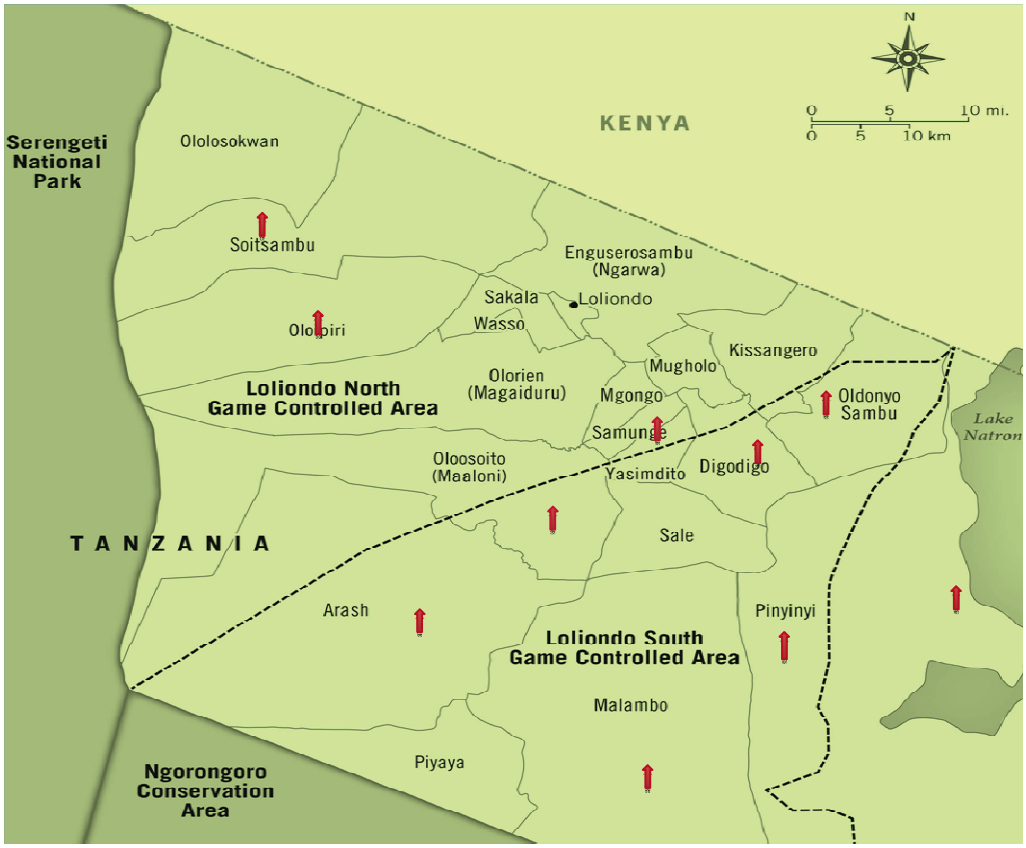
2005). A similar trend was observed during 2005/06 drought when death toll reached 41%, 36%, and 33% for sheep, goats and cattle respectively. Although in sheep and goats a number of diseases are thought to have contributed to the drought-induced mortalities the major cause in this area, appears to be helminthosis (Ngorongoro District Council, 2006). Recently, there has been an increasing report ofhigh mortality rates associated with nervous syndrome in sheep and goats within the district. Attempts to treat the disease akin to cases of theleriosis (ormillo in Maasai) in cattle could not bear good results and such worrisome problems continue to remain among the pastoral communities.

The purpose of the present study was, therefore, to involve the pastoral communities through participatory appraisal methods to investigate the importance, morbidity and mortality rates and impact of a nervous syndrome ('ormilo') in sheep and goats as perceived by livestock owners on their livelihood in, the study area. In addition, to carry out post-mortem and laboratory investigations to determine the probable causative agent.

Material and Methods

Study Area

The study was conducted in two divisions; Sale and Loliondo in Ngorongoro district, Arusha region, Tanzania. This study area comprised five and three wards in Sale and Loliondo divisions respectively. Administratively the Sale division is sub-divided into five wards: Malambo, Sale, Pinyiny, Oldonyosambu and Digodigo.that comprise thirteen villages. The Sale division largely forms the central and eastern part of the district while Loliondo division forms the northern part. The Loliondo division is also sub-divided into three administrative wards. In this study, a village was the sampling unit.



