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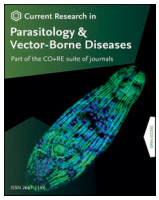

Seroprevalence of Rift Valley fever and associated risk factors in livestock of Afar Region, northeastern Ethiopia

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ABSTRACT

Rift Valley fever (RVF) is one of the emerging arthropod-borne zoonotic viral diseases with serious public and economic significance in the livestock and human populations of East Africa. Its epidemiology is inadequately recognized in Ethiopia. A cross-sectional study was conducted to investigate the seroprevalence and potential risk factors of RVF in domestic livestock of Amibara and Haruka districts of the Afar Region, northeastern Ethiopia. A total of 736 (224 cattle, 121 goats, 144 sheep, 155 camels and 92 donkeys) blood samples were collected, and serum extracted and tested using competitive ELISA. A questionnaire survey was used to assess potential risk factors of RVF infection. The overall seroprevalence was 22.0% (162/736; 95% CI: 19.41–24.79%). The seroprevalence was significantly higher in goats (42.2%, 95% CI: 39.61–44.99%) compared to that of cattle (14.3%, 95% CI: 11.74–17.09%), sheep (21.5%, 95% CI: 18.91–24.29%), or camels (30.97%, 95% CI: 28.38–33.76%) ($P < 0.001$). The study showed that seropositivity for IgG antibody to RVFV infection was associated with locality and species of animal. Goats were two times more likely to be seropositive for RVFV infection than cattle (OR: 2.3, 95% CI: 1.462–3.574, $P = 0.001$). Livestock in the Kealatburi area were five times more likely to be seropositive for RVFV infection than those in the Halidegei area (OR: 5.074, 95% CI: 3.066–8.396, $P = 0.001$). This study revealed that RVF is an important animal health problem in the Afar Region. Therefore, monitoring of RVF in animals, humans, and vectors along with community sensitization of high-risk populations could benefit mitigating the risk posed by the disease. Quarantine measures should be implemented to reduce the risk of RVFV introduction and dissemination among susceptible animals and ultimately transmission to humans.

1. Introduction

Ethiopia has the largest livestock population in Africa and several livestock diseases are endemic there. Given the large livestock population and distribution in the country and poor supply of veterinary services, various infectious diseases cause death and debilitation to a significant number of animals (Gutu et al., 2021; Jaleta et al., 2022). Arthropod-borne viruses (arboviruses) constitute important emerging and re-emerging infectious disease agents which pose substantial threats to animals and human health globally (Suu-ire et al., 2021). Rift Valley fever (RVF) is an arthropod-borne disease, mainly affecting a wide variety of livestock including cattle, small ruminants, and camels. The disease significantly affects livelihoods and national economy of the country (Hassan et al., 2020; Gibson et al., 2023).

Rift Valley Fever is becoming one of the important health issues with significant potential to emerge as a global concern. Within Africa and the Middle East, there are conditions favoring vector populations that are capable of transmitting the disease (Sindato et al., 2022). Competent vectors are known to exist even beyond the current range of RVF endemic areas and there is a recognized risk of global spread (Himeidan, 2016). RVF outbreaks in humans are preceded by epizootics in livestock (Kim et al., 2021). However, most of the major outbreaks have first been

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recognized in the human population (Gibson et al., 2022).

The ecology of RVF results in an ongoing cycle of endemic and epidemic periods and understanding this allows the identification of several potential risk factors for RVF outbreaks (Rostal et al., 2010). The epidemic cycle of RVF, causing large and widespread outbreaks, is thought to be driven by environmental conditions such as flooding caused by abnormally high and prolonged precipitation events that support massive breeding of mosquitoes that are competent horizontal vectors of Rift Valley fever virus (RVFV) which amplifies RVFV infection in susceptible animals (EFSA Panel on Animal Health and Welfare AHAW et al., 2020).

Communities living in areas practicing livestock movement may be at higher risk of RVFV infection that causes major outbreaks and economic harm to human and animal health leading to increased poverty within affected communities (Tigoi et al., 2020). In Ethiopia, the Afar Region is predominately populated by pastoralists and semi-pastoralists spending most of the year in floodplain vegetation areas of the Awash River. The extensive livestock production system potentially creates conducive environmental parameters for the ecology and densities of mosquito vectors of the RVFV but studies on this and other arboviruses are limited.

