Surveillance of Bovine Trypanosomiasis in the peri-urban zone of Bamako as a prelude to eradicate the disease in the basin of River Niger Mali

ABSTRACT

African Animal Trypanosomiasis (AAT) is a haemoparasitic disease that considerably hampers socioeconomic development in sub-Saharan Africa. One way to counter this scourge is through vector control and treatment. **Objective**: This study aims to help breeders in the study zone to control AAT. **Location and duration of the study:** About three-year longitudinal follow-up was conducted in seven municipalities around Bamako city (Mande, Kalabancoro, Sanankoroba, Kati, Tienfala, Baguinéda, and Koulikoro) indistrict Bamako fromMarch 2007 to December 2009. **Methodology**: Thirty to fifty heads of cattle were randomly selected in each municipality, and depending on herd size, 5 to 10 heads of cattle were selected from each herd for examination. For each run, all animals diagnosed with *Trypanosoma* spp*.* positivity were systematically treated. **Results:**A total of 7,622 blood samples from 312 cattle of different breeds (Peulh zebus, Metis, and Mereas predominant breeds) were collected and examined.A total of 106 animals were found infected with two *Trypanosoma* species (*T. vivax*, 99% and *T. congolense*, 1%). Prevalence was significantly (P<0.05)variable not only by breed (78.25% for zebu and nil for N'Dama) but also by year (4.47%, 0.53% and 0.1% in 2007, 2008 and 2009, respectively). Variability was also observed according to locality. However, this did not vary according to the sex of animal (P= 0.07). A total of 1691 doses of trypanocidal products were administered to infected animals. **Conclusion:** As a result of treatment, the incidence and prevalence of the disease has decreased considerably. However, the risk of disease transmission remains, as biological and mechanical vectors are omnipresent in the area. Besides, seasonal animal movements are also a risk factor. Study suggests regular monitoring, vector management and trypanocidal treatment to reduce the disease incidenceand improve livestock productivity.

Keywords: Trypanosomiasis, Cattle, Prevalence, Peri-urban, Bamako Mali.

1. INTRODUCTION

Trypanosomiasis is a parasitic disease of humans and animals transmitted by tsetse flies (biological vector) or other insects such as tabanids or stomoxes, which transmit the parasite mechanically. Endemic mainly in domestic animals, this disease remains a major obstacle to the development of livestock farming in infested regions (Farougou*et al.,* 2012). Endemic primarily in domestic animals, this condition remains a major obstacle to livestock development in infested regions (Farougou*et al.,* 2012). According to Affognon*et al.* (2012), nearly 80% of the human population lives in tsetse-infested areas and depends mostly on agriculture. In these countries, livestock farming contributes between 10% and 20% of the country's GDP. Trypanosomiasis, a debilitating and fatal livestock disease, is one of the major constraints on the socio-economic development of populations, causing a drop in productivity and considerable economic losses (Bouyer*et al.,* 2006). The Koulikoro region

and the Bamako district are 80% infested with tsetse fly (Traoré*et al.,* 2024). Every year, around 2.7 million cattle and 2.5 million people are exposed to the risk of the disease (Djitèye*et al.,* 1992). Faced with the constraints imposed by African Animal Trypanosomiasis (AAT) and its vectors on the promotion of agriculture and livestock farming in countries affected by the scourge, several national tsetse fly and trypanosome control projects have been developed in Africa. While some of these projects have been successful (reducing tsetse fly density and trypanosome infection rates in livestock), unfortunately, they have not led to the eradication of tsetse fly and trypanosomiasis. They continue to represent a major health and economic challenge in sub-Saharan Africa. Animal trypanosomiasis can lead to a progressive deterioration in the affected individual's general condition. Domestic animals infected with the disease can act as reservoirs.
The peri-urban area is the dairy belt and source of meat production for a population of approximately 4.228 million (INSTAT, 2024). There are very few equidaes (François *et al.,* 2002).Poultry farming is practiced in almost every village. The invertebrate fauna is rich in insects of medical, veterinary, and agricultural interests (Muscidaes, Culicidaes and Simuliidae) (François *et al.,* 2002).These environmental conditions provide a biotope conducive to the proliferation of tsetse flies, vectors of trypanosomiasis. Hence, this site is, also an agrosilvo-pastoral zone. Dairy products, poultry, truck farm produce, and other products come from these sites, and many local livestock farmers are tempted by the idea to fatten up small ruminants. Regular summer rainfall also allows the development of wooded savannahs, cereal, and industrial crops such as sorghum, corn, and cotton.

