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Epidemiology and Community Knowledge of Bovine Trypanosomiasis in Yirgacheffe District, Southern Ethiopia: A Cross-Sectional Study

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Abstract

A cross-sectional study was conducted from December 2021 to June 2022 in selected kebeles of Yirgacheffe District, Southern Ethiopia, to assess the epidemiology of bovine trypanosomiasis and farmers' knowledge, awareness, and management practices. A total of 384 indigenous cattle were systematically sampled and examined using the buffy coat technique and packed cell volume (PCV) determination. In addition, 200 cattle-owning households were purposively interviewed using semi-structured questionnaires. Data were analyzed using SPSS version 25, employing descriptive statistics, t-tests, chi-square tests, and odds ratios (ORs) with 95% confidence intervals. Trypanosomiasis infection prevalence ranged from 8.6% to 11.9% across origins (OR = 1.30–1.55). Infection was higher in adults (15.48%, OR = 1.56) and in poorly conditioned cattle (6.02–21.1%, OR = 2.16–3.16). Sex showed no significant effect, indicating that age and body condition are the main determinants of trypanosome infection risk. Community findings showed that 67% of farmers recognized bovine trypanosomiasis and 85% were aware of its clinical signs. Most respondents relied on trypanocide drugs and insecticide application, and 77.5% were willing to pay for improved veterinary services. Despite this awareness, ongoing transmission suggests gaps in vector control, diagnostics, and extension services. In conclusion, bovine trypanosomiasis remains an important constraint to cattle productivity in Yirgacheffe District, with anemia as a key pathological indicator. Integrated, area-specific control strategies —including targeted vector management, strengthened veterinary services, routine PCV monitoring, and farmer-focused extension —are essential for sustainable disease control.

Keywords/Phrases: Anemia, Bovine trypanosomiasis, Community knowledge, Epidemiology, Ethiopia

1 Introduction

Livestock production is central to rural livelihoods, food security, and national economies across sub-Saharan Africa, particularly among smallholder farming communities, where it provides income, nutrition, draught power, and improves soil fertility. However, its contribution is severely constrained by tsetse-transmitted African animal trypanosomiasis, one of the most economically devastating livestock diseases on the continent. The disease affects more than 50 million cattle across over 10 million km² of tsetse-infested land, leading to substantial losses in milk and meat production, fertility, draught power, and animal survival. As a result, it undermines agricultural development and perpetuates rural poverty (Leta *et al*., 2016; Shaw *et al*., 2014; Auty *et al*., 2022).

In Ethiopia —where the livestock sector contributes approximately 45% of the agricultural gross domestic product and supports over 80% of the rural population —bovine trypanosomiasis, caused mainly by *Trypanosoma congolense*, *T. vivax*, and *T. brucei* and transmitted predominantly by tsetse flies (*Glossina* spp.), remains a major constraint to livestock productivity and land use (FAO, 2023). Large areas of

fertile land remain underutilized due to persistent tsetse infestation, particularly in southern Ethiopia, where the disease has been endemic for decades despite repeated control efforts. In districts such as Yirgacheffe, earlier studies reported infection rates as high as 25.6% in some localities (Mengistu, 2002). Although vector control and chemotherapy programs have been implemented, recurrent outbreaks continue to compromise livestock productivity and, in some cases, force households to abandon cattle rearing (Alemayehu *et al*., 2021).

Despite the sustained burden of the disease, most previous studies in the area have focused primarily on parasitological prevalence and vector distribution, with limited attention to farmers' knowledge, perceptions, and disease management practices. This gap is important because community awareness and behavior strongly influence treatment-seeking, compliance with control measures, and the long-term sustainability of interventions. Accordingly, this study aimed to assess the epidemiology of bovine trypanosomiasis alongside farmers' knowledge, awareness, and management practices in Yirgacheffe District, Southern Ethiopia, using an integrated cross-sectional approach that combines laboratory-based parasitological analysis with community-level data.

2 Materials and Methods

2.1 Study Area

The study was conducted in Yirgacheffe District, one of six districts in the Gedeo Zone of Southern Ethiopia. The district covers an area of about 266 km^2 and lies between 6°06' – 6°29'N latitude and 38°09' – 38°31'E longitude. It has an estimated human population of 246,573 (87% rural) with a high population density of 933 persons km^2 and an average landholding of 0.65 hectares, which is below the national rural average.