A modified sketch map of Loliondo division area showing the villages (pointed by red arrow) where the study was conducted. Source: Original map by Gardner, (2015)

Seven wards, one to two villages from each ward (three in Sale and two in Loliondo) divisions were selected by stratified random sampling technique that assured the representation of not only the overall population, but also key subgroups of the population, especially small minority groups. The total surveyed villages were ten and the criterion used for stratification was based on the ecological zones namely lowlands, midlands and highlands. Where it happened that a selected ward has one or two villages, the whole area of that ward was sampled. The followings are sampled village with their GPS coordinates.

Table1: Surveyed villages in Ngorongoro districts showing GPS coordinates.

S/n	Ward	Village	GPS coordinate
1	Loliondo	Enguserosambu	S 02. 04382º E 035. 72425° Elev. 2762 m
2	Arash	Arash	S 02. 43204º E 035. 60114° Elev. 1827 m
3	Arash	Maaloni	S 02. 16617º E 035. 69972° Elev. 1912 m
4	Malambo	Malambo	S 02. 50917º E 035. 60584º Elev. 1261 m
5	Malambo	Piyaya	S 02. 58119º E 035. 50424° Elev. 1581 m
6	Pinyiny	Pinyiny	S 02. 28206º E 035. 95460° Elev. 604 m
7	Pinyiny	Engaresero	S 02. 61259º E 035. 87908º Elev. 661 m
8	Digodigo	Samunge	S 02. 15647º E 035. 69972° Elev. 1374 m
9	Oldonyosambu	Oldonyosambu	S 02. 18083º E 035. 82884° Elev. 1223 m
10	Soit-sambu	Ololosokwan	S 01. 87738° E 035. 33665º Elev. 1904 m

Methodology

Data on small ruminants disease incidences was obtained by employing Participatory Epidemiology (PE) tools notably informal interviews, ranking and scoring, visualization and direct observation and as described previously by Catley (2005), Ctatley *et al*. (2001, 2012), Ameri *et al*. (2009). Both primary and secondary data were collected. Semi-structured interviews (SSI), timelines, seasonal calendars, simple ranking and proportional piling were used to collect most of the primary data. During the informal interview a checklist of areas of interest about major diseases affecting the goats and sheep was used as a point of reference rather than a

questionnaire. Secondary data were collected from district veterinary office records, literature and through web browsing. Informal interview was carried out by using semi-structured interviews where a checklist of areas of interest to be covered was used as a point of reference.

Simple Ranking and Proportional Piling

Simple ranking was carried out by asking the participants at the beginning of the interviews to give a list of livestock species that were kept in each of ten villages and thereafter to rank them based on abundance. Proportional piling technique was used to determine the herd size proportions in different livestock species that were kept and the demonstration of the relative importance of each species to their livelihood. In this case, representative group of respondents from each of the ten villages were asked to divide 100 objects (bean seeds or pebbles) into piles of sizes representing the relative size or importance of each animal species to their livelihood. After piling, the number of seeds/pebbles in each pile was then counted and average score for each livestock species were calculated. After calculation the livestock species were ranked based on their score to determine their importance to livelihood.

Similarly proportional piling technique was employed to determine the importance of various diseases in flocks of both goats and sheep. The farmers were asked to list important diseases of goats and sheep and thereafter by using a pile of 100 counters to represent the flock or herd of animals, farmers were asked to show within a period of one year which proportion was health and sick. From the sick piles the farmers were asked to show proportion of the animals suffered from each specific disease. Furthermore, from each group of animals that suffered from a particular diseases, the pastoralists were asked to indicate the proportion that recovered or died from the disease episode. Based on the information gathered, it was possible to calculate overall flock morbidities, mortalities and case fatality rates

as well as disease specific morbidity, mortality and case fatality rates in sheep and goats separately.