Ibrahim et al. (2021) showed that an individual apparent seroprevalence of RVF-IgG was 17.9% in cattle, 42.6% in camels, 6.3% in goats, and 7.4% in sheep in the Somali Region, eastern Ethiopia. Studies conducted by Asebe et al. (2020) and Endale et al. (2021) showed 7.6% and 5.0% seroprevalence of anti-RVFV IgG antibodies in cattle of South Omo Zone and Gambella Region, respectively.

The presence of a wide range of host and vector species, the geographical proximity to endemic areas like Djibouti and Somalia, cross-border livestock movement and geographical expansion of the virus increase the risk of RVF in Afar Region, Ethiopia. Therefore, the present study was conducted to assess the seroprevalence of RVF and associated risk factors in the Afar areas.

2. Materials and methods

2.1. Description of the study area

The study was conducted in the Afar Region (Fig. 1) (Amibara and Haruka districts) from June 2021 to April 2022. The Afar Region is located in the northeastern part of Ethiopia (39°34′– 42°28′E, 8°49′–14°30′N). The region shares regional borders with Tigray Region in the northwest, Amhara Region in the southwest, Oromia Region in the south, and Somali Region in the southeast. It also shares international boundaries with Djibouti in the east and Eritrea in the northeast (CSA, 2021). The climate of the region is characterized as arid and semi-arid. The pastoral production system dominates in the region, the livelihood of the rural community mainly relies on livestock rearing (90%) and agriculture along the Awash River basins and low-lying riverine areas (10%) (CSA, 2021).

The Amibara District is one of the districts in Zone 3 of the Afar Region located in the Middle Awash Basin, about 260 km northeast of Addis Ababa. The district has 11 *kebeles* (a small administrative unit in Ethiopia) and a total human population of 60,146 of which most of the inhabitants are pastoralists rearing 37,394 cattle, 61,403 goats, 42,899 sheep, 15,112 camels, and 1094 donkeys. Because of the presence of large pastureland and rivers in Amibara District, animals from different districts also migrate to Awash riverbanks and vast pasture lands where intermixing of different species and herds of livestock occur, creating a potential risk factor for interspecies and inter-herd disease transmission. The Amibara District also has the "Adadi" wildlife sanctuary site and Awash National Park in its territory, hence, the wild animals from the Parks share the majority of the grazing land and watering points. It is common to observe cattle grazing in proximity to wild animals in the grazing sites.

Haruka District is one of the districts in Zone 3 of the Afar Region located in the Middle Awash Basin, about 300 km northeast of Addis Ababa. The district has 9 *kebeles* and a total human population of 20,146 of which most of the inhabitants are pastoralists. The livestock population of Haruka District is composed of 21,269 cattle, 35,027 goats, 30,985 sheep, 3236 camels, and 1270 donkeys.