Livestock farming is the second most important primary sector in the Niger River basin. Livestock numbers have risen steadily in recent decades. Livestock comprised mainly of poultry (17,253,244), sheep and goats (132,206), cattle (43,285), asians (872), and only 790 horses (DNPIA, 2022).Livestock production systems are traditionally extensive and characterized by exclusive or semi-intensive herding, especially in the peri-urban area of Bamako. Most of the herds were sedentary. Cattle breeds include Peulh zebu, Maure zebu, N'Dama, stabilized crossbreeds (Méré), and local/exotic crossbreeds (Montbéliard, Rouge des Steppes and Holstein). Among small ruminants, the Djalonké and related breeds are predominant (Traoré*et al.,* 2019). Intensive livestock farming is booming in this area. The introduction of improved breeds during this period significantly increased milk production and led to the establishment ofsmall milk processing units. However, transhuman herds are present during the dry season. Endoparasites such as transboundary trypanosomes can considerably reduce herd productivity, exposing almost 50% of the human population to food insecurity (Matteroni*et al.,* 2004). The asymptomatic nature of AATcan often result in reduced productivity and weakened animals;hence, this study aimed to determine the prevalence of AATin different breeds of cattle in the peri-urban zone of Bamako to help breeders control the diseaseand improve animal productivity.

2. METHODOLOGY

2.1. Study area

The study was conducted in Bamako and its suburbs from 2007 to 2009. The District of Bamako stretches 22 km from West to East and 12 km from North to South, covering an area of 277 km^2 (Figure 1). In 2009, the human population was estimated at 1,810,366, with a density of 4,563.17 inhabitants/km^2 (ANMM, 2021). The city of Bamako is watered by the Niger River over a length of approximately 26 km and therefore enjoys a fairly humid tropical climate with a marked dry season and rainy season.The livestock are mainly cattle, sheep, and goats. These animals are a source of income for the local population.

