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Using local language syndromic terminology in participatory epidemiology: Lessons for One Health practitioners among the Maasai of Ngorongoro, Tanzania

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Abstract

Pastoralists and agro-pastoralists often occupy remote and hostile environments, which lack infrastructure and capacity in human and veterinary healthcare and disease surveillance systems. Participatory epidemiology (PE) and Participatory Disease Surveillance (PDS) are particularly useful in situations of resource scarcity, where conventional diagnostics and surveillance data of disease prevalence may be intermittent or limited. Livestock keepers, when participating in PE studies about health issues, commonly use their local language terms, which are often syndromic and descriptive in nature. Practitioners of PE recommend confirmation of their findings with triangulation including biomedical diagnostic techniques. However, the latter is not practiced in all studies, usually due to time, financial or logistical constraints. A cross sectional study was undertaken with the Maasai of Ngorongoro District, Tanzania. It aimed to identify the terms used to describe the infectious diseases of livestock and humans with the greatest perceived impact on livelihoods. Furthermore, it aimed to characterise the usefulness and limitations of relying on local terminology when conducting PE studies in which diagnoses were not confirmed. Semi-structured interviews were held with 23 small groups, totalling 117 community members within five villages across the district. In addition, informal discussions and field observations were conducted with village elders, district veterinary and medical officers, meat inspectors and livestock field officers. For human conditions including zoonoses, several biomedical terms are now part of the common language. Conversely, livestock conditions are described using local Maasai terms, usually associated with the signs observed by the livestock keeper. Several of these descriptive, syndromic terms are used inconsistently and showed temporal and spatial variations. This study highlights the complexity and ambiguity which may exist in local terminology when used in PE studies. It emphases the need for further analysis of such findings, including laboratory diagnosis where possible to improve specificity before incorporating them into PDS or disease control interventions.

Keywords:

Participatory epidemiology; local terminology; syndromic; biomedical diagnoses; Maasai

Introduction

The pastoralist Maasai of East Africa traditionally inhabit large areas of savannah and semi-arid to arid rangelands, which are considered unsuitable for other forms of agriculture. As a result, these regions lack investment for development and infrastructure. They have limited or no capacity in terms of government funded public or veterinary healthcare and disease surveillance systems (Lawson et al., 2014, Swai and Masaaza, 2012). This is despite the Maasai pastoralists' obvious need, given their dependence on livestock for nutritional and financial needs (Swai and Neselle, 2010) and the evidence of their food insecurity and poor children's health (Lawson et al., 2014).

Pastoralists have built up a well-established knowledge of livestock health, diseases and treatments to support their livestock dependent lifestyle. This knowledge base is referred to by several names in the literature; it is broadly referred to as local, cultural, traditional or indigenous knowledge (Wako et al., 2016) or more specifically ethnoveterinary knowledge (Catley et al., 2012, Moritz et al., 2013, Jacob et al., 2004) or existing veterinary knowledge (Etter et al., 2006, Jost et al., 2007). Maasai mostly use terms in their own language (Maa) for livestock conditions. These local terms of diagnoses are commonly descriptive and often relate to syndromes rather than specific diseases. The terms are often linked to the recognition of the signs of disease in the live animal or carcase, presence of vectors, species and age of the affected animal and location or seasonality of outbreaks. Their understanding of risk factors for both human and livestock conditions is often based on their existing knowledge of conditions with similar symptoms or signs, their historic knowledge, customs and beliefs, and the advice given by local veterinary and health professionals (Ole-Miaron, 2003).

Participatory epidemiology (PE) is increasing recognised and accepted as a useful research tool, including in situations of resource scarcity, where conventional biomedical diagnosis may be intermittent or limited. It is defined as "the systematic use of participatory approaches and methods to improve understanding of diseases and options for animal disease control" (Catley et al., 2012). It developed out of Participatory Rural Appraisal in the late 1990's, with veterinarians using

participatory methods to investigate livestock diseases. In several studies among pastoralists, PE has been used to identify and rank important livestock diseases and to estimate the incidence thereof (Byaruhanga et al., 2015, Catley et al., 2004, Catley et al., 2001, Jost et al., 2010, Mariner and Roeder, 2003). Methods used in PE fall into three main groups: informal interviews, ranking and scoring, and visualisation or observations (Catley et al., 2012). However, findings must be cross checked or triangulated using several PE tools to strengthen the results (Catley, 2005). Triangulation should include, where possible, confirming the diagnosis through biomedical or "conventional veterinary" diagnostic methods (Mariner and Paskin, 2000, Catley, 2005, Catley et al., 2012, Toribio and Rushton, 2012, Jost et al., 2007).

However, in certain studies (Bedelian et al., 2007, Bett et al., 2009, Elelu et al., 2016, Shirima et al., 2003, Swai and Neselle, 2010) the confirmation of PE findings by biomedical diagnosis was not possible for various reasons (often time or logistical constraints). The local syndromic terms of ethnodiagnoses were linked to biomedical disease names, without confirming their accuracy with biomedical diagnostic methods. Instead, these studies rely on the PE techniques of proportional piling, matrix scoring for clinical signs and risk factors and seasonal calendars (Catley, 2005). These in turn however, depend on the level of expertise in existing veterinary knowledge of the participants, their description of symptoms or signs associated with syndromic diagnoses and the interpretation of these findings by local biomedical veterinarians and the researchers themselves.