Clinical Signs and Parasite Isolation cum Identification

Probing of the farmers was carried out to obtain additional information about the CNS syndrome in goats and sheep. This included disease history and timing of the disease events, distribution and variation of disease incidence with the season. Brain and spinal cord tissue samples were specifically collected from sheep and goats that were showing CNS signs prior to slaughter or those which had a history of locomotion disturbance, or walking in circles or any nervous disorder were collected from local slaughter slabs in study villages. The collected samples were preserved in 10% formalin. The identification of each sample was performed by labelling indicating village, species, sex, and age of each sample. Brain tissues were first grossly examined and where cysts were superficially located, the site and the size were recorded. Parasites (cysts) were then removed from the brain tissue and closely examined under microscope.

Data Analysis

Data validation was carried out by using probing questions to verify the information and getting more and detailed information on a particular issue. Where conflicting information/ideas were provided by different groups/individuals, that particular information was assessed by triangulation (cross-checking) – comparing the information which was obtained. The collected data were summarized and analysed using simple ranking and proportional piling where mean scores and ranks were determined. Overall herd and disease specific morbidity, mortality, and case fatality rates were calculated as shown below:

a) Overall herd morbidity = (number sick/number in herd) x 100 %
b) Overall herd mortality = (number dead/number in herd) x 100%
c) Overall case fatality = (number dead/number sick) x 100%

d) Morbidity due to specific disease = (number sick from disease/number in herd) x 100 %
e) Mortality due to specific disease = (number dead from disease/number in herd) x 100%
f) Case fatality rate for specific disease = (number dead from disease/number sick from disease) x 100%

Results

The results of the PE study are as summarized in Tables 2, 3, 4 and 5. These include simple ranking of the number of animal species keptTable 2, proportional pilling showing the relative importance of different livestock species to the community livelihoods Table 3, simple ranking on the important livestock diseases as perceived by stock owners, Table 4 and 5 proportional piling for morbidity and mortality Table 5. Others are observed clinical signs, forms of gid (ormilo), post-mortem findings identification of parasites, available local knowledge (diagnosis and control), seasonal calendar and timelines

Simple Ranking (for number of animals kept)

Goats were perceived as the most abundant among livestock species kept in the 10 surveyed villages. Others in order of descending rank were sheep, cattle, donkeys, and poultry being the least.

Table 2. Simple Ranking of Animals being kept by number with goats ranked as the most abundant livestock species followed by sheep and cattle in that order

Animal species	Surveyed ten villages										Total score	Rank
	Engusero	Arash	Maaloni	Malambo	Piyaya	Pinyiny	Engaresero	Eamunge	Oldonyosambu	Ololosokwan		
Cattle	2	3	3	3	3	3	3	3	2	2	27	3
Goats	3	1	1	2	2	1	1	2	1	1	15	1
Sheep	1	2	2	1	1	2	2	4	4	3	22	2
Donkeys	4	4	4	4	4	4	4	5	5	4	42	4
Poultry	5	5	5	5	5	5	5	1	3	5	44	5

Proportional Piling

Cattle with the mean score of 51.6 were perceived as the most important to the community livelihood among the livestock species kept in the 10 surveyed villages (see Table 3). Others in order of descending rank were goats, sheep, donkeys and poultry being the least.

Table 3. Proportional piling of the relative importance of different livestock species to their livelihoods with cattle as the most important livestock with regards to economy and livelihood of the pastoral farmers

	Surveyed ten villages												
Animal Species	Engu-sero	Arash	Maa-loni	Malambo	Piyaya	Pinyiny	Engaresero	Samunge	Oldonyosambu	Ololoso-kwan	Total score	Average score	Rank
Cattle	54	63	68	32	36	50	28	56	58	71	516	51.6	1
Goats	21	15	13	26	23	22	29	31	25	14	229	22.9	2
Sheep	20	11	11	27	29	19	27	6	8	9	167	16.7	3
Donkeys	4	9	8	12	11	7	14	1	1	5	62	6.2	4
Poultry	1	2	0	3	1	2	2	6	8	1	26	2.6	5
Total	100	100	100	100	100	100	100	100	100	100	1000		

Livestock Diseases

Ranking Diseases of Goats

The results for identification of diseases that affected goats in the past yearbased on simple ranking ranked"Ormilo" (Gid), PPR, Pox, CCPP and Helminths as major health problems. For sheep, "Ormilo"was raked as problem number one, followed byPPR, mange, pox, and worms.

Proportional Piling for Morbidity and Mortality

The results for analysing important diseases in goats and sheep by employing proportional piling (PE) tool is shown in Table 4. and table 5. In both species "ormilo' (gid) has highest (100%) case fatality rates.