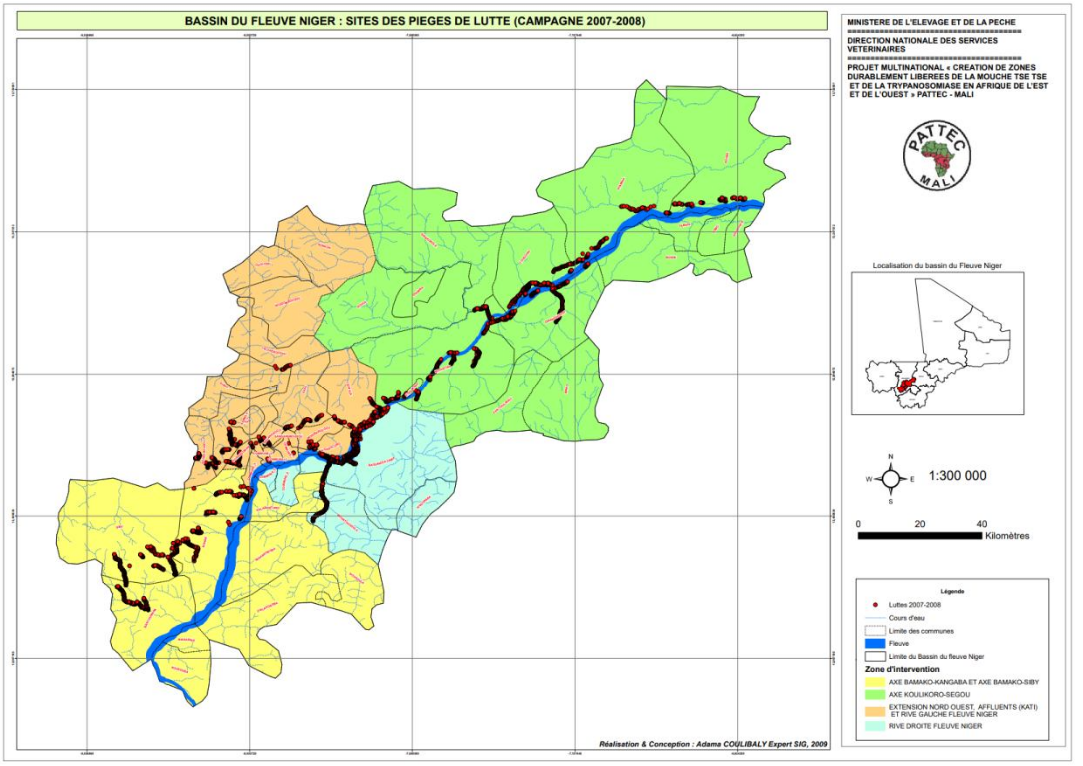

Figure 1: Location of thestudy area (source, PATTEC-Mali, 2007)

2.2. Methods :

This descriptive cross-sectional study with repeated passages included seven municipalities (Mande, Kalabancoro, Sanankoroba, Kati, Tienfala, Baguinéda, Koulikoro) inthe Bamako district. Five villages in each of these communes were randomly selected. For each run, blood samples were collected from around 12 animals in different herds, depending on the availability of the owners, giving an averageof 312 cattles per run.The sample size was determined by using online questionnaire (Winepi.net) with a confidence level of 95% andmargina of error of 5%.The selected animals were entered by noting the identification code, sex, age, breed, and date of the last trypanocidal treatment received. Blood was drawn from the jugular vein and collected in vacutainer tubes, each containing an anticoagulant. The method of Murray (1977) was used to examine buffy coats after differential centrifugation in the capillary tubes of trypanosomes. The hematocrit level was determined using the Buffy Coat test. This procedure consisted of filling microtubes 2/3 full with blood and sealing one end with plasticine (modeling paste). The tubes were then centrifuged for 5 min at 12,000 rpm in a hematocrit centrifuge. The hematocrit level was estimated using a hematocrit reader after examination of the interface (Buffy Coat). After reading, the tube was cut 1 mm below the interface using a diamond cutter to, include the layer of erythrocytes. This fluid was then observed under a darkfield or phase-contrast microscope at 400X magnification to determine the animal's parasitemia.During the investigations, all animals diagnosed as positive for and those with hematocrit levels below 25% were treated with a trypanocide (Diminazene aceturate) at a dose of 3.5 mg/kg.

2.3. Cattleselectioncriteria

Cattle were selected at random, regardless of sex, age or breed, according to availability and the number of herds in the region. Verbal consent was obtained from the owner of each herd. 12 breeds were recorded during our surveys. Of these, 3 breeds were predominant, the Peulh zebu (33.5%), the Metis (33.5%) and the Mérés (30.6%). Breeds such as the zebu Maure and N'Dama accounted for 2.5% and 0.5%, respectively. A few isolated breeds such as Azawak, Goudale, Bodouro, Holsten and Batorodji accounted for just 0.5%.

2.4. Data analysis

Data were entered into Excel version 2007. Statistical analyses were performed using R software (R version 4.4.2, http://www.r-project.org) which generated the graph, determined the frequency and the average. Bartlett's Chi^2 test was used to compare variances at the 5% level of significance.