The aim of this study was to characterise the usefulness and limitations of relying on the local language syndromic terminology of the Maasai of Ngorongoro in PE studies, which are unable to confirm diagnoses using biomedical methods. The objectives were to 1) identify the terminology used by the Maasai to describe the livestock and zoonotic infectious diseases of greatest perceived impact on their livelihoods; 2) identify the perceived risk factors for the main diseases within each group to further understand the terminology used; and 3) assess the value of utilising the syndromic terms from Maasai diagnoses in PE.

Materials and methods

Study context, area and date

A cross sectional study was undertaken among Maasai livestock keepers using semi-structured group interviews, field observations and key informant interviews and discussions. This study formed part of a larger, four-year project by the Southern African Centre for Infectious Disease Surveillance (SACIDS), funded by the International Development Research Centre in Canada. The larger project is focused on developing community based interventions to control human and animal infectious diseases which impact on pastoralists' livelihoods.

The study area was the Ngorongoro District (Northern Tanzania), which lies to the East of the Serengeti National Park (SNP). It is made up by three divisions, Loliondo and Sale in the North and the Ngorongoro Division or Ngorongoro Conservation Area (NCA) in the South. (Figure 1).

The NCA is a multiple land use area for conservation, tourism and limited settlement and is controlled by the Ngorongoro Conservation Area Authority (NCAA). The Game Controlled Area of Loliondo lies to the North-East of the Serengeti and includes the whole of the Loliondo Division and approximately half of the Sale Division. Settlement, cultivation and hunting by government lease is permitted here. In contrast, NCA residents are prohibited from cultivation and traditional pasture management (e.g. burning) and have restricted access to certain areas (Århem, 1985, Homewood et al., 2012). Many NCA Maasai are therefore primarily dependant on livestock for their livelihoods making them especially vulnerable to the impact of rising livestock diseases and droughts (Chengula et al., 2013). Maasai outside the NCA are increasingly reliant on cultivation (McCabe et al., 2010, Niboye, 2010) and follow a more sedentary and agro-pastoralist lifestyle where the environmental

conditions permit. Others, living in areas not ecologically or economically suited to cultivation, retain the traditional pastoralist way of life.

This study was conducted in May and June 2014 after the "long rainy season" (April–May).

Village selection

The method for village selection used the Outcome Mapping approach (Earl et al., 2001). Outcome Mapping recognises the significance of behavioural change in key individuals in achieving project goals. Therefore, researchers identified individuals who would be essential in facilitating and influencing the larger project's outcomes. These included members of the NCAA, District Veterinary and Medical Officers, Ngorongoro Pastoralist Council and village chairpersons and elders. After a project briefing, these partners assisted in the initial selection of villages[1] based on the larger project aims. The final selection (Table 1 and Figure 2), was made by purposive sampling and aimed to represent the different environments (highland and lowland) and production systems across the district. Production systems consisted of pastoralists within the NCA (i.e. no cultivation allowed), pastoralists by choice (outside the NCA but choosing not to cultivate) and agro-pastoralists by choice (outside the NCA).

Data collection

Data was collected by two researchers (Authors 1 and 2), assisted by two interpreters. A local Maasai elder was identified as a key informant and interpreter by the village chairperson at Endulen village, NCA. The elder also participated in an in-depth trial interview and a discussion of Maasai

[1] Villages in Ngorongoro are not natural, traditional settlements but originated as a result of relocation of Maasai residents from the Serengeti, when it was declared a national park in 1951. In addition, the government in 1974/5, attempted to congregate pastoralists in permanent homes around pre-existing trading centres, whilst providing basic social services centres such as primary schools and dispensaries. The locations below refer to these "village" centres, although the settlements relating to these cover a wide area forming intra-divisional wards.

culture and regional socio-political issues. An additional interpreter was recruited and guided through the interview questions beforehand. Each researcher used the same interpreter for the duration of the study.

The project was introduced and discussed at each village with village officials. They assisted in selecting livestock keepers to take part in small group semi-structured interviews. Verbal consent to participate and for voice recording was acquired. Interviews were conducted in either the local Maasai language (Maa) or Kiswahili, the Tanzanian national language. Male and female groups were interviewed separately. Open-ended questions and further probing questions were asked through the interpreter. Each researcher conducted approximately half the interviews within each village independently.

Questions included asking participants to list the most common livestock diseases or health problems which had the greatest impact on livelihoods in the last 12 months or more. Responses were discussed and probed in more detail to include questions on common clinical signs and the livestock groups affected. Furthermore, they were asked to give the perceived risk factors for the highest impact conditions. The above process was repeated for zoonotic diseases. Although there is no direct translation for “zoonoses” in Maa, interviewees were asked about diseases they could get from any livestock group, dogs or wildlife.

In addition, observations were undertaken outside of the selected villages e.g. at market days in Endulen (NCA), and Piyaya (en route to Loliondo) and Malambo (Sale). These included taking part in a livestock sale negotiation, sharing lunch with local villagers and witnessing slaughter and meat inspections. Informal discussions also took place, with a district veterinary officer, a livestock field officer and a veterinary meat inspector, in an attempt to understand their interpretation of the local diagnostic terms. In addition, District Medical officers were interviewed at Wasso (Loliondo) and Endulen (NCA) hospitals.

