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ORIGINAL RESEARCH

# Economic burden of bovine trypanosomosis in three villages of Metekel zone, Northwest Ethiopia

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**Abstract** The study was carried out to assess the economic burden of trypanosomosis in three villages of the Metekel zone in 2009. The disease was found to cause substantial economic losses through cattle mortality, drug purchase, and draft power loss of infected oxen. The farmers in the area were spending a significantly ($p<0.05$) higher amount of money for the treatment of trypanosomosis than all other diseases combined. The overall mortality rate of cattle due to trypanosomosis was 4.4%. The mortality was significantly higher ($p<0.05$) in an area where trypanosomosis prevalence was also higher. Many of the farmers prioritized losses of draft power as the most important impact of the disease. The overall prevalence of the disease was 12.1%. The disease burden was significantly ($p<0.05$) higher in the rainy season than at other times of the year. In general, farmers had good knowledge on the signs and seasonality of trypanosomosis. Thus, tsetse suppression activities that involve the local community can be an important tool towards minimizing the economic burden of the disease in the area.

**Keywords** Economic burden · Trypanosomosis · Bovine · Metekel zone · Ethiopia

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## Introduction

African trypanosomosis, transmitted mainly by tsetse flies, is prevalent in 37 sub-Saharan African countries which are among the poorest of the world. It has been claimed that trypanosomosis is threatening the wellbeing of cattle and thus the agricultural production more severely than any other livestock disease in the continent (FAO/IFAH 2008). In Africa, a total of US$ 35 million is spent per annum for the treatment of the disease (Geerts and Holmes 1998). Moreover, trypanosomosis-affected animals have lower calving and growth rates, lower milk production, higher rate of calf mortality rate, and have lower ploughing power (Swallow 1999). In susceptible animals, trypanosomosis reduces the calving rate by up to 20%, causes the death of another 20% of young animals, reduces milk offtake by up to 26%, and reduces lambing and kidding rates by 37% (FAO 1998a). In Africa, about 3 million cattle die each year due to trypanosomosis in tsetse-infested areas (PATTEC 2001). All impacts of the disease combined results in an estimated economic loss of US$ 4.5 billion per annum across the continent (DFID 2010). In some cases, the burden of the disease can be so devastating that it becomes difficult to practice livestock production as well as the integrated crop–livestock production system.

In many of east African agro-pastoral communities, animal trypanosomosis/Nagana has become the major constraint for development (Baumgartner et al. 2008). Tsetse flies and trypanosomes are widely distributed in the arable low altitudes of Ethiopia causing a devastating effect on the farming community (Abebe 2005). About 14 million cattle and a comparable number of small ruminants from the Northwest to Southern parts of the country are at risk of contracting the disease (Keno 2005). Metekel zone is found in the main tsetse belt of Ethiopia; however, there have

been few studies conducted on the disease. Particularly no attempt has been made to estimate the economic impact of the disease. Hence, the study at hand was conducted to estimate the economic burden of the disease, to evaluate the perception of farmers about trypanosomosis, and to quantify the seasonal prevalence of trypanosomosis.

## Materials and methods

### Study site

Metekel zone is one of the three zones of Benshangul Gumuz Regional state of Ethiopia. The zone is found 578 km from Addis Ababa in the northwest direction. There are seven districts in the zone covering a total land surface of 25,705 km$^2$. The present study was conducted in two of the seven districts, namely Pawe and Dibate (Fig. 1). The rainfall in the area has a mono-modal pattern extending from May to October with an annual average precipitation of 1,200 mm. Mean minimum and maximum annual temperatures of the area are 23 and 31.1°C, respectively. Pawe has cattle density of 55 heads/km$^2$ while Dibate has 13.3 heads/km$^2$. Pawe and Dibate districts have an average altitude of 1,100 and 1,480 m above sea level (masl), respectively (MZDA 2008). Acacia woodland and bamboo thickets are the main vegetation cover in the area found along the major rivers. The riparian species, *Glossina tachinoides*, is the only tsetse fly species found in the area (Tesfaye 2010; Mekuria and Gadissa 2011).