3. RESULTS AND DISCUSSION

Parasitological analysis was carried out on a total of 7,622 blood samples from seven communes over three survey years. The expected sample size was 312 cattle by run. Due to the constraints encountered in the field, this number slightly decreased or increased, hence 2015, 2,646 and 2,961 samplesin 2007, 2008 and 2009, respectively (P=0.39) were collected. The majority of cattle were females (70.6%), with a sex ratio of 1:2.62 (5878/2244). More than ten breeds were recorded in the area, with a predominance of the Peulh zebu breed (33.5%), mixed breeds (32.3%) and merés (30.6%). The N'Dama breed was in the minority (0.5%). A few isolated races such as Azawa, Goudale, Bodouro, Holsten and Batorodji accounted for only 0.5%. Two species of *Trypanosoma* sp. were detected (*T. congolense* and *T. vivax).* 99% of the cases detected were due to *T. vivax* (102/106) compared with only 1% (04/106) for *T. congolense* (Figure 2).

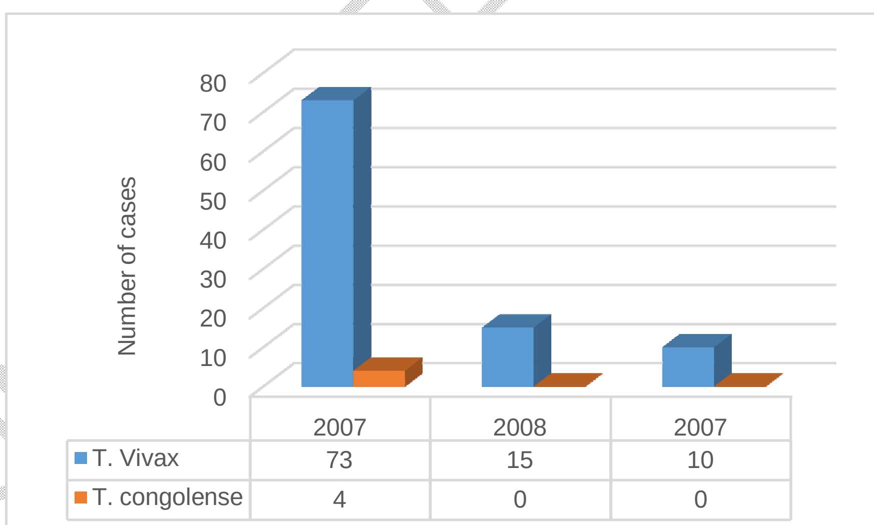

Figure 2: Annual prevalence according to *Trypanosoma* species

The highest infection rate was obtained in 2007 (4.47%) and the lowest in 2009 (0.1%). The difference was highly significant (P=0.7) (Figure 3).