Triangulation was used to enhance and verify findings by gathering data from multiple sources. These included a literature review for similar studies in the area, duplicating interviews using two researchers at each site, separating group interviews by gender, comparing group interview results with those from the multiple key informants and by making personal observations at markets and meat inspections.

Data analysis

Qualitative data

Individual interview participants' answers were directly translated verbally by the interpreters and written notes were made by the researchers. Answers from individual group participants were noted separately, whilst group consensus was used to list the diseases or syndromes of greatest impact. Voice recordings were used to review notes at the end of each day and during later analysis. Descriptive results from discussions were thematically colour coded by hand and summarised to represent the most common trends.

Quantitative data

A list of syndrome or disease names mentioned in each small group semi-structured interview was created. This list was entered in Microsoft Excel software together with the results from each group discussion. The results were analysed to generate a frequency table of the number (and percentage) of groups who mentioned each syndrome or disease as impacting on their livelihood. Graphs were generated from this data analysis within Microsoft Excel.

Ethics

Ethical clearance was obtained from the National Institute for Medical Research (NIMR/HQ/R.8a/Vol.IX/1649), the Tanzanian Wildlife Research Institute (2013-328-NA-2013-153) and the Royal Veterinary College (M2013 0006).

Results

Participants

A total of 117 people took part in 23 group interviews, consisting of 12 male and 11 female groups. Group sizes depended on availability of willing participants. Mean group size was five participants with a range of three to seven.

Livestock and zoonotic diseases

Livestock conditions were reported using local Maa terms, which were primarily syndromic or descriptive. Zoonoses included a combination of Maa syndromic terms and more specific disease names. Several biomedical terms, as used by clinic and hospital staff, were part of the common local language. These included brucellosis, rabies and TB (tuberculosis in humans). Some interviewees in Enguserosambu and Osinoni used "*nang'ida eton*" for human brucellosis which was translated as "comfortable whilst sitting", implying discomfort when active or standing.

Figure 3 lists the livestock and Figure 4 lists the zoonotic syndromes and conditions, showing the percentage (and number) of the 23 groups which reported them as impacting on their livelihoods.

Livestock syndromes

Ormilo was used to describe a neurological syndrome with signs ranging from "dizziness to madness". In this study participants referred to ormilo primarily as a condition in both sheep and goats. Local veterinarians[2], when interviewed, stated that this syndrome was associated with coenurosis, the metacestode stage of the canine tapeworm, *Taenia multiceps*. Confirmation of this has been subsequently published by Miran et al. (2015). However, the term *ormilo* has previously

[2] Biomedically qualified veterinarians working locally, including some of Maasai origin

been used for the tick borne diseases of heartwater (in all ruminant livestock) (Bedelian et al., 2007) and cerebral theileriosis in cattle (Cleaveland et al., 2001). Most groups recognised signs of "water under pressure" in the cranium and fluid-filled, speckled brain cysts at slaughter. These were also witnessed by the research team during meat inspections. It impacted on livelihoods because it was reported to affect large numbers of animals with a 100% case fatality rate. Participants report that it caused a loss of body condition affecting sale price and slaughter yields. Perceived risk factors included ticks, long grasses and the rainy season. Many participants said they used acaricide dipping for prevention and treated affected cases with injections of oxytetracycline (OTC) and buparvaquone (Butalex™) but they reported little response, which added to financial losses. Only a few individual in some groups had learnt from local veterinarians to associate this syndrome with a dog tapeworm.

N'digana (also *oltikana*) was used to describe a syndrome affecting cattle, with signs of enlarged lymph nodes in the cervical area and submandibular oedema. Its impact was perceived as significant because it affected cattle (of greater value than small ruminants), and it caused high mortality in calves. When local veterinarians were questioned, they attributed these signs to East coast fever (ECF), caused by *Theileria parva*, transmitted by the tick *Rhipicephalus appendiculatus*. Perceived risk factors mentioned by interviewees included ticks, the rainy season and tall grasses, the latter being associated with hillsides and highlands. Acaricide dipping was reported to be used as a prevention measure, whilst treatments used included injections of OTC and buparvaquone. Vaccination through veterinarians was reported to be often unavailable and was considered expensive.

Orkipei was used to describe a respiratory syndrome in both cattle and small ruminants, associated with laboured breathing, coughing and nasal discharge. It impacted on livelihoods because it was reported to be highly contagious and affected all ages. Local veterinarians, when questioned, linked this syndrome with contagious bovine and contagious caprine pleuropneumonia (CBPP and CCPP), although the syndrome was reported by livestock keepers in sheep as well, suggesting a more complex aetiology. Participants reported the perceived risks to be droughts (which caused higher

concentration of animals at water points), dust and increased water salinity. Common treatments mentioned included the confinement of affected animals and injections of OTC and tylosine. Vaccine availability was reported as inconsistent.