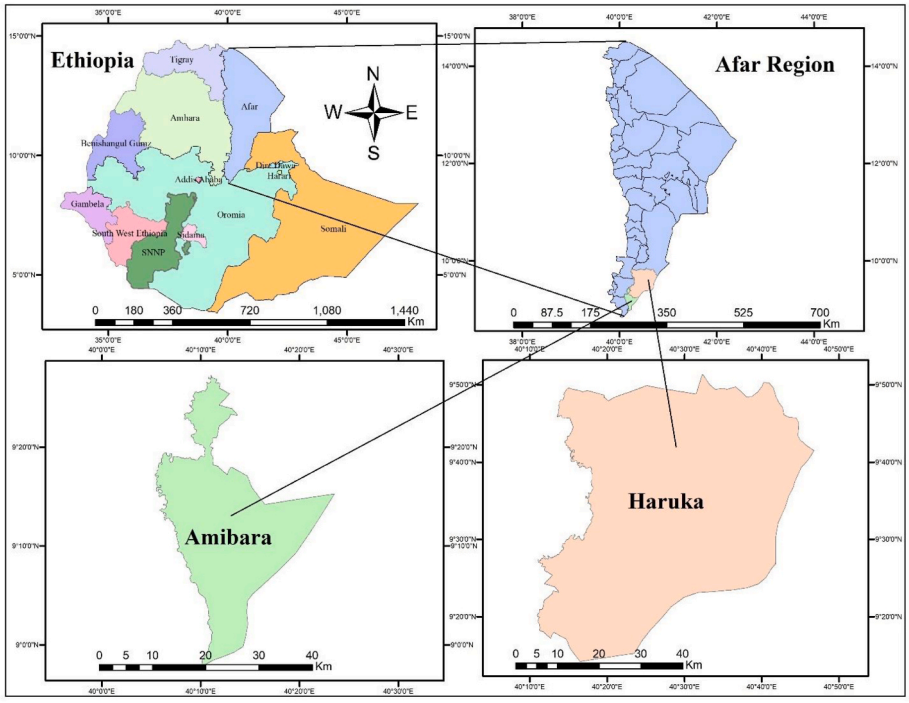

Fig. 1. Map of the study area in Ethiopia (ArcGIS 10.8. 2).

2.2. Study design

A cross-sectional study design with a mixed research approach method was used to assess the sero-epidemiology of RVFV from June 2021 to April 2022. Since there were no previous studies in the study area, a community-based survey and study site observation was piloted in June 2021 before commencing the study to generate information on RFV infection in the two districts (Amibara and Haruka), and assess the presence of a large population of livestock, water bodies, large and medium-scale irrigation activities, history of flooding, factors favoring the breeding and multiplications of arbovirus vectors, evidence of abortion and retained placenta, accessibility to the respective sub-districts, evidence of wildlife sanctuaries, prevalence of the potential vectors in the adjacent districts (Mekuriaw et al., 2022) and proximity to borders.

2.3. Study animals

The study animals comprised cattle, camels, goats, sheep and donkeys in the two districts of the Afar Region. All settlers in each selected *kebele* were included systematically after obtaining the elder's/clan leaders or *kebele* administrators consent to participate in the study.

2.4. Sample size determinations

The sample size was determined based on seroprevalence of 17.9% in cattle, 42.6% in camels, 6.3% in goats, and 7.4% in sheep reported from Somali Region (Ibrahim et al., 2021). Other parameters include 5% margin of error at 95% confidence interval and addition of 10% for the effectiveness and to mitigate the influence of population characteristics in haphazard sampling.

2.5. Sample collection

Due to a lack of livestock registration in the study area, the animals within the herd were selected using the haphazard sampling technique after gaining the approval of the local elders and owners. A sterile plain vacutainer tube with 18G by 1-inch needles was used to puncture the jugular vein and collect 5 ml blood sample; the vacutainer was properly labeled and stored at room temperature for about 4 h. Blood samples were centrifuged for 10 min at 3000 rpm at room temperature. Using Pasteur pipettes, sera were separated and then poured into labeled 1.8-ml Eppendorf tubes. Sera samples were shipped to the laboratory of Aklilu Lemma Institute of Pathobiology, Addis Ababa, using a cool box with an ice pack. Upon arrival, the samples were stored at −20 °C until the serological analysis was conducted.

2.6. Serological analysis

Using the ID screen® RVF competition multispecies ELISA kits (ID-Vet Innovative Diagnostics, Montpellier, France), the detection of anti-RVFV IgG antibody was evaluated based on the manufacturer procedure in a single-well test. Using a MultiskanTM FC Microplate Photometer, a 96-well ELISA plate reader, the results were read at an optical density (OD) of 450 nm. The manufacturer's suggested cut-off values were used to determine whether the results were positive or negative. Following the manufacturer's manual, the test was deemed validated when the positive control OD (ODPC) mean value was less than 30% of the ODnc (ODPC/ODnc < 0.3) and the negative control optical density (ODnc) mean value was greater than 0.7 (ODnc > 0.7). Then, the inhibition rate was calculated according to the following formula:

$$S/N\ (\%) = ODs/ODnc \times 100$$

where OD is the optical density, nc is the negative control, S is the sample, and S/N is the competition percentage. S/N-values $\leq 40\%$ were considered positive and S/N-values $> 40\%$ were considered negative (Kainga et al., 2022).