Table 4. Proportional piling for morbidity and mortality rates of diseases of goats in the surveyed ten villages(s with gid (ormillo) having the highest case fatality rate

Village	Healthy	Sick	Gid (Ormilo)		PPR		Pox		CCPP		Others	
			S	D	S	D	S	D	S	D	S	D
Loliondo	39	61	13	13	33	11	3	0	10	8	2	1
Arash	41	59	17	17	12	9	-	-	24	11	6	2
Arash	34	66	11	11	14	8	9	2	21	6	11	5
Malambo	56	44	12	12	-	-	9	2	23	5	-	-
Malambo	33	67	10	10	4	2	14	11	26	7	13	6
Pinyiny	28	72	9	9	26	13	10	4	21	5	6	3
Pinyiny	46	54	-	-	5	3	18	5	14	9	17	2
Digodigo	74	26	5	5	-	-	-	-	12	3	9	4
Oldonyosabu	47	53	34	34	14	10	-	-	15	7	-	-
Soitsambu	15	85	9	9	28	21	12	1	27	5	9	5
Mean	**41.3**	**58.7**	**12**	**12**	**13.6**	**6.6**	**7.5**	**2.5**	**19.3**	**6.6**	**7.3**	**2.8**

Key: S = Sick, D = Dead (both are proportions). PPR=Peste des petits ruminants*, CCPP=Contagious Caprine pleuropneumonia*

Interpretations.

i. Flocks mean morbidity (all diseases) = 58.7%
ii. Flocks mean mortality (all diseases) = 35%
iii. Ormilo: mean morbidity = 12%, mean flock mortality =12%, mean case fatality = 100%
iv. PPR: mean morbidity = 13.6%,mean flock mortality = 6.6%, mean case fatality = 48.5%

v. Pox: mean morbidity = 7.5%, mean flock mortality = 2.5%, mean case fatality = 33.3%
vi. CCPP: mean morbidity = 19.3%, mean flock mortality = 6.6%, mean case fatality = 34%
vii. Others: mean morbidity = 7.3%, mean flock mortality = 2.8%, mean case fatality = 38.3%

Table 5. Proportional piling for Morbidity and Mortality Rates of diseases of sheep with gid (ormillo) having the highest case fatality rate.-

Village	Healthy	Sick	Ormilo		PPR		Pox		Mange		Others	
			S	D	S	D	S	D	S	D	S	D
Loliondo	14	86	23	23	20	6	-	-	35	4	8	3
Arash	37	63	14	14	6	4	-	-	28	1	15	8
Arash	31	69	10	10	23	7	19	2	14	1	3	1
Malambo	69	31	16	16	-	-	12	7	3	0	-	-
Malambo	11	89	17	17	-	-	21	3	37	2	14	4
Pinyiny	32	68	12	12	27	15	6	2	11	0	12	1
Pinyiny	36	64	-	-	11	8	21	8	26	0	6	2
Digodigo	70	30	3	3	-	-	-	-	16	0	11	4
Oldonyosabu	58	42	19	19	10	9	-	-	13	0	-	-
Soitsambu	27	73	11	11	27	11	8	1	18	3	9	3
Mean	38.5	61.5	12.5	12.5	12.4	6.0	8.7	2.3	20.1	1.1	7.8	2.6

Key: S = Sick, D = Dead (both are proportions).

Interpretation

i. Flocks mean morbidity (all diseases) = 61.5%
ii. Flocks mean mortality (all diseases) = 24.5%
iii. Ormilo: mean morbidity =12.5%, mean flock mortality=12.5%, mean case fatality =100%

iv. PPR: mean morbidity = 12.4%, mean flock mortality = 6%, mean case fatality = 48.3%
v. Pox: mean morbidity = 8.7%, mean flock mortality = 2.3%, mean case fatality = 26.4%
vi. Mange: mean morbidity = 20.1%, mean flock mortality = 1.1%, mean case fatality = 5.4%
vii. Others: mean morbidity = 7.8%, mean flock mortality = 2.6%, mean case fatality = 33.3%