Oloirobi was used to describe both a livestock and zoonotic syndrome. Affected livestock show mouth sores and lesions on feet causing lameness. Local veterinarians, when questioned, linked the term in livestock with foot and mouth disease (FMD). *Oloirobi* in livestock was reported to have high morbidity.

Iingati was used to describe a syndrome in cattle, associated with the presence of wildebeest and characterised by signs of "eye disease", mucous from the nose and mouth and high mortality. The term was translated to mean "of wildebeest" and local veterinarians, when questioned, associated the term with malignant catarrhal fever (MCF). It impacted on livelihoods due to its high case fatality rate and because forced slaughter or sale of affected animals was the only option. Sharing water and pastures with wildebeest was reportedly often unavoidable, especially in periods of scarcity and drought.

Engirowaj was used to describe an acutely fatal syndrome that occurred in sporadic outbreaks in both cattle and small ruminants. Local veterinarians, when questioned, linked the term with anthrax, although it was reported to not always be associated with haemorrhagic exudates from mouth, nose and anus. It was listed by lowland groups only. Small ruminants were reported to be more susceptible than cattle. It impacted on livelihoods because of its acuteness, high case fatality rate and zoonotic potential. It also resulted in the restricted use of pastures and water points where animals had died. Interviewees were aware of the risks from wildlife carcases too.

Olodwa was reported to mean "bitterness", indicating the devastation it caused, or "poison" indicating its high case fatality rate. Groups in Enguserosambu and Malambo used *olodwa* and ***olomorooj*** interchangeably. Signs of disease reported with this syndrome included lethargy and lost appetite, swollen eyes, facial skin sores and diarrhoea leading to death within 3-7 days. A swollen

head and black intestines were reportedly seen in the carcases of affected animals. Groups in Olbalbal referred to this syndrome coming from wildlife some 30 years ago. Local veterinarians reported that this term had been used for rinderpest in previous outbreaks but was now used in suspected cases of peste des petits ruminants (PPR).

Lipis was reported to be a term from Kenyan Maasai which means "a disease that kills", sometimes referred to as a "second *olodwa"*. Local veterinarians, when questioned, understood this term to refer to acute anaplasmosis, recognised by yellow meat and generalised jaundice in affected carcases. ***Emonua*** means enlarged liver and was reported by veterinarians to refer to a more chronic form of the syndrome.

The following terms are also listed in Table 2 but due to their apparent lower incidence, further discussion of these were not undertaken. Local veterinarians provided their opinions of associated diseases with these terms as follows: ***Emburuo:*** associated with black quarter caused by *Clostridium chauvoei*, but often used interchangeably with anthrax. ***Olomorony:*** a skin condition usually referring to lumpy skin disease or pox. ***Olkurto:*** helminth infestation. ***N'dorobo:*** African animal trypanosomiasis.

Zoonotic conditions and syndromes

Brucellosis was perceived as a "more recent condition" occurring over the past eight years. In the Endulen (NCA) hospital report for 2012/2013, it was ranked as the fifth most common diagnosis (malaria ranked third) in over five year olds. In the Wasso (Loliondo) hospital report of 2008 it was not listed in their "top ten" diagnoses. It was however, not possible to establish when biomedical diagnostic capacity was introduced to the district, which may have coincided with the apparent rising incidence. It impacted on livelihoods because it was perceived as common, affecting adults and children, and because the diagnosis and treatment required travelling to the hospital, which incurred additional costs. It involved 14 daily injections before returning home with oral medication. Pain affected adults' ability to work and children could not walk to school. Interviewees reported

that medical staff informed them of the risks from consumption of undercooked meat, un-boiled milk and uncooked blood. Participants were questioned why they had not mentioned brucellosis in livestock as a condition of significant impact. They replied that they had no way of identifying which animals were infected or posed a risk to themselves. They were also unaware of the risk of exposure from assisting with livestock dystocia and handling foetal membranes.

Emboroto was reported to be the term for anthrax in humans, both the cutaneous and intestinal forms. Ingestion of meat from carcases was recognised to potentially cause acute death and children were most susceptible. Handling carcases, skins or pelts and even skeletons were considered risk factors. Treatment was reported to be available at local dispensaries for mild cases or the cutaneous form. Groups in Malambo and Osinoni said, because of food scarcity, they would risk eating meat from suspect carcases, knowing they could get treated at the dispensary should they fall ill.

Oloirobi was a term used for humans with symptoms of flu-like fever, headaches, and signs of coughing and mouth ulcers. Risk factors reported for this perceived zoonotic condition included drinking un-boiled milk from a cow with *oloirobi* or handling or sharing a confined environment with an animal with *oloirobi*. *Oloirobi* in humans was a local diagnosis, made in the home as it was not severe enough to warrant investigation or diagnosis at a clinic.

Rabies was also referred to as *oloirirwa lo oldie* or “dog disease” or *ormilo* of dogs. Its impact was important due to its case fatality rate. All villages had reportedly benefitted from dog vaccination programs in the past, including within the last 12-24 months (except Osinoni and Olbalbal), and human cases were now apparently rare. In Osinoni and Olbalbal participants could recall recent human cases of rabies, including a current case in the clinic at Olbalbal. Dog bites were identified as the main risk for humans and livestock.