Agro-ecologically, the district is mainly '*Weina Dega*' (93%), with elevations of 1,501–3,000 meters above sea level, annual rainfall of 1,201–1,800 mm, and temperatures ranging from 15.1°C to 20°C. The study focused on four kebeles: Hafurssa Harranji, Hafurssaworabi, Harru, and Chirku-Tutitti (Figure 1), with approximately 3,190 people living in 726 households.

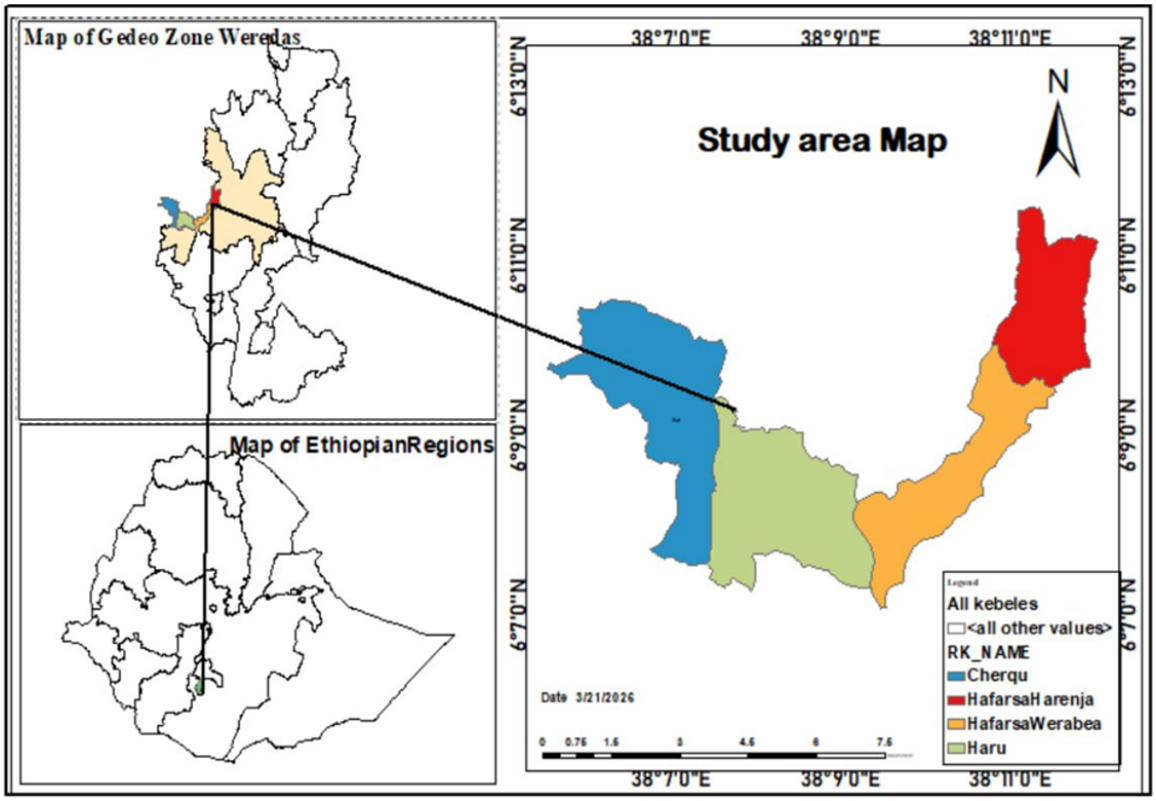


Figure 1. Map of the study area

In the study area, livestock —predominantly indigenous cattle (96%) —are vital for draft power, milk, meat, and manure. Trypanosomiasis is the most significant cattle health challenge (Mebrate *et al*., 2022).

2.2 Study Design

This study employed a cross-sectional design conducted from December 2021 to June 2022 in selected kebeles of Yirgacheffe District, Southern Ethiopia. The cross-sectional design was used to assess the prevalence of bovine trypanosomiasis, associated hematological alterations, and community perceptions during the study period. The methodology integrated parasitological examination of cattle blood with a socioeconomic perception survey of cattle owners, enabling a comprehensive evaluation of the biological, ecological, and socio-economic dimensions of the disease.

2.3 Study Population

The study population comprised indigenous zebu cattle managed under traditional extensive production systems and cattle-owning households residing in the four selected kebeles. In the study area, cattle are the primary source of draft power, milk, meat, and household income. Cattle population estimates for the selected kebeles were obtained from the woreda livestock office and are presented in Table 1 below. In addition, local farmers participated in the perception survey to provide insights into community-level knowledge and management practices.