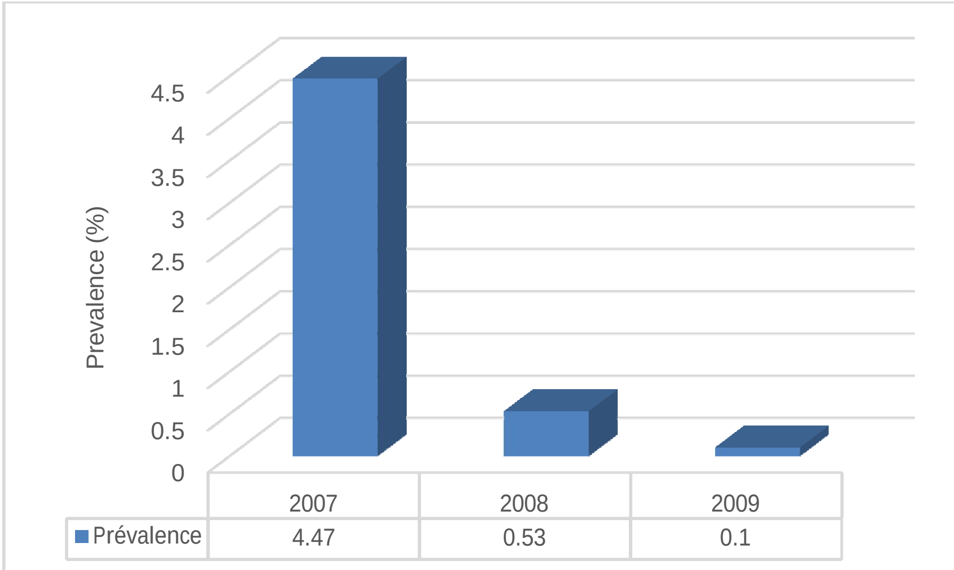

Figure 3: Change in prevalence during the study period

The AAT infection rate was significantly different according to breeds (Figure 4).The breeds most affected were Peulh Zebu (79.25%), Maure Zebu (14.15%), and mixed breeds (Azawak, Goudale, Bodouro, Holsten and Batorodji) (3.14%). The prevalence for imported dairy cows and heifers breeds were 3.14% and 1.89%, respectively. The prevalencerate of AAT was zero according N'Dama.

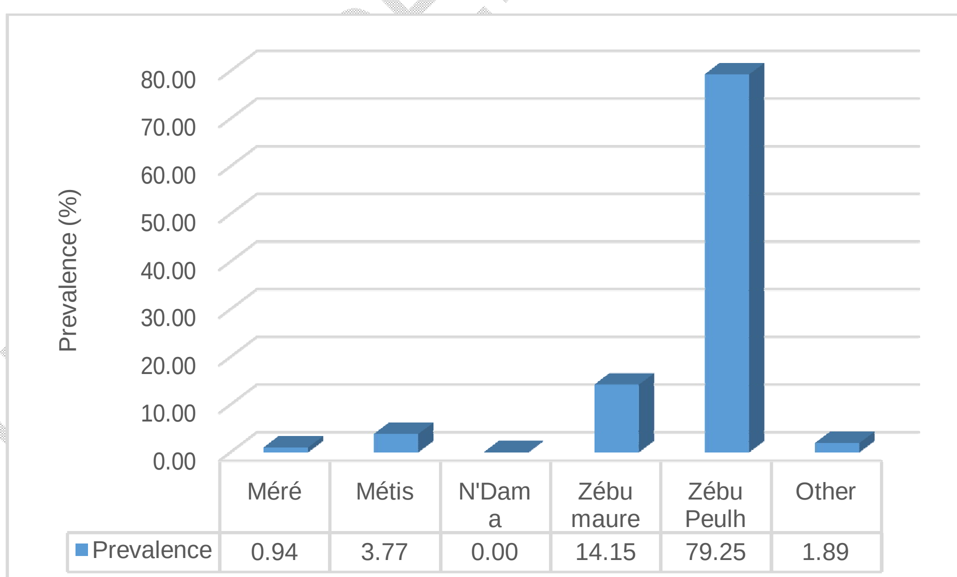

Figure 4: Prevalence varies by breed

The overall mean prevalence was 0.4% (33/7622) for males and 0.9% (73/7622) for females. Specifically, 1.49% (33/2244) males were infected compared with 1.36% (73/5378) females (Figure5).