TB was the term used broadly for tuberculosis. Although it was recognised as a disease of humans and animals and one which could spread between them, there was no obvious understanding or reference to *Mycobacterium tuberculosis,* typically human to human transmission, and zoonotic

Mycobacterium bovis infection, typically cattle to human. *TB* was perceived to mostly affect adults and the elderly and it was reported that prolonged treatment was required. Endulen Hospital's 2012/2013 case report, classified Tuberculosis (TB) cases as 57% Pulmonary TB and 43% extra-pulmonary TB (EPTB). Risk factors of old age, close living and sleeping conditions, sharing utensils, poor ventilation, dust, smoking and alcohol were reported. Risk of transmission from cattle via consumption of un-boiled milk and undercooked meat was mentioned by most groups.

Emburuo was listed by some groups as a zoonosis in humans. When local vets were questioned, they associated with black quarter in livestock and, as mentioned in the livestock syndromes, it was also used for anthrax.

Discussion

Practitioners of PE recognise the value of livestock keepers' local veterinary knowledge and their active participation in investigating animal health problems. However, several reports compare accuracy of Maasai and biomedical or "Western medicine" practitioners and give mixed opinions thereof. Ole-Miaron (2003) claimed that the accuracy of a Maasai livestock keeper's "ethnoveterinary diagnostic ability" was comparable with, what the author calls, "a modern veterinarian". Studies by Catley et al. (2004) and Cleaveland et al. (2001) confirmed a high degree of accuracy of Maasai diagnoses when compared to biomedical diagnostics for foot and mouth disease (FMD) and malignant catarrhal fever (MCF) respectively. On the other hand, Jost et al. (2010) found the traditional knowledge of livestock diseases of Maasai pastoralists of Northern Tanzania was less than that of Somali pastoralists. The authors considered the increasing dependence of Maasai on ecotourism and cultivation rather than purely livestock for livelihoods and greater access to animal health services and conventional medicines as reasons for their decreasing reliance on existing traditional knowledge.

It was not within this study's capacity to use laboratory tests to confirm the likely aetiology of the syndromes described by livestock keepers. It is also not within the scope of this paper to argue the accuracy of one medical system against another. Indeed, Western or biomedicine is arguably just another cultural system of medicine or ethnomedicine, i.e. rooted in a particular cultural and historical context (Pool and Geissler, 2005). Participatory epidemiology calls for use of biomedical diagnostic techniques, not to discredit but to improve the specificity of local syndromic diagnoses.

Participatory epidemiological studies in remote, resource poor or conflict areas are sometimes limited in their ability to use biomedical diagnostic methods to confirm participatory findings (Catley et al., 2012). In such studies, local terminology for syndromes and diseases are sometimes linked to biomedical disease names, albeit through probing and discussions with key informants such as local veterinarians and through using additional PE techniques (Bedelian et al., 2007, Bett et al., 2009, Elelu et al., 2016, Shirima et al., 2003, Swai and Neselle, 2010). This study explored and identified the challenges in this context, of understanding the local names of syndromes used by Maasai livestock keepers in Ngorongoro.

Previous studies had already identified variations and overlaps in use of terminology for livestock syndromes amongst Maasai, specifically *ormilo* for heartwater and cerebral theileriosis, *olodwa* for rinderpest and anaplasmosis, and *emburuo* for anthrax and black quarter (Bedelian et al., 2007, Cleaveland et al., 2001). In this cross sectional study, observations and semi-structured group interviews (with open ended questions and probing) and key informant interviews and discussions were used to identify the terminology in the ethnodiagnoses of common livestock and zoonotic diseases. This research found ongoing temporal and spatial variations in livestock syndromic terminology.

The Maasai participants were not consistent in their use of the Maa terminology to describe syndromes. The Maasai of the Ngorongoro District are widely distributed and form different clans of close knit communities. They are often self-reliant for livestock diagnoses and therapies; perhaps the

reason for the variation within the study area of some livestock syndromic terms and the understanding of aetiology and risk factors. In contrast, the more serious human conditions, including zoonoses were more likely to be diagnosed at the few local hospitals, where medical staff used the terminology for the biomedical diagnosis and supplied information on risk factors.

Local language syndromic terms are defined using local traditional and cultural concepts, which may include many criteria outside of scope of those used in biomedical diagnoses. Biomedical practitioners should therefore take the time to tease out and understand these terms in the local cultural context and look for areas of commonality. The livestock syndromic terms sometimes relate to the signs of disease or the organ system affected, such as *ormilo* (neurological) or *oloirobi* (respiratory), or they may be more descriptive like *olodwa*, previously used to indicate the devastation caused by rinderpest. However, their historic use and meaning may not be accurately translated for their current use. For example, the current use of *olodwa* for suspected PPR is likely to relate to the similarity of the signs of disease with rinderpest, rather than the devastation of rinderpest's high mortality. Although PPR has been reported in Northern Tanzania since 2007, it is now seemingly endemic with lower mortality rates. The use of *ormilo* remains consistent with neurological signs, however the aetiology has varied over time from heartwater (Bedelian et al., 2007) to bovine cerebral theileriosis (Catalano et al., 2015, Cleaveland et al., 2001) to most recently, coenurosis in small ruminants (Miran et al., 2015).