Table 1. Herd composition by age and sex categories across selected kebelesy

Kebele	Herd composition age in years				
	Oxen ≥ 5	Cows ≥ 5	Heifers < 5	Bulls < 5	Older ≥ 10
Hafurssa Harranji	300	410	215	350	85
Haffursa Worabi	1700	1405	901	98	1451
Haru	445	395	360	132	158
Chirku – Tuttit	700	638	438	366	660
Total	3145	2848	1914	946	2354

2.4 Sample Size Determination

Cattle Sample Size

The sample size for parasitological examination was determined using the standard formula for estimating prevalence in a cross-sectional study (Thrusfield, 2007):

This assumption was made due to the absence of previous prevalence data in the specific study area.

$$n = \frac{1.96^2 \times P_{exp}(1 - P_{exp})}{d^2}$$

Where:

n = required sample size
Pexp = expected prevalence (50%)
d = desired absolute precision (5%)
1.96 = Z-value at 95% confidence level

In the absence of prior prevalence data specific to the study area, 50% expected prevalence was assumed to maximize sample size and statistical precision. Accordingly, 384 cattle were sampled.

For the perception and socioeconomic survey, 200 cattle-owning households were included. This sample size was selected to balance statistical representativeness, logistical feasibility, and time constraints, while ensuring adequate coverage of all four kebeles. The number allowed proportional representation across kebeles and is consistent with similar community-based livestock perception studies conducted in Ethiopia (Gizaw *et al*., 2020). Cattle were selected using a systematic random sampling approach, with sampling intervals determined by herd size to ensure equal selection probability. Livestock owners were selected through purposive sampling based on cattle ownership, farming experience, and willingness to participate. Purposive sampling may introduce selection bias, as surveyed households may not fully represent all cattle owners in the district; this was considered during the interpretation of perception-related findings.

2.5 Data Collection Methods

Parasitological Examination

Blood samples of 10 ml were aseptically collected from the ear vein of each selected animal into heparinized microhematocrit capillary tubes, sealed, and centrifuged at 12,000 rpm for 5 minutes (Murray *et al*., 1977). Packed Cell Volume (PCV) was measured using a microhematocrit reader, and cattle with PCV < 25% were classified as anaemic (Van den Bossche & Rowlands, 2001). Parasite detection was performed using the buffy coat technique: the tube was broken above the buffy coat, the content was placed on a glass slide, covered, and examined under a phase-contrast microscope at 400× magnification (Paris *et al*., 1982). Trypanosome species were identified based on morphology and motility, focusing on *T. congolense* and *T. vivax*, the predominant species in Ethiopia (Radostits *et al*., 2007).

Perception and Socioeconomic Survey

A semi-structured questionnaire was administered to 200 purposively selected cattle-owning households across the four kebeles. It assessed awareness of trypanosomiasis symptoms and transmission, perceived economic impacts (milk yield reduction, mortality, loss of draft power), treatment and coping strategies, and knowledge of previous control programs. The questionnaire was pretested, translated into Gedeo'fa, and conducted via face-to-face interviews by trained enumerators to ensure clarity and cultural relevance.

Ethical Considerations

Ethical approval was obtained from the Dilla University Research Ethics Review Committee. Animal handling and blood sampling followed international welfare guidelines to minimize stress, and informed verbal consent was obtained from all participating farmers, with assurances of confidentiality and voluntary participation.

2.6 Data Analysis

Data from parasitological and socioeconomic surveys were analyzed using SPSS version 25. Trypanosomiasis prevalence was calculated as proportions, and mean PCV values of infected and non-infected cattle were compared using independent t-tests ($p < 0.05$). Associations between infection and categorical variables were evaluated using the Chi-square (χ^2) test, and the strength of associations was estimated using Odds Ratios (OR) with 95% confidence intervals. Qualitative survey responses were thematically categorized, and frequencies were summarized to identify community knowledge gaps and perception trends.

3 Results

3.1 Community Perception and Parasitological Evidence

A total of 200 cattle-owning households from the four study kebeles participated in the perception survey. Overall, respondents demonstrated a good level of awareness of bovine trypanosomiasis: 67% recognized the disease, and 85% identified its main clinical signs. Most respondents obtained information from local sources, and farmers reported using various treatment and control methods. Most were also aware of the disease's adverse effects on livestock health and productivity, highlighting the importance of community knowledge in disease prevention and control (Table 6).