### Sampling design

After a pre-testing phase, a semi-structured questionnaire was administered to a total of 55 farmers in the three study villages in May 2009. The study attempted to quantify the direct economic impact due to cattle mortality and trypanocidal drug purchase. Moreover, farmers were also allowed to prioritize the effects of trypanosomosis on parameters like milk yield, draft power losses, growth rates, cost of trypanocides, and mortalities. The selected farmers were interviewed in Amharic which is well understood in the area. Farmers were selected through systematic random sampling method using five households as an interval between two points.

Additionally, a total of 1,200 cattle blood samples were collected from the three villages in the four seasons (rainy, late rainy, dry, and late dry) from January 2008 to February 2009. The study districts and the corresponding villages were selected based on occurrence of trypanosomosis and their accessibility. Care was taken to make sure that the study villages were geographically representative to the rest of the villages in the study districts. Zigih was selected from Dibate while village 30/7 and village 28/29 were selected from Pawe district (villages in Pawe district were restructured and given numbers following a resettlement program that was undertaken in 1984). Animals to be tested from the herd of the villages were selected randomly.

### Parasitological examination

The dark ground buffy coat method (Murray et al. 1977) was used to examine the collected blood samples. The marginal ear vein of each sampled animal was pierced with a sterile lancet and the blood to be examined was added to a capillary tube by capillary attraction until the tube was filled three fourths of the way. Each tube was sealed at one end with plasticine and then centrifuged at 13,000 rpm for 4 min. After centrifugation, the capillary tube was cut below the buffy coat to include 1 mm of erythrocytes. The buffy coat was expressed on microscope slides and examined using compound microscope at 400× magnification. Species identification was conducted by using thin smear of the buffy coat with Giemsa staining.

### Statistical analysis

Descriptive statistics, namely means, frequencies, and percentages, were used to compute different parameters of the questionnaire survey using SPSS 11.5 (2001). Poisson regression was employed using Stata 11.0 (StataCorp 2009) to compare the mortality rates of cattle among the three villages where cattle number of the household was used as exposure. Mortality rates were calculated by adding all deaths of cattle that occurred in the households due to trypanosomosis during the last 1 year (only animals which showed the common signs of trypanosomosis before their death were considered in the calculation to quantify trypanosomosis-induced cattle mortality). Linear regression was used to compare the cost of trypanocidal drug purchase among the three sites as well as to compare the cost of treating trypanosomosis and costs of treating all other animal diseases. Logistic regression was employed to study the variations in the apparent prevalence of trypanosomosis among the four sampling seasons. In all the analysis, $p$ value$<0.05$ was considered to have statistically significant difference.

## Results

### Questionnaire survey

#### *Generalities*

The overall average family size in the study area was 6.4± 0.29 (95% CI=5.8–7.0). On average, a household in the


**Fig. 1** Map of Ethiopia and the study districts in Metekel zone

area has 8.4±0.8 cattle (95% CI=6.8–10.1), 2.9±0.7 goat and sheep (95% CI=1.4–4.4), 4.5±0.6 poultry (95% CI= 3.7–5.6), 0.4±0.1 equine (95% CI=0.2–0.6), and 3.4± 0.5 ha of land (95% CI=2.4–4.5). The major source of drinking water for the cattle in the area is river streams. Most of the respondents (96.6%) said they were dependent both on crop and livestock for their income source. On average, a household harvests 3.47±0.37 tons (95% CI= 2.74–4.21) of different crops that grow in the area which mainly includes maize, sorghum, finger millet, soya bean, sesame, and ground nuts. Linear regression made on the total crop harvested as a function of cattle number revealed a strong association between the two parameters ($p<0.05$, correlation coefficient=2.8).