A single syndromic term may relate to complex mixed infections (Catley et al., 2001). Attempting to link a syndromic term with a single disease fails to recognise complex co-infections or poly-microbial disease which may present with common symptoms and clinical signs within the same patient. Individuals, both human and livestock, may be infected by more than one pathogen, but when given a single term, it may misrepresent the complexity of the aetiology. Equally, co-infections causing complex syndromes with multiple symptoms and clinical signs are difficult to identify using a single

syndromic term. Such syndromes present diagnostic challenges to practitioners working in areas of poor infrastructure and limited laboratory capacity.

Diseases may affect several organ systems at the same time or several different systems as the disease progresses. Therefore, a different term may be used for the same disease dependant on the presenting signs at the time it is recognised. Some diseases may have non-specific symptoms and signs such as chronic wasting and may not be recognised at all (Catley et al., 2001). For example, Brucellosis was listed as a human condition in this study but was not recognised in livestock. Abortion in livestock is a non-specific sign, whilst the more chronic effects of brucellosis, such as reduced fertility and milk production, are even less likely to be recognised, yet the disease would have a significant impact on livelihoods over time.

This study has identified the spatial and temporal variations, and the sometimes lack of specificity of these syndromic terms in Maasai diagnoses. In such cases, further steps must be taken to clarify what is meant by these local terms. Triangulation methods used in PE, such as matrix scoring and proportional piling (Catley, 2005, Reeves et al., 2008), help to strengthen these associations and narrow the differentials. In situations where complexity and ambiguity of terminology persists, confirmation of diagnoses with biomedical testing is recommended before developing and implementing recommendations for disease control based on participatory research findings. However, this decision will be based on a number of factors including the availability and costs of biomedical tests, the impact of misinterpretation and the objectives of the research project, surveillance system or intervention.

Conclusions

Participatory epidemiology and its use of livestock keepers' existing veterinary knowledge is a valuable tool to prioritise diseases. Findings from PE can provide the foundation for participatory disease surveillance (PDS), which may be the only option in resource poor settings. Syndromic reporting by livestock keepers in PDS may lack specificity but it is usually sensitive and prompt. It is

well documented that findings from PE studies must be strengthened through triangulation and biomedical diagnostic methods. However, situations may arise where the latter is not possible or is not undertaken. The PE techniques of informal interviews, ranking and scoring, proportional piling and visualisation or observations allow practitioners to unpack the detail of syndromic terms and tighten case definitions. This can be used to produce differential diagnoses and prioritise attempts to validate findings with biomedical diagnostics, but should not be attached to a biomedical diagnosis without such validation. This study has shown temporal and spatial variations exist in the syndromic terminology used by Maasai livestock keepers of Ngorongoro, which may also exist in similar pastoralist communities. Attempting to connect syndromic terms to specific diseases using PE techniques or previous research alone or even when supported by the expertise of local veterinarians (which often lacks laboratory confirmation), carries the risk of misinterpretation. Furthermore, and perhaps more critically, it may miss emerging or re-emerging diseases in the region e.g. PPR and coenurosis. This study therefore highlights the complexity and ambiguity which may exist beneath local syndromic terms. It emphasises the need for further unpacking and analysis, including laboratory diagnostics where possible, in an attempt to improve specificity of the findings, before incorporating them into participatory surveillance systems or disease control interventions.

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Conflict of interest

None.

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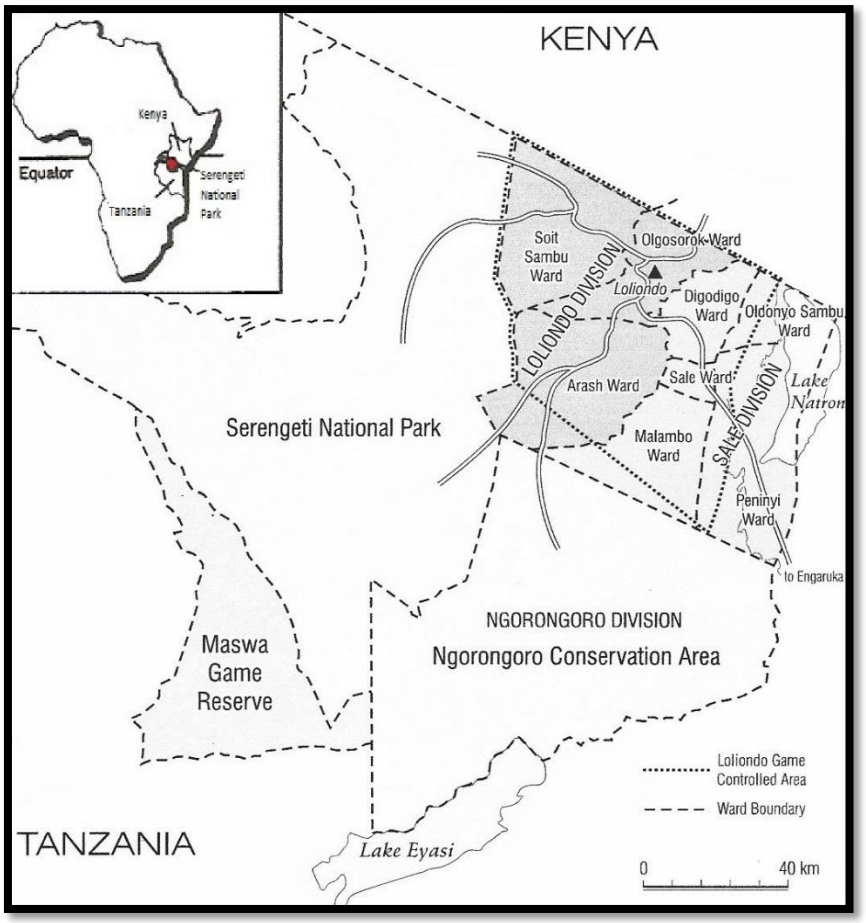
Figure 1: Map showing Serengeti National Park, Ngorongoro Conservation Area, Loliondo and Sale Divisions (Adapted from Ojalammi (2006) and Cleaveland et al. (2001))