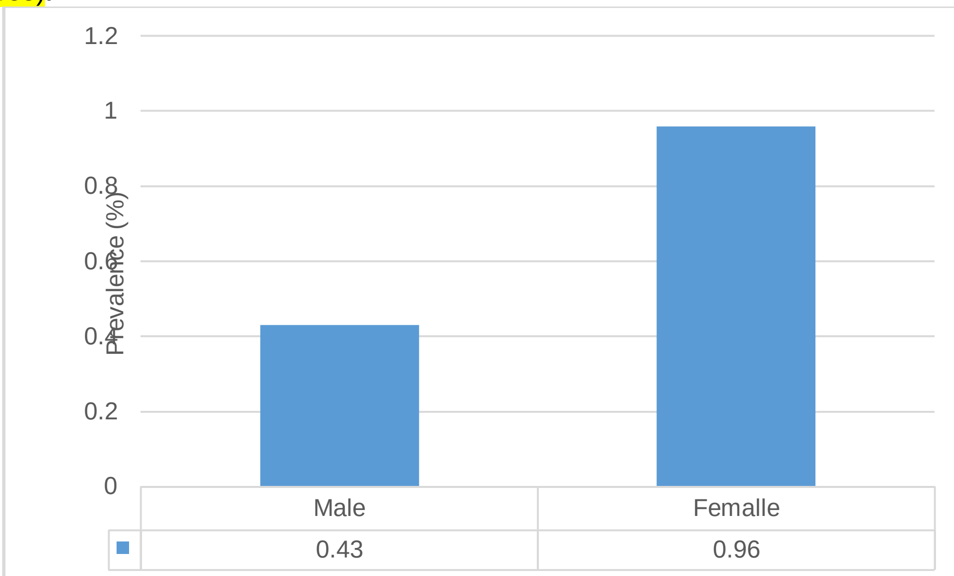

Figure 5: Variation in prevalence according to sex

Depending on the locality, cattle in the municipalities of Tienfala and Baguinéda were the most affected, with almost 15% and 11.49% prevalence, respectively in 2007, while Koulikoro (1.72%) and Kati (0.9%) recorded the highest rates in 2008. The prevalence was almost zero in all the municipalities in 2009, with the exception of Baguinéda (0.38%) and Sanankoroba (0.19%) (P<0.5%) (Figure 6).

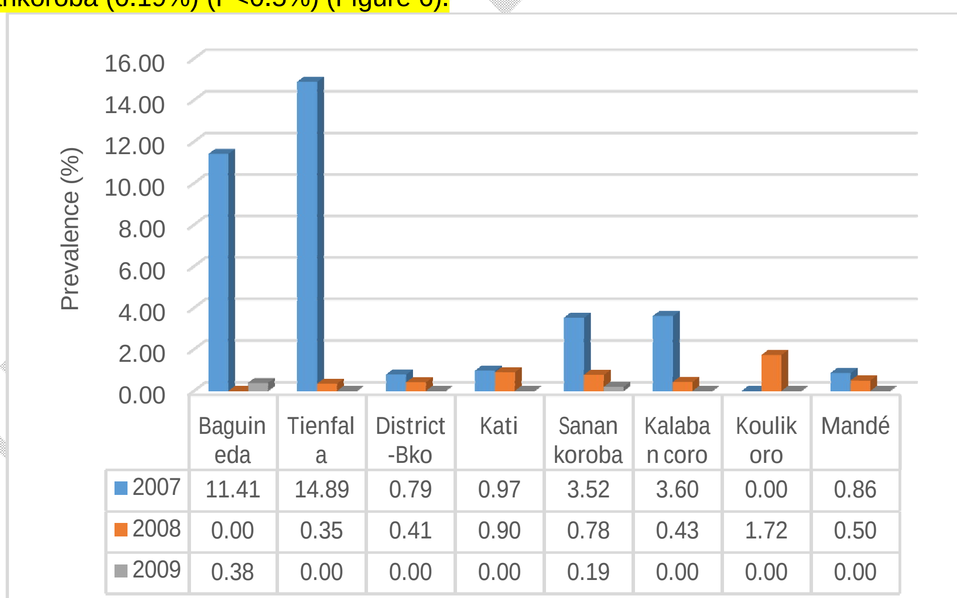

Figure 6: Variation in prevalence by municipality

According to the trypanocidal treatment received by the animals (Figure 7), the prevalence was highest among those not treated (99%), very low among those whose status was unknown, and nil among those who had received a dose of trypanocide, as shown in figure 8.