Parasitological examination of 384 cattle identified 39 positive cases, resulting in an overall prevalence of 10.16%. This finding confirms that bovine trypanosomiasis remains a persistent challenge to livestock health and productivity in Yirgacheffe. Taken together, the community perceptions and parasitological findings highlight the value of combining local knowledge with epidemiological evidence to inform effective disease-control strategies.

3.2 Spatial Distribution and Risk Factors

Origin was significantly associated with bovine trypanosomiasis ($p = 0.005$). Cattle from Haru and Chirku–Tuttit had higher odds of infection, with the highest odds observed among cattle from Chirku–Tuttit (Table 2). Although the 95% confidence intervals for the individual site estimates included unity, indicating uncertainty in these estimates, the overall association suggests that infection risk varied by geographical origin, potentially reflecting differences in vector density and transmission pressure. Age was also significantly associated with trypanosomiasis ($p < 0.001$). Adult cattle had

higher odds of infection than young cattle, possibly reflecting greater cumulative exposure over time. Although the confidence intervals crossed unity, the overall pattern suggests that age may be an important population-level risk factor.

Sex was not significantly associated with trypanosomiasis (p = 0.61). Males had slightly higher odds of infection than females, but the wide, overlapping confidence intervals indicate no clear difference in infection risk between the sexes.

Cattle with medium or poor body condition had higher odds of trypanosomiasis than those with good body condition, although the overall association was not statistically significant (p = 0.517). The highest odds were observed among cattle with medium body condition. The wide confidence intervals indicate limited precision; therefore, the observed pattern should be interpreted cautiously and does not establish an association between body condition and infection.

Table 2. Association between selected risk factors and bovine trypanosomiasis

Variable	Category	No. examined	No. positive	Prevalence (%)	OR (95% CI)	P-value
Origin	Hafurssa Harranji	120	13	10.83	1.30 (0.54–3.12)	0.005
	Haffursa Worabi	105	9	8.57	1.21(0.51–2.23)	
	Haru	58	5	8.62	1.45 (0.61–3.45)	
	Chirku–Tuttit	101	12	11.88	1.55 (0.71–3.67)	
Age	Young	120	12	10.00	1.52 (0.61–3.17)	<0001
	Adult	264	27	15.48	1.56 (0.78–3.15)	
Sex	Male	225	24	10.66	1.54 (0.68–3.57)	0.610
	Female	159	15	9.43	1.23 (0.53–2.26)	
Body condition	Good	19	4	21.05	2.16 (1.10–10.20)	0.517
	Medium	216	13	6.02	3.16 (1.20–12.20)	
	Poor	168	26	15.48	2.85 (1.38–5.90)	

3.3 Species Distribution

Three categories of trypanosome infection were identified among cattle across the four kebeles: *T. congolense*, *T. vivax*, and mixed infections (Table 3). Overall, *T. vivax* was the most frequently detected category (51.3%), followed by mixed infections (30.8%) and *T. congolense* (17.94%).

By kebele, the highest overall prevalence was reported in Chirku–Tuttit (45.6%), followed by Hafurssa Harranji (41.6%), Haru (33.1%), and Hafurssa Worabi (32.9%). *T. congolense* infections were most frequent in Hafurssa Harranji (27.7%), while *T. vivax* infections were most frequent in Hafurssa Worabi (58.3%). Mixed infections occurred most frequently in Hafurssa Harranji (36.9%). The distribution of trypanosome infections differed significantly among kebeles (χ^2 = 10.20, p = 0.005).

Table 3. Species Distribution of Trypanosoma parasites in Various Kebeles

Species	Study site in %				Total Prevalence	χ^2	P-value
	Hafurssa Harranji n=120	Haffursa Worabi n=105	Haru n=85	Chirku & Tuttit n=101	% N=384		
T. Congolese	3(27.7)	1(11.7)	1(11.6)	2(16.8)	7(17.94)		
T. Vivax	6(55.3)	5(58.3)	3(34.8)	6(50.5)	20(51.3)		
Mixed	4(36.9)	3(35.0)	1(11.6)	4(33.7)	12(30.8)		
Total	13(41.6)	9(32.9)	5(33.1)	12(45.6)	39(100)	10.20	0.005

3.4 Prevalence of Trypanosomosis and Packed Cell Volume (PCV)

A total of 384 cattle were examined across the four kebeles, and 39 (10.16%) tested positive for trypanosome infection (Table 4). The highest prevalence was recorded in Chirku and Tuttit (11.88%), followed by Hafurssa Harranji (10.83%), Haru (8.62%), and Hafurssa Worabi (8.57%).