*Farmers' perception of trypanosomosis*

Most of the respondents (98%) said trypanosomosis, which is locally called "Gendi", was the major animal health problem in the area. Moreover, 45.5% of the respondents said that the disease reaches to its peak during the rainy and late rainy seasons in terms of its profound morbidity and mortality effects, whereas some 14.4% and another 10.9% of the farmers claim the disease was mostly prevalent during the late dry and late rainy seasons, respectively.

Furthermore, 36.4% of the respondents said the disease was most severe in draft oxen and lactating cows. Others (23.6%) claimed the disease was equally severe to all groups of animals; 17% of the farmers said it was most severe for draft oxen and 18% of them said lactating cows were suffering most of this disease. Draft power losses due to sickness of oxen was the most important impact of trypanosomosis for 50.9% of the farmers, treatment costs were most important for 30.9% of the farmers, whereas trypanosomosis-induced mortalities and production losses (milk and growth reduction) was the most important for 14.6% and 3.6% of the respondents, respectively. Most frequently reported signs for trypanosomosis by the farmers include rough hair coat, diarrhea, lacrimation of the eyes, constipation, anorexia, emaciation, and coughing in their decreasing order of being mentioned. Out of the farmers, 56.4% did mention the combination of rough hair coat, lacrimation of the eyes, and diarrhea as typical symptoms of trypanosomosis. The combination of emaciation, diarrhea, and rough hair coat was mentioned by 40% of the farmers, whereas 29.1% of them found a combination of anorexia, emaciation, and rough hair coat typical for an outbreak of trypanosomosis.

*Management of trypanosomosis*

Use of trypanocidal drugs was the only way of combating cattle trypanosomosis in the area when the study was conducted. Most of the respondents (63.3%) said they buy the drugs from private veterinary pharmacies. None of the respondents use traditional medicine for treating the disease. Farmers in Zigih and village 28/29 had no

veterinary service in their village. Most farmers (61.9%) walk 1 h or more to reach a nearby veterinary clinic. In general, sick animals in the area were treated by a family member, traditional healers, animal health workers, or a combination of them. Even farmers in village 30/7, who had access to veterinary service, did not totally depend on the clinic and often administered drugs themselves to treat their sick animals. Figure 2 shows personnel involved in the treatment of sick animals in the area.

*Cost of trypanosomosis through drug purchase*

The average amount of money a household was spending in the area for the treatment of all animal diseases was estimated at 271.8±39.7 Ethiopian birr (ETB) (95% CI= 192.2–351.5) (US$ 24.5) per year of which 177.1±28 ETB (95% CI=121–233.4) (US$ 16.0) was spent for purchasing trypanocidal drugs per year per household (Table 1). Though livestock population among the study villages was not significantly different, mean expenditure for treating all diseases was significantly higher ($p<0.05$) in Zigih than in both other villages 30/7 and 28/29. Expenditure for treating trypanosomosis was also significantly higher ($p<0.05$) in Zigih as compared to village 28/29. Overall costs of treating trypanosomosis was significantly ($p<0.05$) higher than all costs of treating other diseases in the area. Costs for treating other diseases in the area were mainly due to the purchase of antibiotics and anthelmintics.

About 21.13 ETB (US$ 1.9) was spent on average for one animal (large ruminant) for the treatment of trypanosomosis per annum. Considering the average market price of 6 ETB (US$ 0.54) for a single dose of trypanocidal drug during the study period, more than three doses of trypanocidal drugs could be purchased annually for each animal. Therefore, it is likely that on average an animal was treated three times a year with trypanocides in the area.