Clinical Signs

Generally, the described clinical signs which were reported during the survey showed that there is central nervous system (CNS) involvement. According to the explanations from the community, there are no significant differences in disease manifestation between sheep and goats. However, frequent making of abnormal noises and tilting of the head were more elaborated in goats than in sheep. The clinical signs included continuous circling movement which is restricted to one side (unidirectional) failure to chew and swallow food, making of abnormal noises, lack of response to external stimuli and paralysis of the backbone as shown in Figure 1. In Table 6 there is a detailed information of two goats and two sheep that had history of long-term CNS ranging from difficult to follow the herd, elevated head, uncoordinated movements and lack of balance, convulsions and making loud noises. The observed clinical signs were related to the site in the brain where the cyst was located

Figure 1: Sheep with swaying movement due to partially paralysed hind legs as a result of spinal cord infection with *Coenuruscerebralis.*

Table 6: Individual case history, clinical signs and parasitological findings after post-mortem of gid (ormilo). This is a narration of results rather than a caption, rephrase

S/n	Species	Sex	Age	History	Clinical signs	Parasitological findings
1	Caprine	F	1.5	Sick for the past 9 months	Elevate and tilted head	Multiple cysts in hindbrain
2	Ovine	F	Adult	Sick for long time (about 1 year ago)	Cannot follow the herd. Sometimes convulsions	Cyst extracted from the middle brain
3	Ovine	F	Adult	Sick for about 5 months	Uncoordinated movements and lack of balance	Cyst in the brain stem where it joins the spinal cord
4	Caprine	M	Adult	Sick for about 3 months	Cannot follow the herd. Makes loud noises. Uncontrolled	Two cysts on upper superficial layers of brain

Post-mortem Findings

The results of the post-mortem findings are shown in Figure 2 and Table 6. Large cyst were found in different parts of the brainas shown in Figure 1a where a large coenurus cysts "arrows" was located between the front lobes of brain under the meninges. The exposed large cyts (some up to 6 cm in diameter is shown in Figure 1b. The cyts were flabby and with a translucent delicate milky-whitish capsule that contained aggregate foci of coenuri scolices attached beneath the membrane.

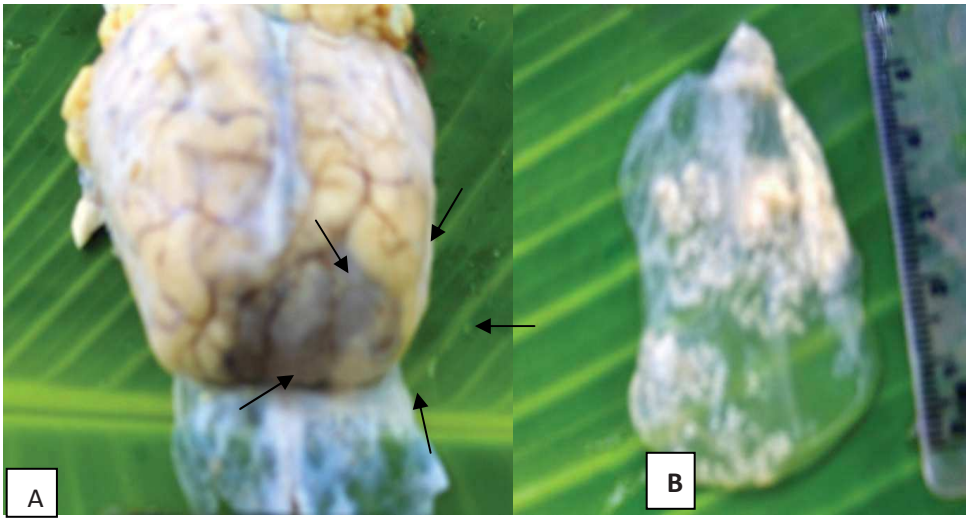


Figure 2: Field photographs of coenurus cysts in the brain of a goat. (A) Large coenurus cysts "arrows" between the front lobes of bran under the meninges. (B) Individual coenuruscysts almost 6 cm in diameter with several scolices inside them

Parasite Identification

`Appearance showed that the cysts had the following characteristics. (i) They measured up to 6 cm. in length. (ii) They were whitish milky coloured containing hundreds white granule-like substances (numerous). When examined microscopically, the scolices had four suckers and armed rostellumie had hooks. The cyts were confirmed to be of *Coenurous cerebralis* the larvae of *Taenia multiceps*