Packed cell volume (PCV) assessment showed that 172 cattle (44.79%) were anemic (PCV < 25%), while 212 (55.21%) had normal PCV levels (PCV $\geq$ 25%). Among the kebeles, the proportion of anemic cattle was highest in Haru (56.90%) and lowest in Hafurssa Worabi (38.10%).

Table 4. Packed Cell Volume (PCV) Distribution and Trypanosomiasis Prevalence in Cattle Across Different Study Areas

kebeles	No. of animals examined	No. of animals positive	PCV < 25%	PCV > 25%
Hafurssa Harranji	120	13(10.83)	51(42.50)	69(57.50)
Haffursa Worabi	105	9(8.57)	40(38.10)	65(61.90)
Haru	58	5(8.62)	33(56.90	25(43.10
Chirku and Tuttit	101	12(11.88)	48(47.52)	53(52.48)
Total	384	39(10.16)	172(44.79)	212(55.21)

The mean packed cell volume (PCV) of cattle varied significantly between anemic and non-anemic animals. Anemic cattle (PCV < 25%) had a mean PCV of 17.35% (95% CI: 17.13–20.48) with a standard deviation of 1.56, whereas non-anemic cattle (PCV $\geq$ 25%) had a significantly higher mean PCV of 22.23% (95% CI: 23.43–24.40) with a standard deviation of 2.20. Overall, the mean PCV across all examined cattle was 21.82% (95% CI: 21.34–22.31; SD = 2.57). The difference in PCV between anemic and non-anemic cattle was statistically significant (P < 0.001), confirming that anemia is a prominent hematological feature in the studied population (Table 5).

Table 5. Comparison of mean packed cell volume (PCV) between trypanosome-infected and non-infected cattle

Variables	PCV range	Mean PCV (%)	95% CI	SD	P-value
Anemic	16-21	17.35	17.13-20.48	1.56	
Non-Anemic	19-29	22.23	23.43-24.40	2.20	<0.001
Total	16-29	21.82	21.34-22.31	2.57	

SD = Standard Deviation

3.5 Community Knowledge, Awareness, and Practices

A survey of 200 cattle-owning households revealed variation in awareness, knowledge, and management practices related to bovine trypanosomiasis (Table 6). Overall, 67% of respondents recognized the disease, while 33% did not (χ^2 = 18.3, p = 0.001), indicating moderate but incomplete community awareness. Awareness of clinical signs was higher, with 85% of respondents familiar with the disease's characteristic signs (χ^2 = 11.4, p = 0.002), suggesting that direct exposure to the disease may enhance farmers' knowledge.

Regarding disease management, 60.5% of respondents relied on public or private veterinary services, whereas 39.5% used traditional remedies (χ^2 = 9.1, p = 0.005). This reflects the use of both formal veterinary services and indigenous practices. Regarding the perceived effects of trypanosomiasis on livestock, 69% of farmers identified reduced milk yield as the main impact, followed by fertility problems (14.5%), weight loss (8.5%), and behavioral changes such as restlessness (8%) (χ^2 = 34.6, p = 0.005). These findings indicate that farmers are aware of both the clinical signs of trypanosomiasis and its broader effects on livestock productivity.

Table 6. Farmers' Perception and Awareness of Bovine Trypanosomiasis in Ethiopia

Variable	Category / Response	Frequency (n)	Percent (%)	χ^2	P-value
Farmers' understanding of trypanosomiasis	Recognized	134	67.0	18.3	0.001
	Not recognized	66	33.0		
	Total	200	100		
Awareness of clinical signs	Yes	170	85.0	11.4	0.002
	No	30	15.0		
	Total	200	100		
Treatment/control measures reported	Supported by veterinary clinic	121	60.5	9.1	0.005
	Traditional/home treatment	79	39.5		
	Total	200	100		
Awareness of effects on livestock	Reduced milk yield	138	69.0	34.6	0.005
	Reduced body weight	17	8.5		
	Makes livestock restless	16	8.0		
	Disturbs fertility period	29	14.5		
	Total	200	100		

3.6 Economic Impact and Preventive Practices

The survey results indicated that 77.5% of respondents recognized trypanosomiasis as a disease affecting their livestock, and 85% were aware of its clinical signs (Table 7). More than half of the farmers (51.5%) perceived the disease as causing major economic losses, while 27.5% and 20.0% reported moderate and minor losses, respectively. Only 1.0% perceived no economic impact.