**Table 1** Mean annual cost of treating trypanosomosis and other diseases per household (in ETB)

| Sites | Treatment cost of trypanosomosis (ETB) | Treatment cost of other diseases (ETB) | All treatment costs (ETB) |
|---|---|---|---|
| Village 30/7 | 172.3[ab] | 52.9[a] | 225.2[a] |
| Village 28/29 | 107.6[a] | 63.1[a] | 170.7[a] |
| Zigih | 263.8[b] | 176.3[b] | 440.1[b] |
| Mean total costs | 177.1 | 94.7 | 271.8 |

[a,b,c] Mean costs with same letters along the column are not significantly different from each other

*ETB* short form of Ethiopian currency (11.1 ETB=US$ 1 at the time the study was conducted)

*Cost of trypanosomosis through cattle mortality*

According to information obtained from the interviewed farmers, the mortality rate of cattle as a result of trypanosomosis was 4.4% (Table 2). A significantly higher ($p<0.05$) mortality rate was reported in village 30/7 than in village 28/29. Based on an estimation of the market price of animals that died due to trypanosomosis, about 1,132 ETB (US$ 102.0) per year per household was lost as a consequence of trypanosomosis-triggered mortalities.

Prevalence of trypanosomosis in the study area

The overall apparent prevalence of trypanosomosis in the area was 12.1%. The prevalence was 15%, 10.6%, and 9.9% in village 30/7, village 28/29, and Zigih, respectively. The overall prevalence in village 30/7 was significantly ($p<0.05$) higher than the other villages. The disease burden was significantly ($p<0.05$) higher in the

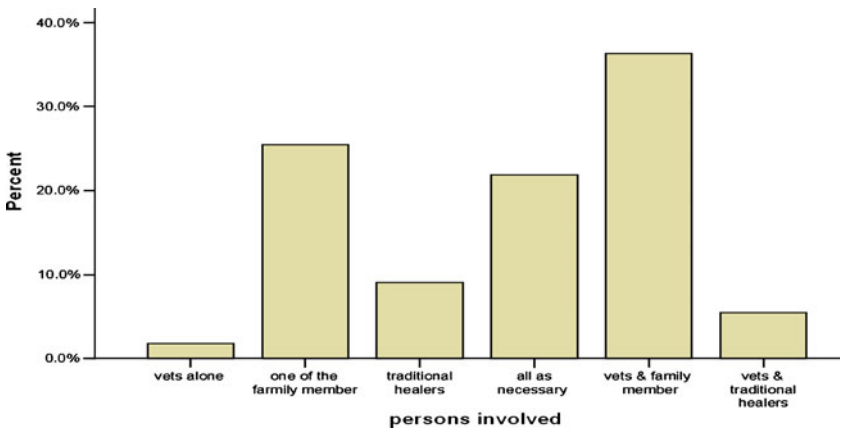


**Fig. 2** Personnel involved in the treatment of sick animals in the area

**Table 2** Mortality rates of cattle due to trypanosomosis in the three study villages

| Sites | Number of deaths reported in 1 year | Total cattle owned by the farmers | Mean mortality rates (%) |
|---|---|---|---|
| Village 30/7 | 12 | 149 | 7.5[a] |
| Village 28/29 | 3 | 137 | 2.1[b] |
| Zigih | 6 | 173 | 3.4[ab] |
| Total | 21 | 459 | 4.4 |

[a,b,c] Mortality rates with same letters along the column are not significantly different from each other

rainy season than in the remainders. Table 3 shows the seasonal overall prevalence of trypanosomosis in the study area.

## Discussion

### Perception and management of trypanosomosis

Most of the farmers mentioned that trypanosomosis was the major livestock disease in the area. Consistent results have been reported in other tsetse infested parts of the country and elsewhere in Africa. All farmers interviewed at Dano district in the Southern Ethiopia replied trypanosomosis was the number one important disease in their area (Riedel et al. 2007). A survey in Tsetse and Trypanosomosis control Project areas of Nigeria showed that farmers knew the disease very well and prioritized it first for its devastating impact on their farm activities (Oluwafemi et al. 2007). Most of the interviewed farmers seemed to be well aware of the seasonality of the disease. Quite a lot of them said the disease was more prevalent during the rainy or late rainy or in both seasons associating it with fly activities. The speculation made by most farmers was matched with the parasitological finding, where the apparent prevalence of the disease was also higher in the rainy season followed by the late rainy season.