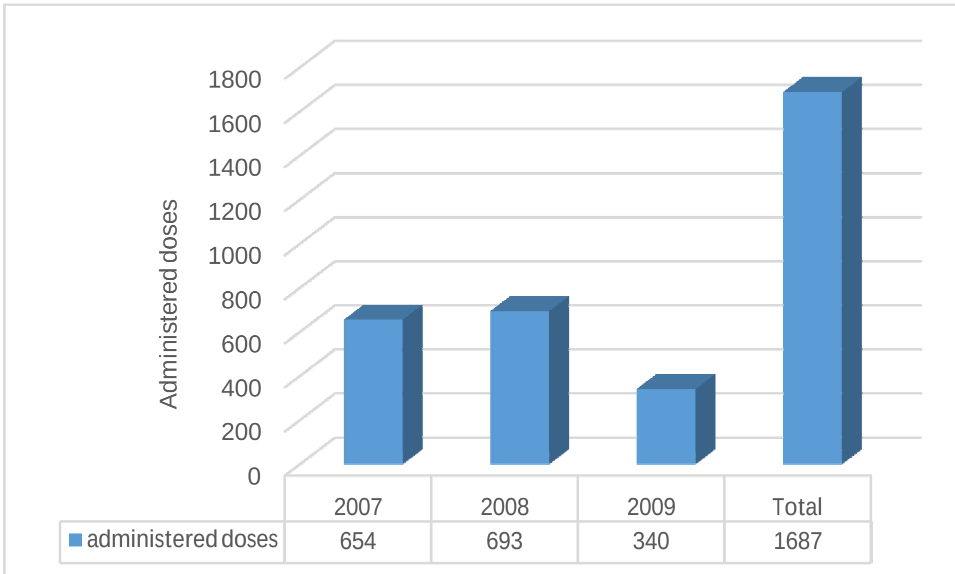

Figure 7: Doses of trypanocides administered per year

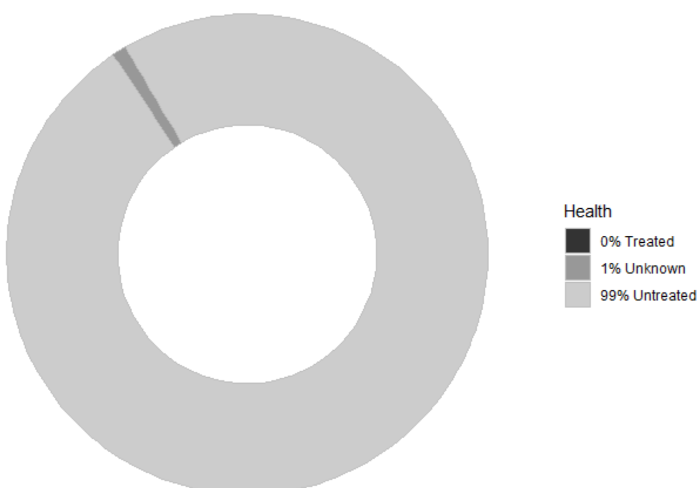

Figure 8: Variation in prevalence according to animal health status

Careful monitoring can help reduce disease incidence. Lowering pressure in an area can reduce disease transmission by biological vectors (Traoré*et al.,* 2019). The reduction in the number of infestation cases recorded during the study period could be explained by the systematic investigation and treatment of all animals detected positive and those suspected of being infected, in order to interrupt the chain of transmission in the area between 2007 and 2009. These results corroborate those of Traoré*et al.* (2019) and Diall et al. (1987) on the MadinaDiassa ranch. In 2005, a project to control tsetse flies and trypanosomosis in Mali (PLMT) was able to control the AATepidemic in the Tienfala-Baguinéda agropastoral zone by reducing the average prevalence from 17.6% to 1.1%, then 1.48% and 1.22% for three consecutive years [AAT control coordination unit(UCLT), 2005]. The average prevalence rate was 1.4%. Despite the high number of females, the average prevalence rate by sex was not significant (P>0.05%). However, when considering the group by sex, the rate was higher in the males than in the females (P=0.00). These results are contrary to those reported by Tanenbe*et al.* (2010) in Cameroon, who reported a prevalence rate of 46.1% in males and 35.6% in females.