2.7. Questionnaire survey

Within each *kebele*, there were two settlements, each containing 250–300 households and 80–120 herd owners. We selected one settlement from each kebele. A total of 87 livestock owners (27 from Halidegae, 20 from Sidafagae, 20 from Hassoba, and 20 from Kalatburi) gave informed consent for questionnaire administration and whole blood sample collection from their livestock. Large herds comprising various species of animals were kept together in these settlements. Due to the high density of animals, disease spread could occur rapidly in the event of an outbreak.

A modified version of a structured questionnaire was utilized to gather data regarding possible risk factors for individual animal levels (Asebe et al., 2020). First, the questionnaire collected the demographic data of the herd owners over the age of eighteen who gave their informed consent to be included in the study and lived in the chosen homes whose animals were sampled. The second section collected data regarding the knowledge of herd owners regarding RVF, including its zoonotic nature, clinical signs, incidence of abortion, neonatal mortality, mode of transmission, and awareness of vector *Aedes* mosquitoes. Selected herd owners who did not want to participate in the study were replaced by other herd owners and corresponding herds within the villages.

2.8. Data analysis

Data were entered, cleaned, and validated in a Microsoft Office™ Excel® 2019 spreadsheet. The RVFV ELISA test results (positive or negative) were the dependent variable in this study. Descriptive and inferential analyses were performed using R software version 4.0.3 for Windows *via* R-Studio Version March 1, 1093 and Microsoft Office™ Excel® 2019 spreadsheets. The seroprevalence/apparent prevalence of IgG antibody elicited towards RVFV was estimated by dividing the number of sampled animals with positive test results by the total number of tested animals. The livestock included in the study were apparently healthy and no samples were taken from diseased animals where true prevalence could be determined. Univariable logistic regression was used to assess the crude association between the seropositivity of IgG antibody and the hypothesized individual potential risk factors such as age, sex, species and site, was calculated with descriptive and analytical analysis using a Chi-square (χ^2) test. Multivariable logistic regression analysis was used to assess the effect of each of the independent variables on the outcome variable (seropositivity) after adjusting each independent variable for all other variables. A *P*-value below 0.05 was considered indicative of a statistically significant association at a 95% confidence level. For the survey, Pearson chi-square was used to evaluate the statistical significance of the bivariate association of parameters and selected covariate in each kebele (lowest administrative structure in Ethiopia). Differences were considered significant at $P < 0.05$.

3. Results

3.1. Description of study participants and animals

Of the 87 participants, 68.97% (60/87) were males, and 31.03% (27/87) were females. Of the 87 participants, 91.95% (80/87) depended on subsistence farming for their livelihoods, while 8.05% (7/80) had other income-generating activities.

3.2. Seroprevalence of RVFV

A total of 736 serum samples were screened for IgG antibodies against RVFV infection and the overall seroprevalence was 22.0% (162/

736, 95% CI: 19.41–24.79%). The seroprevalence was significantly higher in goats (42.2%, 95% CI: 39.61–44.99%, $P < 0.001$) compared to camels (30.97%, 95% CI: 28.38–33.76%), cattle (14.3%, 95% CI: 11.74–17.09%), sheep (21.5%, 95% CI: 18.91–24.29%); all samples from donkeys were negative (Table 1).

3.3. Seroprevalence in different locations

The seroprevalence varied across locations (Table 2). Animals from Kealatburi *kebele* had the highest seroprevalence (30.72%, 47/153) compared to Halidegei (22.40%, 51/228), Sidahfagei (19.2%, 37/193) and Hassoba (16.67%, 27/162) ($P = 0.016$). District seroprevalence ranged from 20.90% to 23.49%. The highest seroprevalence was observed in Kealatburi (30.72%, 95% CI: 28.48–33.13%) and the lowest - in Hassoba (16.67%, 95% CI: 14.43–19.08%).