Although trypanosomosis does not have pathognomonic signs, most farmers in the study areas were able to recognize the usual clinical signs of the disease which are specified in veterinary literature such as on OIE (2008). A study conducted in tsetse-infested areas of three West African countries also revealed that most of the interviewed farmers were able to mention the common symptoms of trypanosomosis (Grace et al. 2009).

The majority of trypanosomosis cases in the area were treated by the farmers themselves. A similar result was observed in Eastern Zambia where in most of the cases trypanocidal drugs were administered by the farmers (Van den Bossche et al. 2000). Isomethamidium chloride and diminazene aceturate were the most commonly used trypanocides in the area. Moreover, the use of quinapyramine dimethylsulfate, a trypanocide contraindicated in cattle, was also noticed to be used in the area. This drug has been banned from use in cattle due to its toxicity and ability to induce cross-resistance (FAO 1998b).

**Table 3** Seasonal variation of trypanosomosis in the area

| Sampling season | Cattle number examined | Number of positive animals | Apparent prevalence (%) | 95% confidence intervals |
|---|---|---|---|---|
| Rainy | 479 | 82 | 17.1[a] | (13.7–20.5) |
| Late rainy | 386 | 44 | 11.4[b] | (8.2–14.6) |
| Dry | 243 | 15 | 6.2[c] | (3.1–9.2) |
| Late dry | 152 | 12 | 7.9[bc] | (3.6–12.2) |
| Over all | 1,260 | 153 | 12.1 | (10.4–13.9) |

[a,b,c] Prevalence values with the same letters are not significantly different from each other

### Treatment cost of trypanosomosis

Drug expenditure for the treatment of trypanosomosis was higher in Zigih than in village 28/29. The higher expenditure in Zigih could be due to the frequency or cost of trypanocides usage. Zigih is a marginalized village where there has never been any veterinary service or private veterinary pharmacies. As a result, information about the proper way of treating animals as well as on the cost of trypanocides may be less in Zigih. That may lead farmers in this village to treat their animals more frequently and/or to pay more for the trypanocides than in the other two villages. The physical distance between the farmers and the veterinary service is believed to be the main limiting factor for providing an effective animal health service in much of rural Africa by increasing transaction costs (Van den Bossche et al. 2004). Three doses of trypanocidal drug were estimated to be administered per year per animal in the area. A study in the tsetse infested Southern part of Ethiopia by Karanja (1999) showed six doses of trypanocidal drug were administered per year per animal with an overall 22.7% of trypanosomosis prevalence, whereas Stein et al. (2011) reported a single trypanocidal treatment per year per animal to be given to the Ethiopian Sheko cattle breed found in Western Ethiopia. The lower number of treatment in this case could be due to the higher trypanotolerance characteristics of this cattle breed (Lemecha et al. 2006). The overall cost of treating trypanosomosis was significantly higher than the sum of treatment costs for all other cattle diseases which clearly indicates the importance of the disease in the area.

### Cattle mortality due to trypanosomosis

Although village 30/7 was the only village having animal health workers present in the village, cattle mortality due to trypanosomosis was higher in that village. A significant higher mortality in village 30/7 may be due to the relatively higher level of overall apparent prevalence (15%) as compared to 10.6% and 9.9% in village 28/29 and Zigih, respectively. As far as trypanosomosis is concerned, our results may suggest that the presence in the village of a veterinary clinic, which is only engaged in providing chemotherapeutic service, does not result in an exceptional reduction of trypanosomosis prevalence. This is due to the free access of cattle owners in the area to purchase trypanocidal drugs from private pharmacies and using those drugs by themselves. The overall estimated mortality rate of trypanosomosis in Metekel zone was 4.4%. Karanja (1999) reported a higher mortality rate of 6.5% in the Southern part of Ethiopia. But the overall disease prevalence in that area was also higher (22.7%) than in the present study area (12.1%). In Africa, about 3 million cattle die due to trypanosomosis (at about 6% mortality rate) every year from 50 million cattle population at risk in the tsetse-infested areas (PATTEC 2001).