Diagnosis of the Diseases based on Local Knowledge

As perceived by the livestock owners, most times it was very difficult to diagnose the Ormilo cases especially when the infected animal was at rest. Sometimes an infected animal which had already shown clinical signs might stay for some days without showing any sign of illness. To avoid losses many infected sheep and goats are sold in livestock auction markets for subsequent slaughter. The pastoralist community has developed mechanisms/techniques for testing positive cases. The tests are carried out by getting hold of the ear,

gentle squeezing combined with pulling and release or by gentle striking on the head the space between the two horns of a suspected infected animal. However, such tests are not carried out unless a buyer is intending to buy an animal for domestication. In common practice the tests are not applied by butcher men. Sometimes the animals are chased and the sick ones may show CNS signs such as staggering and swaying.

Attempt Treatment for Ormilo

Although the majority of livestock keepers are quite sure that a goat or a sheep which is succumbing to "Ormilo" cannot be cured, no one is ready to "sit" and look for his/her animal die without making any effort of trying to rescue a sick animal. He or she will try whatever possible to serve the animal's life especially the lactating ones by making several attempts. These attempts are such as the use of chemotherapeutics (oxytetracyclines), hot iron for branding (cauterization) the head, and by inserting a piece of wood in the nose and making a thorough scratching on the inner walls to encourage nose bleeding. However, none of such farmer mitigation has succeeded to cure gid (ormillo) in sheep and goats in the study area.

Timelines

During the interviews, there were a great concern that the "ormilo" (Gid) is a new and one of the emerging small stock health problems. In other places the disease was initially sporadic but it has gained momentum and it appears to be an epidemic. Table 6 shows a historical period when the disease was observed in different villages as explained by the farmers. The disease started to become vivid as early as mid-1990s. It is suspected that the disease was introduced through introduced white coloured Isiolo goats from the neighbouring country.

Table 7: Historical information on the occurrence of "Ormilo" disease in Ngorongoro district.

Village	Period when the disease was observed
Pinyiny village	Since 1998 in very few goats.
Oldonyosambu	Five years back was sporadic, today is epidemic.
Enguserosambu	Became a serious problem since 2004.
Samunge	Since 1995.
Piyaya and Malambo	Since Mid 1990s.

Discussion

Participatory epidemiology is a promising new branch of veterinary epidemiology where participatory tools are employed by scientists involving livestock keepers in making analysis of a disease problem as well as suggesting effective control measures (Catley *et al*., 2001, 2012; Makundi *et al*., 2012). Such methods are cost effective and useful in underserved rural areas where deliveries of veterinary services are poor. These methods have been successfully employed in countries such as Southern Sudan, Ethiopia, Somalia, Zimbabwe, Uganda, Kenya and Tanzania by involving community animal health workers (CAHW) in programmes such as rinderpest and tsetse fly control (Nalitolela *et al*., 2001; Leyland and Catley, 2002; Alloport *et al*., 2005).

In the present study participatory epidemiology methods were used to investigate morbidity and mortality rates of a nervous syndrome in sheep and goats in Ngorongoro district. Despite of the existence of this problem for many years little has been conducted to determine the causes of CNS syndrome in small ruminants in the present study area. This could partly be masked by a number of emerging killer diseases that have incessantly been occurring in this area notably contagious caprine pleropneumonia (CCPP), rift-valley fever as well as rinderpest-like disease of small ruminants (Loomu, 2008). In the present study both post-mortem and parasitological findings confirmed that the cause of the CNS syndrome (omilo) was *Coenuruscerebralis* (larvae of tape worm - *Taeniamulticeps)*.