3.4. Seroprevalence based on the sex of the livestock population

The overall seroprevalence was 22.16% in female animals and 21.43% in male animals, Furthermore, the overall seroprevalence across the species of livestock was higher in goats (58.33% in males and 38.14% in females) followed by camels (37.04% in males and 29.69% in females) (Table 3).

3.5. RVFV seroprevalence at livestock herd and location level

The highest seroprevalence of RVFV infection (73.68%, 95% CI: 71.93–75.49%) was observed in sheep from Kealatburi *kebele* followed by 65.71% and 48.57% in goats from Halidegei and Hassoba, respectively ($P < 0.001$). The seroprevalence of RVFV infection was significantly different between camels (48.72%) from Kealatburi and Sidahfagei (27.5%) ($P < 0.001$) (Table 4).

3.6. Determining potential risk factors

The study showed that the risk factors for RVFV seropositivity at individual level were location and species of livestock (Tables 5 and 6). Goats were six times more likely to be seropositive for RVFV infection than cattle (OR: 6.295, 95% CI: 3.716–10.460, $P = 0.001$). Livestock herds in Sidahfagei were 0.5 times less likely to be seropositive for RVFV infection than those in other areas (OR: 0.547, 95% CI: 0.333–0.899, $P = 0.017$).

3.7. Questionnaire survey

Livestock owners' knowledge and experiences regarding zoonotic infections were higher among those older than 30 years ($\chi^2 = 3.951$, $P = 0.041$). The questionnaire survey revealed that 62.1% of livestock owners perceived that diseases affecting livestock could be transmitted from animals to humans. Most of the owners (82.8%) were also aware of the potential risks associated with consuming raw food of animal origin such as raw milk or undercooked meat. However, none of the respondents had protocols for handling aborted foetuses and placental tissues to minimize disease transmission risks. Regarding prevention from vector mosquitoes, more than half of the respondents did not use bednets routinely and did not appreciate that the use of bednets decreases the risk of zoonotic diseases. (Table 7).

Table 1
Seroprevalence of RVF in different species of livestock in Afar, Ethiopia.

Species	*N*	No. positive (%)	95% CI	*P*-value
Cattle	224	32 (14.3)	11.74–17.09	<0.0001
Goat	121	51 (42.2)	39.61–44.99	<0.0001
Sheep	144	31 (21.5)	18.91–24.29	0.001
Camel	155	48 (31.0)	28.38–33.76	<0.0001
Donkey	92	0 (0)	–	–
Overall	736	162 (22.0)	19.41–24.79	0.001

Abbreviations: *N*, number of animals sampled; CI, confidence interval.

Table 2
Seroprevalence of RVFV infection in different locations in Afar, Ethiopia.

Location	*N*	No. positive (%)	95% CI	*P*-value
Halidegei	228	51 (22.40)	20.16–24.81	0.017
Sidahfagei	193	37 (19.20)	16.96–24.61	0.023
Hassoba	162	27 (16.67)	14.43–19.08	0.002
Kealatburi	153	47 (30.72)	28.48–33.13	0.001

Abbreviations: *N*, number of animals sampled; CI, confidence interval.

Table 3
Seroprevalence of RVFV infection by sex of animals.

Species	Sex	*N*	No. positive (%)	95% CI	*P*-value
Cattle	Male	45	5 (11.11)	9.93–12.35	0.546
	Female	179	27 (15.08)	13.9–16.32	
Goat	Male	24	14 (58.33)	57.15–59.57	0.544
	Female	97	37 (38.14)	36.96–39.38	
Sheep	Male	27	5 (18.52)	17.34–19.76	0.547
	Female	117	26 (22.22)	21.04–23.46	
Camel	Male	27	10 (37.04)	35.86–38.28	0.913
	Female	128	38 (29.69)	28.51–30.93	
Donkey	Male	31	0 (0)	–	0.470
	Female	61	0 (0)	–	
Overall	Male	154	33 (21.43)	20.25–22.67	0.845
	Female	582	129 (22.16)	20.98–23.40	

Abbreviations: *N*, number of animals sampled; CI, confidence interval.

Table 4
Seroprevalence of RVFV infection across locations and species.