### Effect of trypanosomosis as ranked by the farmers

Many farmers (50.9%) ranked draft power loss of oxen as the most important impact of the disease. Crop and livestock productions are highly inter-dependent in the farming system of the area, where oxen are the sole source of draft power for crop production. The parasitological examination also showed that trypanosomosis was significantly higher in the rainy season which is also the time in the area draft oxen engage in a busy continuous ploughing. This could explain why farmers showed more concern towards losses of draft power. It has been observed that when draft oxen are kept under hard work for long time, they become more susceptible for trypanosomosis infection than other animals (Uilenberg 1998).

### The disease burden in the area

The parasitological study estimated the overall apparent prevalence of trypanosomosis at 12.1%. This result is corroborated by a cross-sectional study made in the Northwestern part of the country by Kebede and Animut (2009) and Mekuria and Gadissa (2011) who reported an overall prevalence of 10.1% and 12.4%, respectively. Cherenet et al. (2004) showed; however, a lower overall apparent prevalence of 7.3% in a seasonal prevalence study conducted in Amhara regional state, Northwest Ethiopia. This lower apparent prevalence may be due to the location of their sampling sites which were close to the edge of the tsetse belt and are expected to have less tsetse activity and thus low trypanosomosis prevalence rate. Another relatively lower prevalence of 4.4% was reported by Tadesse and Tsegaye (2010) in Bench Maji zone of Southwestern Ethiopia. The lower prevalence in their case could be attributed to the use of Deltamethrin as a "pour on" in the area in contrast to our study sites where chemotherapy was the only means being employed to control the disease. A 90.5% reduction in the incidence rate of trypanosomosis was reported by Bekele et al. (2010) in the Southern rift valley of Ethiopia through monthly application of Deltamethrin as a "pour on".

The disease burden in the area was significantly higher in the rainy season. Normally, the dry season is the time when the temperature in the area goes to its peak and maximum daily temperature usually amounts then between 36 and 40°C; moreover, the mean daily rainfall during this time is usually zero. Extreme environmental conditions in the dry season could be unfavorable for the survival and reproduction of tsetse and many other biting flies which can mediate the transmission of the disease (Kebede and Animut 2009). Cherenet et al. (2004) reported that the density of *Glossina tachinoides*, *Glossina morsitans submorsitans*, biting flies as well as the corresponding prevalence of trypanosomosis was higher in the long rainy season than the dry season. In addition, in order to protect the crops during the rainy season, cattle are not allowed to cross crop fields and are forced to drink water at a common site from rivers. This results in aggregation of animals at a point and could aid the propagation of trypanosomes from infected animals to healthy ones through the riparian tsetse species, *G. tachinoides*, which is the only *Glossina* species found in the area (Tesfaye 2010; Mekuria and Gadissa 2011). The relative higher prevalence at Pawe district could be due to its lower altitude as compared to Dibate. In Metekel and Awi zones, the density of tsetse fly and the corresponding prevalence of trypanosomosis were seen to decline as the altitude rises beyond 1,250 masl (Mekuria and Gadissa 2011). Moreover, the cattle density at Pawe is much higher than in Dibate which could increase the contact rate of tsetse flies with cattle enhancing the transmissibility of the disease.

## Conclusion

Trypanosomosis was found to cause substantial economic losses to the local farmers through cattle mortality, trypanocides purchase, and draft power loss of oxen. Veterinary clinics in tsetse-infested areas should be involved in tsetse control activities besides their chemotherapeutic service in order to control trypanosomosis effectively. Moreover, the

concerned zonal officials should regularly check the type of trypanocides that circulate in the area. Further research need to be undertaken in the area to study the presence and extent of trypanocidal drug resistance combined with the view of farmers on the efficacy of currently available trypanocides. The knowledge of farmers about trypanosomosis can play a great role in the control of tsetse and trypanosomosis provided that future integrated control programs involve the active participation of the community.

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