Regarding control efforts, 77.5% of respondents were willing to pay for improved veterinary services to control trypanosomiasis. Most respondents (93.0%) recognized the role of insects in disease transmission: 44.5% reported being regularly aware of insect transmission, and 48.5% reported being occasionally aware of it. The remaining 7.0% were unaware of insect transmission.

Table 7. Economic Impact and Preventive Practices

Response Options	Frequency (n=200)	Percent (%)
Would You Be Willing to Pay for Improved Veterinary Services to Control Trypanosomiasis?		
Yes	155	77.5
No	35	17.5
Not sure	10	5.0
Economic Impact of Trypanosomiasis Perceived by Farmers		
Major economic loss	103	51.5
Moderate economic loss	55	27.5
Minor economic loss	40	20
No impact perceived	2	1.0
Do You Believe Trypanosomiasis is Transmitted by an Insect Vector?		
Yes, regularly	89	44.5
Occasionally	97	48.5
Not aware of it	14	7.0
Which Preventive Measures Do You Use? (for those who answered Yes above)		
Use of insecticide/chemical spray	110	59.1
Grazing management (avoiding tsetse areas)	37	19.9
Using treated nets or traps	23	12.4
Keeping in the house & smoking	30	16.1

The most commonly reported preventive measure was the use of insecticides or chemical sprays (59.1%), followed by grazing management to avoid tsetse-infested areas (19.9%), traditional practices such as housing animals and smoking (16.1%), and the use of treated nets or traps (12.4%). As these percentages total more than 100%, please clarify whether respondents could report more than one preventive measure.

3.7 Discussions

3.8 Prevalence and Risk Factors

The present study confirms that bovine trypanosomiasis remains an important endemic constraint in the study area, with an overall prevalence of 10.3%. This is consistent with national and regional reports of prevalence ranging from 9% to 11%, despite long-standing vector-control and chemotherapeutic interventions (Abebe, 2005; Leta *et al*., 2016). These findings underscore the continued epidemiological importance of tsetse-transmitted trypanosomiasis in southern Ethiopia.

Geographical origin was significantly associated with infection: cattle from Haru and Chirku–Tuttit had higher odds of infection, with the highest odds observed in Chirku–Tuttit. This finding is consistent with previous studies documenting spatial variation in trypanosomiasis prevalence in relation to differences in vegetation, altitude, tsetse density, and the intensity of local control measures (Dagnachew *et al*., 2015; Tasew & Duguma, 2017). Unlike studies that have identified clearly defined hotspots (Feyissa *et al*., 2011), the absence of a single dominant high-risk area in the present study suggests that transmission may be shaped by multiple interacting ecological and environmental factors.

Age was associated with higher odds of infection, with adults showing greater odds than younger cattle. This pattern is consistent with reports from Ethiopia linking infection risk to cumulative exposure, longer grazing periods, and wider movement ranges in older animals (Feyissa *et al*., 2011; Lelisa *et al*., 2014). However, because the confidence limits crossed unity, this association should be interpreted cautiously. The elevated odds may reflect prolonged exposure rather than an inherent difference in susceptibility.

Sex was not significantly associated with infection. Although males had slightly higher odds, the overlapping confidence intervals indicate no clear difference between the sexes. This is consistent with studies reporting similar prevalence in males and females under comparable management and grazing systems (Abebe, 2005; Leta *et al*., 2016). The finding differs from reports of higher prevalence in males, often attributed to exposure associated with draught work (Lelisa *et al*., 2014), suggesting that sex-related differences may depend on local husbandry practices.

Cattle in medium or poor body condition had higher odds of infection than those in good condition, although the association was not statistically significant. This pattern aligns with previous findings that poor body condition can be an indicator of trypanosomiasis, which is associated with anemia, chronic weight loss, and reduced productivity (Abebe, 2005; Leta *et al*., 2016). The elevated odds observed among well-conditioned cattle should be interpreted cautiously given the small sample size and wide confidence intervals, limitations also noted in other localized studies.