Species	Location	*N*	No. positive (%)	95% CI	*P*-value
Cattle	Halidegei	63	10 (15.90)	14.15–17.71	0.017
	Sidahfagei	72	10 (13.90)	12.15–15.71	
	Hassoba	45	3 (6.70)	4.95–8.51	
	Kelatburi	43	9 (20.93)	19.18–22.74	
Goat	Halidegei	35	23 (65.71)	63.96–67.52	0.023
	Sidahfagei	24	7 (29.17)	27.42–30.98	
	Hassoba	35	17 (48.57)	46.82–50.38	
	Kelatburi	26	4 (15.38)	13.63–17.19	
Sheep	Halidegei	61	5 (8.20)	6.45–10.01	0.002
	Sidahfagei	31	9 (29.03)	27.28–30.84	
	Hassoba	32	2 (6.25)	4.5–8.06	
	Kelatburi	19	14 (73.68)	71.93–75.49	
Camel	Halidegei	53	13 (24.53)	22.78–26.34	0.013
	Sidahfagei	40	11 (27.50)	25.75–29.31	
	Hassoba	22	5 (22.73)	20.98–24.54	
	Kelatburi	39	19 (48.72)	46.97–50.53	
Donkey	Halidegei	15	0 (0)	–	–
	Sidahfagei	26	0 (0)	–	
	Hassoba	27	0 (0)	–	
	Kelatburi	24	0 (0)	–	

Abbreviations: *N*, number of animals sampled; CI, confidence interval.

4. Discussion

The present sero-epidemiological investigation showed the seroprevalence of RVF antibodies in apparently healthy livestock population and evaluated the association of potential risk factors for exposure to the virus in livestock in the two selected districts, Amibara and Haruka, of the Afar Region, Ethiopia. The present study detected an overall seroprevalence of 22% (162/736; 95% CI: 19.41–24.79%), and seroprevalence rates of 14.3% in cattle, 42.2% in goats, 30.97% in camels, 21.5% in sheep, and 0% in donkeys. A comparable study in Malawi showed that the overall seroprevalence of RVF was 17.14% (Kainga et al., 2022).

The seroprevalence of RVF in cattle (14.3%) exceeded the previously reported values of 10.2% in Chad by Özcelik et al. (2023) and 7.6% in

Table 5
Binary logistic regression analysis of the relationship between potential risk factors of RVFV seropositivity.

Variable	Level	*N*	% Positive	*P*	COR	95% CI
Species	Cattle	224	32 (14.28)	<0.0001	Ref	Ref
	Goat	121	51 (42.15)	0.085	1.373	0.957–1.969
	Sheep	144	31 (21.53)	<0.0001	3.645	2.450–5.424
	Camel	155	48 (30.97)	<0.0001	2.229	1.586–3.133
	Donkey	92	0 (0)	–	–	–
Sex	Female	582	129 (22.16)	0.470	Ref	Ref
	Male	154	33 (21.43)	<0.0001	3.512	2.888–4.270
Age	< 2 years	74	8 (10.81)	0.318	Ref	Ref
	2–< 5 years	208	24 (11.54)	0.865	1.076	0.461–2.513
	5–< 10 years	332	28 (8.43)	0.516	0.760	0.331–1.742
	> 10 years	122	8 (6.61)	0.202	0.502	0.174–1.447
Location	Halidegei	228	51 (22.37)	<0.0001	Ref	Ref
	Sidahfagei	193	37 (19.17)	<0.0001	3.471	2.542–4.739
	Hassoba	162	27 (16.67)	<0.0001	4.216	2.946–6.034
	Kealatburi	153	47 (30.72)	<0.0001	5.000	3.308–7.558

Abbreviations: *N*, number of animals examined; COR, crude odds ratio; CI, confidence interval; Ref, reference.

Table 6
Multivariable logistic regression analysis for potential risk factors associated with RVF in livestock.