Farougou*et al.* (2012) identified two *Trypansoma*sp. species (*T. vivax* and *T. congolense*); however, they found that 33.3% of infections were due to *T. vivax* and 44.5% to *T. congolense*, in contrast to our study where 99% of cases were caused by *T. vivax* versus 1% for *T. congolense* (P<0.05%). Tanenba*et al.* (2010) found that *T. congolense* predominated in their study area and attributed this increase to the probable proximity of tsetse flies to other animals(Tanenbe*et al.,* 2010). The predominance of this species over *T. congolense* in this study is explained by the presence of *Glossina palpalis gambiensis*, the only species identified for over 10 years in the municipalities of Mandé, Tienfala, Baguinéda, and even Kati, and the main biological vector of *T. vivax* (Traoré*et al.,* 2024). In 1986, in MadinaDiassa (Diall*et al.,* 1986), identified three species (*T. vivax*, *T. congolence* and *T. brucei*), with a predominance of *T. congolence*. Boka*et al.* (2019) identified only one species (*T. vivax*) with a prevalence of approximately 6%. There was a highly significant variability in prevalence between breeds (P=0.00). The percentage was high for the zebus (79.25%) and null for the N'Dama breed. Aka *etal*. (2022) also showed the tolerance of certain breeds to trypanosomes, such as the Lagunaire breed in Côte d'Ivoire, compared with the N'Dama breed. In southern Mali, Diall*et al.* (1986) reported that the N'Dama breed is more resistant to trypanosomiasis infections.

Prevalence varied significantly between localities(P=0.00). In 2007, it ranged from 0% (KouliKoro) to 14.89% (Tienfala), while in 2009 it was 0.38% in Baguinéda, 0.19% in Sanankoroba, and zero in the other communes (P<0.05%).This variability in prevalence has also been shown by Bengaly*et al.* (1998) in the provinces of Boulagouriba, Kénédougou, and Mouhoun in Burkina Faso (Bengaly*et al.,* 2001), as well as by Tanenbe*et al.* (2010). a few cases of *T. theileri* have been reported, but since its pathogenic role is poorly known, as shown by Amato *et al.*(2019), they have been neglected(Amato *et al.,* 20191).

The Bamako district is at the center of the abovementioned municipalities and is a focal point for trade. In the area, most livestock breeders fatten their animals and, in most cases, sell their calves, while others use them for dairy production. Controlling certain diseases can help improve livestock production. Animal production capacity can be influenced by several factors (Diaf, 2008), including zoonoses. As livestock farming is the main economic activity in the peri-urban area of Bamako, infection of animals with haemoparasites, such as trypanosomes, can affect the quantity and quality of animal productivity. Houndje*etal.* (2024) reported that knowledge of dominant parasitic pathologies can help estimate the costs of agropastoral products and that assessing the prevalence of these parasitic pathologies is vital for the agropastoral sector (Houndje*et al.,* 2024). This low prevalence does not negate the risk of disease transmission. Although tsetse densities have been low in recent years, the very remarkable roaming of animals, as well as transhumance (moving from one area to another at the same time)are factors that favor close contact between hosts and vectors and consequently increase the risk of transmission. Houndje*et al.* (2024) reported that even if the prevalence of trypanosomosis is declining, interbreeding and/or roaming of animals can increase the risk of transmission. Diaf (2008) showed that despite booming animal productivity in southern countries, supply is not keeping pace with demand because of demographic growth (Diaf, 2008). Controlling endoparasitic diseases could guarantee better animal production and contribute to improving food safety.

4. CONCLUSION

The aim of this study was to determine the prevalence of AATin cattle in the peri-urban zone of Bamako district to help breeders control the diseaseand improve animal productivity. Trypanosomiasis control campaigns in and around Bamako have reduced trypanosome infection rates in cattle. However, transhumance, or the traditional movement of herds from one pasture to another depending on the seasons, the presence of tsetse flies (biological vector of AAT) and other insects (mechanical vectors) in the study area are risk factors for disease resurgence.

EthicalApproval and Consent :

The studyprotocolwasapproved by the institutionalethicscommittee of the Faculty of Science and Technology (FST). Informed, voluntary consent wasobtainedfrom all owners. All measuresweretaken to minimize the risksassociatedwith participation in the study.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) herebydeclarethat NO generative AI technologies such as Large LanguageModels (ChatGPT, COPILOT, etc.) and text-to-image generators have been usedduring the writing or editing of thismanuscript.

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