3.9 *Trypanosome* Species

Trypanosoma vivax was the predominant species identified, accounting for 51.3% of infections, followed by *T. congolense* (17.94%) and mixed infections (30.8%). This distribution closely resembles findings from the Gambella Region, where *T. vivax* accounted for approximately half of detected infections (Fantahun *et al*., 2019). By contrast, studies from the Assosa and Metekel zones reported *T. congolense* as the dominant species (Ahmed *et al*., 2024), underscoring regional variation in species composition.

These differences may reflect ecological & epidemiological factors, including vector-species composition, vegetation type, and the presence of mechanical vectors. The predominance of *T. vivax* in the present study is epidemiologically important because this species can be transmitted mechanically by biting flies as well as cyclically by tsetse flies. This may allow it to persist even in areas where tsetse density has been reduced (Abebe, 2005). In contrast, *T. congolense* depends primarily on cyclical transmission, making its prevalence more sensitive to vector-control interventions & local tsetse ecology.

The relatively high proportion of mixed infections (30.8%) suggests that cattle may be exposed to overlapping transmission cycles and multiple vector species. Similar proportions of mixed infections have been reported in southwestern Ethiopia and have been associated with more complex disease dynamics and challenges for effective control (Getachew *et al*., 2019; Gebre *et al*., 2022).

Packed Cell Volume

The mean packed cell volume (PCV) was significantly lower in anemic cattle (17.35%) than in non-anemic cattle (22.23%), demonstrating the hematological impact of trypanosomiasis. The overall mean PCV of 21.82% was below the normal reference range for healthy cattle, suggesting a substantial burden of clinical and subclinical anemia in the study population.

Comparable reductions in PCV have been reported in trypanosomiasis-endemic areas of Ethiopia. Tegegn *et al*. (2021), for example, reported a mean PCV of 23.57% in parasitemic cattle in the South Omo Zone, while Muktar *et al*. (2016) reported a mean of 23.22% in infected cattle in Dugda Dawa. Although the absolute values vary, these studies consistently show lower PCV in infected cattle. Similar findings have been reported in the Wolaita Zone and Amhara Region, where parasitemic cattle had markedly lower PCV values than aparasitemic animals (Ashagrie & Zewde, 2021). This consistency across regions supports the use of PCV as an indicator of disease impact.

Anemia associated with trypanosomiasis is multifactorial and may result from hemolysis, immune-mediated erythrocyte destruction, increased erythrophagocytosis, and suppression of erythropoiesis (Abebe, 2005; Getachew *et al*., 2019). The PCV reduction observed in the present study may reflect prolonged or repeated exposure to infection, potentially compounded by nutritional deficiencies and limited access to veterinary services in extensive production systems.

Influence of *Trypanosome* Species on Anemia Severity

The significant reduction in packed cell volume (PCV) observed in the present study is consistent with findings from previous Ethiopian studies of bovine trypanosomiasis, in which anemia is recognized as a key pathological feature, particularly in cattle infected with *Trypanosoma congolense* in tsetse-infested areas (Abebe, 2005; Getachew *et al*., 2019). Although species-specific comparisons are limited, the marked decline in PCV may reflect common pathogenic processes, including erythrocyte destruction, suppression of bone marrow activity, and immune-mediated hemolysis. These effects may be further exacerbated by mixed infections in naturally exposed cattle.

By contrast, Tesfaye *et al*. (2012) reported no significant changes in PCV among cattle in non-tsetse-infested areas. This difference may reflect less frequent exposure, lower infection pressure, earlier diagnosis, or lower parasitemia. Variation in ecological exposure, study populations, and diagnostic methods may also contribute to differences in hematological findings. These observations highlight the influence of endemicity and methodological factors on PCV outcomes and the need for integrated parasitological, hematological, and molecular approaches to better characterize species-specific pathogenicity in Ethiopia's endemic areas.

3.10 Community Perception

The relatively high level of community awareness observed in the present study (67–85%) suggests that livestock farmers generally have a good understanding of bovine trypanosomiasis. This awareness may reflect repeated exposure to the disease and its visible effects on animal health and productivity. Comparable levels of awareness have been reported in other trypanosomiasis-endemic areas of Ethiopia, where farmers often recognize the disease through its clinical signs and production losses rather than through formal training (Fesseha *et al*., 2022).