The neurological clinical signs are often referred to as "gid" or "straggers" and are dependent on the location of the cyst in the central nervous system (Soulsby, 1982). In Loliondo area the respondents described three forms in which gid/Ormilo in sheep and goats is manifested. The disease course will depend on what form a particular animal is succumbing. These forms are; *acute form* that is manifested by paralysis of the backbone and death within few days, *sub-acute form* demonstrated by dullness and unable to graze where the animal emaciates and can stay up to two weeks before death and a *chronic form* where there is raising and tilting of the head but animal can graze. Studies by Braund (2004) and Ozmen (2005) show that symptoms from established *T. multicepscoenuri* appear more slowly, are most common in 16-18 month old sheep, and vary with the location of the parasite in the brain or spinal cord and vary with the location, size and viability of the coenurus. Symptoms were related to cyst localization. Depression, tilting of the head either to the right or left and head pressing were seen when cysts were located in the cerebrum. In-coordination and hyper-excitability were noted if the cysts involved the cerebellum and when located in the spinal cord, hind leg paralysis was the typical clinical sign

The present findings provide true diagnosis to the previous assumption among livestock keepers that, gid (ormilo in Maasai) in sheep and goats was the same disease as that of cattle (a protozoan disease) which is caused by *Theileriataurotragi.* Based to such background, livestock keepers have been taking for granted that it is a well known disease akin to that of cattle, and unsuccessfully trying to cure it by the use of Oxytetracyclines and or Butalex drugs. Therefore, very little efforts have been taken in trying to investigate and analyse the disease situation and its impact on the livelihood and economies of the pastoralists. For example, studies of Bovine cerebral theileriosis in Tanzania, showed that, livestock keepers responded that Ormilo occurred only in cattle, whereas three villages in Loliondo including Samunge where the present study was conducted, reported having seen similar signs in goats while four villages reported the disease in sheep (Bakuname *et al.,* 2002).

Contrary to our present findings, previous post-mortem examination of an infected goat (suspected as an ormilo case) at Samunge revealed hydatid cysts and screwworms in the brain which could lead to clinical signs (as circling) that could be confused with cerebral theileriosis (Bakuname *et al*., 2002)

Although the name "Ormilo" has been used to describe the circling syndrome in cattle, sheep and goats, the present findings have proved that the cause in cattle was different from that in small ruminants. This can be further evidenced by the fact that, during the survey, farmers claimed that, the "Ormilo' for cattle was curable by the use of oxytetracyclines and or Butalex© but attempts to treat sheep and goats failed. Tick control (spraying) that usually gives relief in the control of "ormilo" in cattle has also shown no positive results towards the control of the same (ormilo) in sheep and goats.

In the present study it was shown that "ormilo" disease was not found in Engaresero sub-village (located far south of the district close to the active volcanic mount Lengai). In this village people have not experienced an "ormilo" case in their sheep and goats herds unless a sheep or goat was bought from nearby villages (Monik in Pinyiny and Malambo) or Leparkash sub-village; the only affected area in the village which was not visited. The soils and water in this area have high contents of soda (magadi) where some areas during dry season forms thick soda ash rocks and could partly interfere with the fertility of cestode eggs that are picked by sheep and goats from the environment.

Coenurosis is a disease condition of sheep and goats, it is spread by dogs and jackals that become infected by ingesting raw offals (brain) of dead animal containing cystic (larval) form of the worm *T. multiceps*. The cysts develop into adult stages within the definitive host (dogs and/or jackals). When the segments containing the eggs become ripe, they break off and pass into the environment with faeces. Sheep or goats ingest eggs while grazing and develop the disease (Scala and Varcasia, 2006). Normally the communities in

Ngorongoro district do not eat brain tissues as it is considered aesthetic and the brain tissues are directly fed to dogs and or sometimes cats; in which dogs are definitive hosts for *T. multiceps*. This can now explain as to why the problem of "Ormilo" is becoming a big thereat in the study area following the habit of feeding dogs, which are definitive hosts, with raw brain tissues containing cysts leading to continuous shading of infective eggs.

In general, the results from the present study show that all age groups above six months (both sheep and goats) were equally susceptible. However, there are claims that the prevalence is slightly higher in young and middle age groups than the mature adults. The reason attributed to this speculation can be associated with the duration from the time when young stock starts to graze around nearby boma pastures which are more contaminated with dog faeces probably containing infective *T.multiceps* eggs than the far away field pastures. After ingestion the eggs hatch into larva *Coenuruscerebralis* which arrives in the central nervous system as blood-borne onchosphere, and takes seven to eight months to reach maturity, when it may measure up to 5 cm. in diameter (Williams, 1980). Basing on this duration of the incubation period, it is obvious that the young stock will have more chances of picking infective eggs than adults and later will develop disease clinical signs. Although during the survey it was also noted that both species (sheep and goats) were equally susceptible, the results have shown that, there is a slight difference between the two; sheep being more vulnerable. However, there are claims that initially the differences between goat and sheep susceptibility was obvious and clearly observed and that goat susceptibility is gradually scaling up when compared to that of sheep. These claims need a detailed scientific study for justification.