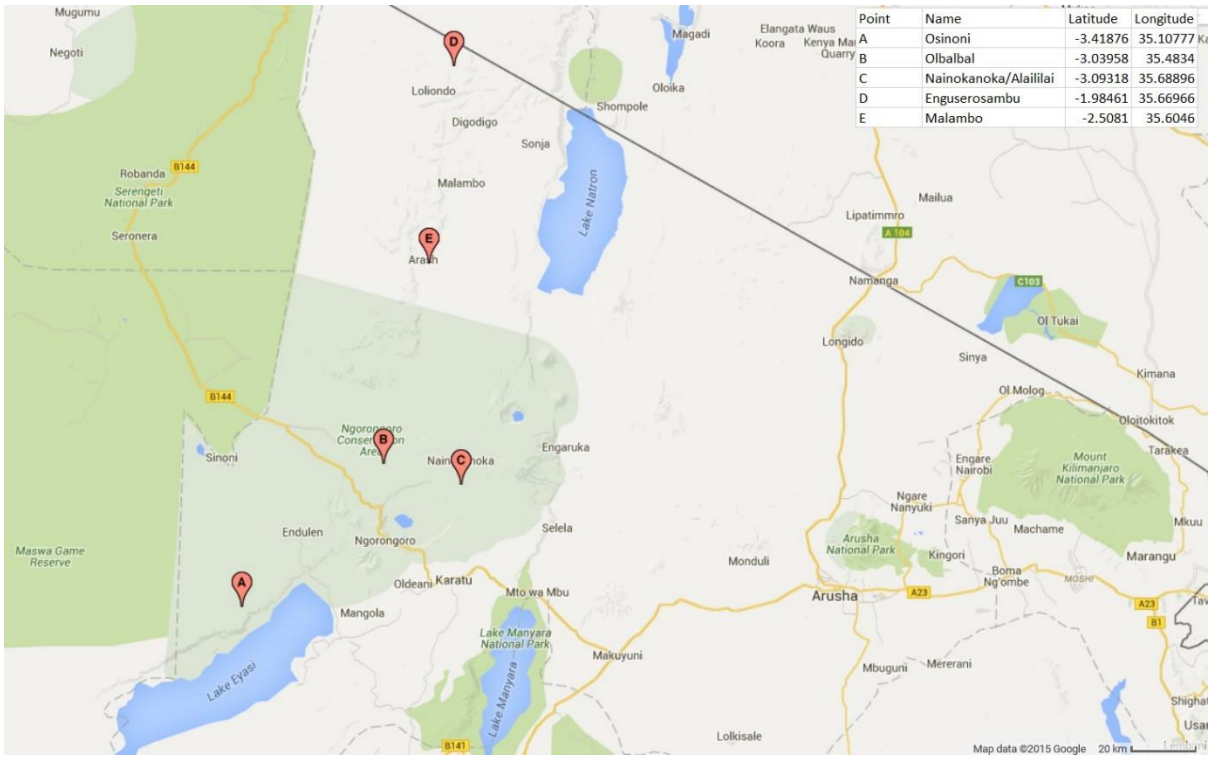
Figure 2: Map of selected village locations