Despite this general awareness, nearly one-third of respondents in the present study could not recognize the disease, indicating persistent knowledge gaps that may delay early detection and appropriate intervention. Similar findings have been reported by Kizza *et al*. (2021) and Bemba *et al*. (2023): although farmers were generally familiar with trypanosomiasis, disease control relied heavily on chemotherapy, while preventive measures such as vector control and herd-level management were less widely adopted. This pattern is consistent with the

present findings and suggests that awareness alone may not be sufficient to reduce the disease burden without practical knowledge and effective control strategies.

3.11 Willingness to Pay for Veterinary Services

The high proportion of respondents willing to pay for veterinary services (77.5%) suggests strong awareness of the economic impact of trypanosomiasis. Similar findings were reported by Fesseha *et al*. (2022), who found that farmers in southern Ethiopia were motivated to seek treatment because the disease directly affects milk production, draught power, and household income. This contrasts with findings from some resource-limited or non-endemic areas, where cost remains a major barrier to accessing veterinary care.

However, the continued presence of trypanosomiasis in the study area, despite farmers' expressed willingness to pay, indicates that economic motivation alone may not be sufficient to ensure effective disease control. Structural constraints—including limited diagnostic services, inadequate vector-control infrastructure, irregular veterinary outreach, and a shortage of trained personnel—may prevent farmers from translating this willingness into consistent preventive action. Similarly, Feyera *et al*. (2023) emphasize that successful disease control depends not only on farmers' awareness and willingness but also on the availability, affordability, and quality of veterinary services.

3.12 Economic Impact and Preventive Practices

The present study confirms that livestock farmers perceive bovine trypanosomiasis as a major cause of economic loss, highlighting its continued impact on livestock productivity in the study area. More than half of the respondents reported that the disease causes substantial economic damage, whereas only a small minority considered it to have no economic impact. These findings suggest that farmers have a strong practical understanding of the disease's effects.

This perception is consistent with findings from southwestern Ethiopia, where trypanosomiasis was identified as a major constraint on livestock production because of reduced milk yield, poor body condition, and diminished draught power (Seyoum *et al*., 2016). The high levels of awareness of clinical signs and transmission reported in the present study also align with the findings of Feyisa *et al*. (2020). However, they contrast with reports from low-prevalence and non-endemic areas, where limited awareness among livestock keepers has been identified as a barrier to early detection and control.

Whereas some studies have reported that control efforts rely mainly on chemotherapy, with limited emphasis on prevention (Bemba *et al*., 2023), the comparatively greater adoption of preventive measures observed in the present study may indicate a more proactive approach among local livestock keepers. This difference could reflect variation in access to extension services, exposure to vectors, or farmers' accumulated experience in managing the disease.

4 Conclusion and Recommendations

4.1 Conclusion

Bovine trypanosomiasis remains a significant constraint on cattle production in Yirgacheffe, with an overall prevalence of 10.16% and marked spatial variation. Prevalence was particularly high in Chirku–Tuttit, where local ecological conditions may favor transmission. Adult cattle were more frequently affected, and *Trypanosoma vivax* was the predominant species. The significantly lower packed cell volume (PCV) values in infected animals confirm anemia as an important pathological outcome and support the use of PCV as a practical indicator of disease impact. Despite relatively high levels of farmer awareness and willingness to invest in veterinary services, continued transmission points to gaps in diagnostic capacity, service delivery, and the implementation of effective control measures.

4.2 Recommendations

- Strengthen veterinary and diagnostic services at the community level to improve access, early detection, and timely treatment of infected animals.
- Implement targeted vector control strategies in high-risk areas, integrating insecticide application, tsetse trapping, and habitat management.

- Promote routine PCV-based monitoring of cattle to identify infection early and assess herd health status.
- Ensure rational use of trypanocide drugs to prevent resistance development and enhance treatment efficacy.
- Enhance extension and awareness programs to empower farmers with knowledge of prevention, early detection, and proper animal management practices.
- Integrate trypanosomiasis control into livestock development policies and food security programs to ensure sustainability and coordinated action across sectors.

Limitation of the Study

The study relied on the buffy coat technique for parasite detection. Because this method is less sensitive than advanced diagnostic approaches, it may have underestimated the true prevalence. The absence of molecular diagnostics also limited precise species confirmation and the detection of low-level infections. In addition, data were collected during a single season and may not capture seasonal variations in disease occurrence or entomological factors. These limitations should be considered when interpreting and extrapolating the findings. Future studies should use more sensitive diagnostic methods and collect data across multiple seasons.

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Conflicts of interest

The authors declare that there are no conflicts of interest related to this manuscript.

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