Variable	Level	*N*	% Positive	*P*	AOR	95% CI
Species	Cattle	224	32 (14.28)	<0.0001	Ref	Ref
	Goat	121	51 (42.15)	<0.0001	2.286	1.462–3.574
	Sheep	144	31 (21.53)	0.002	0.471	0.295–0.753
	Camel	155	48 (30.97)	0.407	1.234	0.751–2.029
	Donkey	92	0 (0)	–	–	–
Location	Halidegei	228	51 (22.37)	<0.0001	Ref	Ref
	Sidahfagei	193	37 (19.17)	<0.0001	3.217	2.076–4.983
	Hassoba	162	27 (16.67)	<0.0001	3.663	2.327–5.768
	Kealatburi	153	47 (30.72)	<0.0001	5.074	3.066–8.396

Abbreviations: *N*, number of animals examined; AOR, adjusted odds ratio; CI, confidence interval; Ref, reference.

Table 7
Livestock owners' knowledge and experiences regarding zoonotic infections.

Variable	Response	Frequency (%)	Chi-square (*P*-value)
Gender	Male	60 (68.96)	0.003
	Female	27 (31.03)	(0.580)
Age	18–30	42 (48.28)	3.951
	>30	45 (51.72)	(0.041)*
Location	Amibara	47 (54.02)	0.019
	Haruka	40 (45.98)	(0.547)
Have you ever heard of vector-borne zoonotic diseases (diseases that can be transmitted from animals to humans) affecting livestock?	Yes	54 (62.07)	2.941
	No	33 (37.93)	(0.071)
Are you aware of the potential risks associated with consuming raw animal-origin foods (such as raw milk or undercooked meat)?	Yes	72 (82.76)	0.036
	No	15 (17.24)	(0.578)
Have you observed any incidents of mass death among young animals in your livestock over the past years?	Yes	33 (37.93)	1.393
	No	54 (62.07)	(0.181)
Have you noticed any evidence of abortion among your livestock over the past six months?	Yes	42 (48.28)	0.371
	No	45 (51.72)	(0.364)
If yes, do you have a protocol for handling aborted fetuses and placental tissues to minimize disease transmission risks?	Yes	0 (0)	
	No	87 (100)	
Do you routinely use bednets during sleep to reduce the risk of vector-borne diseases transmitted by insects (e.g. malaria or Rift Valley fever)?	Yes	24 (27.59)	1.693
	No	63 (72.41)	(0.156)
Do you believe that using bednets can reduce the risk of zoonotic disease transmission?	Yes	31 (35.63)	0.174
	No	56 (64.37)	(0.448)

Note: *$P < 0.05$.

Ethiopia by Asebe et al. (2020) and Bronsvoort et al. (2022); yet it was lower, compared to studies in South Africa (42.9%; Ngoshe et al., 2020), Uganda (18.6%; Ndumu et al., 2021) and Ethiopia (17.9%, Ibrahim et al., 2021). Variations in seroprevalence could stem from differences in sample size, geographical factors, vector activity, and other variables.

The seroprevalence of RVF was notably higher in goats (42.2%, 95% CI: 39.61–44.99%) than in cattle (14.3%), sheep (21.5%), and camels (31%) ($P < 0.0001$). This increased prevalence in goats could be attributed to their browsing behaviour; vegetation provides mosquitoes with resting sites during peak temperatures thus exposing goats to the mosquito vector. However, lower seroprevalence of RVF in goats was observed in the studies by Ngoshe et al. (2020) in South Africa (9.30%) and by Kainga et al. (2022) in Malawi (7.72%).

Kainga et al. (2022) documented a higher seroprevalence of RVF in sheep in Malawi at 25.68%, whereas the present study recorded a seroprevalence of 21.5%, which surpasses the seroprevalence reported in previous studies in Ethiopia (7.4%, Ibrahim et al., 2021), Tanzania (6.1%, Sindato et al., 2022), and Uganda (2.2%, Budasha et al., 2018).

The results of the present study revealed that 31% of camels were seropositive for RVF, indicating significant exposure to the virus among camel populations. A previous study by Ibrahim et al. (2021) conducted in the Somali Region of Ethiopia reported an even higher seroprevalence of RVF (42.6%) in camels. Higher seroprevalence rates were also documented in Mauritania (32%) and Tunisia (34%) by Hammami et al. (2017) and Selim and Abdelhady (2020), respectively. Conversely, lower seroprevalence rates were observed in Egypt (21.5%) and Tanzania (27.5%) according to Imam et al. (1979) and Sindato et al. (2012), respectively.