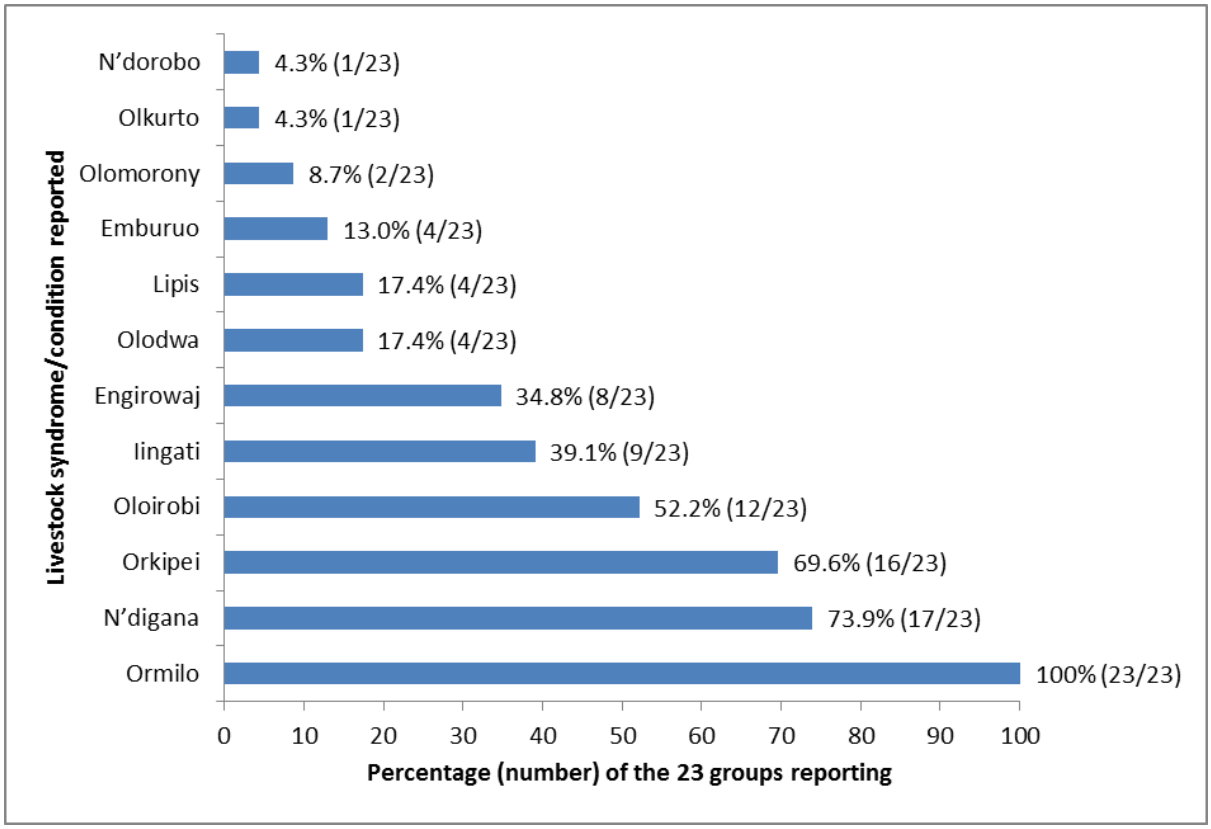
Figure 3: Livestock syndromes, percentage and number of the 23 groups reporting them

Figure 4: Zoonotic syndromes and conditions percentage and number of the 23 groups reporting them

Syndrome terminology, reasons for perceived significance and risk factors







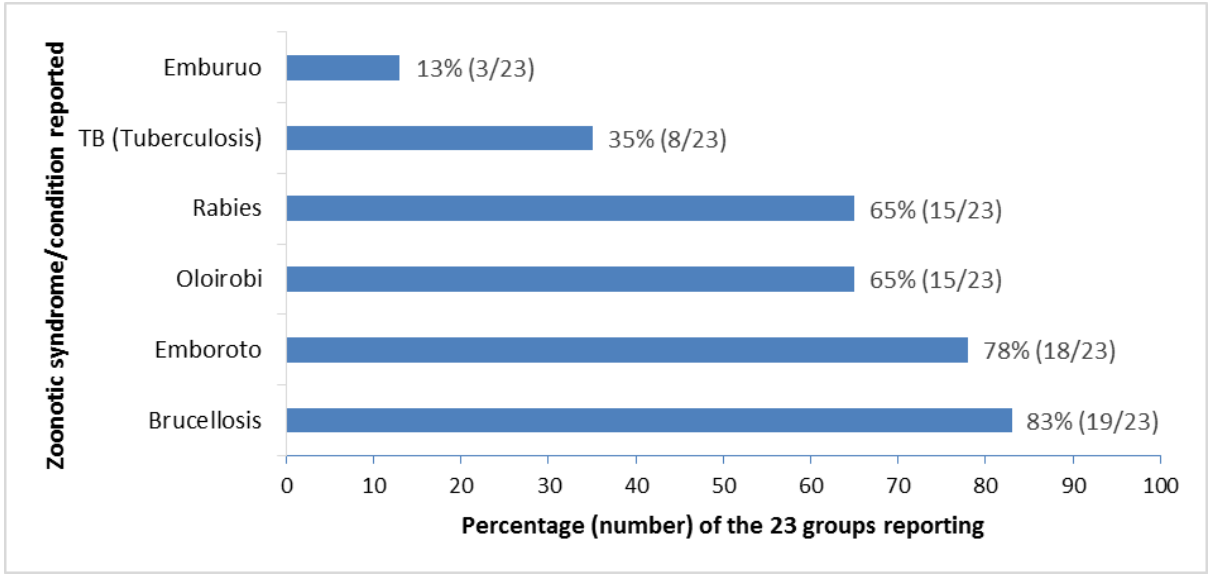


Table 1: Details of villages selected

Division	Village	Latitude	Longitude	Production system	Environment
Ngorongoro	Osinoni	-3.41876	35.10777	Pastoralists	Lowland
	Olbalbal	-3.03958	35.48340	Pastoralists	Lowland
	Nainokanoka/Alaililai	-3.09318	35.68896	Pastoralists	Highland
Sale	Malambo	-2.50810	35.60460	Pastoralists	Lowland
Loliondo	Enguserosambu	-1.98461	35.66966	Agro-pastoralists	Highland