In Ngorongoro district domestic and wildlife animals shares the same grazing areas. There is also a possibility that there is sylivatic transmission between jackals and small wildlife ruminants. Infected jackals may also become a source of infection to domestic small ruminants. Coenurosis may also occur in humans (Michael *et al.*,

1998) and could be among the important zoonotic disease in this area if control measures are not carried out soon. Domestic dogs are also important primary host for other zoonotic cestode diseases such as hydatiodosis and dipylidiosis as well as definitive host for other cestodes that infect domestic ruminants such *as Taeniaovis and Taeniahydatigena* (Soulsby, 1982). Since wildlife ruminant may be infected with some of similar cestodes that infects domestic ruminants and since jackals and other wildlife canids can be infects with dog cestodes and since both wildlife and domestic animals share the same grazing areas, the present findings suggest that small wildlife ruminants are also at risks. Recent studies have also shown that *Spirometra* cestode species that causes spargnosis in humans and was known to be transmitted from lions and hyena to wildlife ruminants including warthogs can also be transmitted by dogs that reside near Tarangire National park (Müller-Graf *et al.,* 1995; Makale, 2013).

Based on the present findings it is clear that, the cause of a nervous disorders syndrome in sheep and goats in Ngorongoro is due to *coenurosis*a disease caused by larval forms of *T. multiceps*. Despommier *et al.* (1994), suggest that sheep are primary intermediate host while the rest act as secondary intermediate hosts. However, in the present study it was shown that, the susceptibility differences between sheep and goats to *T. multiceps* infections were insignificant. Studies have shown that *T. multiceps* has several strains, a wide host spectra and ability to localize in a wide range of intermediate host tissues (Esch and Self, 1965). In sheep *T. multiceps* larvae *Coenuruscerebralis* develops mainly when they reach the brain and spinal cord while in goats it can develop in other tissues such as sub-cutenous and intramuscular (Soulsby, 1982; Shivapraksh *et al.*, 2009). The predilection of the metacestode in the animal tissue depends entirely on the species of the animal rather than the parasite. In the present study only brains of the animals were examined. Further studies are needed to establish the host-parasite relationship between *T. multiceps* larvae in goats and sheep in Ngorongoro to determine other predilection sites. The morbidity of

coenurosis ('ormilo') infection in sheep and goats, its mortality rate and associated economic loss, is at present alarming and is becoming a threat to livestock productivity and could undermine the livelihoods of pastoral community in Ngorongoro district. Therefore there is need for an immediate intervention. It is important to control this disease since coenuruses is among the cause of mortalities of small ruminantin Tanzania even in the neighbouring Mozambique (Alfonso *et al.,* 2011).

Studies have shown that several anthelimintics such as praziquantel, albendazole and fenbendazole are effective against coenurosis in small ruminants (Ghazhaei, 2005). Given the present status of the disease in the area and the type of animal husbandry which is mainly pastoral, regular de-worming could be a method of choice. Other anthelimintics such as oxyfendazole that has of recent been observed as a drug of choice against porcine cyticercosis may be tried too (Pondja *et al*., 2012.). Development of *T. multiceps* synthetic peptide vaccine akin to that of *Taeniasolium* that has proved to be highly efficacious and can reduce tissue cysticerci by 98.7% (Huerta *et al.,* 2001; Lightowlers, 2013) could also be a good control option. Recently in Cameroon it has also been shown that tissue cyticerci in pigs can be controlled by a combination of single dose of oxfendazole and glycosylated TSOL18 vaccine (Assana *et al.,* 2010).

Therefore, at present there are prospects of controlling coenurosis in small ruminants through combination of chemotherapy and vaccine however this is yet to be carried out and venturing production of recombinant *Coenurus cerebralis* vaccine is wanting.The study therefore, provide highlights on the magnitude of small ruminants health problems caused by *Coenuru scerebralis* (larvae of tape worm – *Taenia multiceps)* and validate the need for further research on this parasite aiming at developing appropriate control measures.

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