This study found a seroprevalence of 0% for RVF in donkeys, suggesting that donkeys in the study area do not harbor RVFV. This result aligns with findings from Egypt (Ebogo-Belobo et al., 2023).

The overall prevalence of RVF infection varied across the study sites, with Kealatburi recording the highest prevalence. Livestock herds in the Kealatburi area were five times more likely to be seropositive for RVFV infection than those in Halidegei area (OR: 5.074, 95% CI: 3.066–8.396, $P < 0.0001$). The high risk in Kealatburi can be attributed to environmental modification by the river with flood plains formed during rains and increased temperatures that favor the breeding of mosquitoes transmitting arboviruses. The convergence of wildlife, migratory birds, and livestock for water and pasture, especially during the dry seasons, leads to exposure to the vectors.

One limitation of the present study is that, although ELISA tests offer a rapid and replicable outcome, their utility is hindered by the issue of cross-reactivity among arboviruses. Relying solely on ELISA often leads to erroneous positive results because of the simultaneous presence of various arboviruses (Olufemi et al., 2021). Neutralization tests can mitigate the inconsistencies commonly encountered with other assays as a result of cross-reactivity. While most studies typically conduct confirmatory neutralization tests following initial ELISA screening, this step was omitted in the present study due to budget constraints.

5. Conclusions

The study showed that RVF is circulating among livestock in the Afar Region, as indicated by the presence of RVF antibodies using cELISA. In the present study area where there is heavy rainfall in the upper Awash basin frequent flooding is common and water accumulates and remains for an extended period thus creating environments conducive to mosquito breeding. Mosquitoes, in turn, act as vectors for the Rift Valley fever virus. Increased mosquito populations in areas with stagnant water could lead to a higher likelihood of virus transmission to animals and humans, resulting in an elevated detection of IgG antibodies as an immune response. In addition, species and location were risk factors for the circulation of RVFV in the present study area. Hence, to understand the epidemiology of RVF infection and confirm the presence of the RVF in the study area, further in-depth research on virus isolation and molecular characterization, entomological surveillance, and assessment of the role of wildlife in the transmission of the virus is needed in the Afar Region of Ethiopia. Moreover, within a One Health approach, a human RVF study should be carried out to investigate the potential public health hazard of RVF. It is advised that routine monitoring and management of transboundary animal movements be implemented in the studied areas, together with increasing the community sensitization about the disease dangers, to lower the risk of the disease spreading and set up early warning, surveillance, and control strategies based on the identified risk factors. In order to develop successful prevention and control strategies at the national and regional levels, the seroprevalence data from this study are essential. Additionally, infection control measures targeting the significant risk factors should be put in place to alleviate the burden of disease in the study areas.

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Ethical approval

The Animal Research Ethics Committee of the College of Veterinary Medicine and Agriculture, Addis Ababa University, has reviewed the research project and approved (VM/ERC/40/03/15/2023) all methods, including blood sample handling and collection. Livestock owners have been adequately informed about the nature, purpose, risks, and benefits of the research, and they have voluntarily agreed for the collection of blood samples from their animals and the ARRIVE criteria (Percie Du Sert et al., 2020) were adhered to throughout the entire study process. All ordinary ethical considerations were followed with firm observation to the five degrees of animal welfare.

CRediT authorship contribution statement

Jemberu A. Megenas: Conceptualization, Methodology, Investigation, Data curation, Visualization, Writing – original draft, Writing – review & editing. **Mengistu L. Dadi:** Conceptualization, Methodology, Investigation, Writing – review & editing, Project administration, Funding acquisition, Supervision, Validation. **Tesfu K. Mekonnen:** Supervision, Resources, Writing – review & editing. **James W. Larrick:** Resources, Writing – review & editing. **Gezahegne M. Kassa:** Conceptualization, Methodology, Investigation, Resources, Supervision, Validation, Writing – review & editing.

Declaration of competing interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The data supporting the conclusions of this article are included within the article and its supplementary file.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.crpvbd.2024.100215.

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