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Original Research

Community knowledge, attitude and practice on rabies and retrospective study of human and animal rabies exposures in selected districts of the Southern Zone of Tigray, northern Ethiopia

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Abstract

Introduction: Rabies is a fatal viral disease affecting all endothermic animals, including humans. It predominantly impacts low- and middle-income countries such as Ethiopia. Community awareness plays a vital role in the control of the disease. This study aimed to assess community knowledge, attitudes, and practices (KAP) regarding rabies, and to retrospectively analyze human and animal rabies cases over the previous 5 years in the studied area.
Methods: A cross-sectional study was conducted from September 2021 to August 2023 in the rural Raya-Alamata and Ofla/Korem *woredas* (districts) of the Southern Zone of Tigray Regional State in northern Ethiopia. Data were collected using a structured questionnaire with 20 questions, administered to 375 respondents. Additionally, 5 years of retrospective rabies exposure data were gathered from hospitals and veterinary clinics, and analyzed.
Results: Among the respondents, 52.4% had poor knowledge, 54.9% poor attitudes, and 56.1% poor practices. Poor knowledge was significantly associated with living in rural areas (p=0.002), being a woman working at home (p=0.003), a farmer (p=0.022), and not owning a dog (p<0.001). Poor attitudes were linked to being female (p<0.001), rural residence (p<0.001), and not owning a dog (p<0.001). Poor practices were associated with secondary education (p=0.035), not owning a dog (p=0.013), and having poor knowledge (p=0.03) or attitudes (p<0.001). Overall, 53.1% of respondents had poor KAP scores. Being female and living in rural

areas were significant predictors of overall poor KAP ($p<0.001$) as the two groups have poor access to information and health services. Retrospective data showed 375 human and 71 animal rabies cases. Most human cases were male (80.8%), children aged <15 years (43.2%), and rural residents (86.1%).
Conclusion: The study highlights poor community KAP regarding rabies and high rates of human exposure. There is a need for an increased public education and awareness creation on rabies. Community-based education regarding rabies should be provided especially for rural residents, women at home, farmers, and those who do not own dogs. Government bodies should provide sufficient human and veterinary health facilities, particularly in rural areas. Regular mass vaccination of owned dogs and elimination of stray dogs are important interventions. Finally, to have successful rabies prevention and control strategies, there should be a strong intersectorial collaboration between public health, veterinary professionals and local authorities in one health approach.

Keywords

attitude, dogs, Ethiopia, human, knowledge, practice, rabies exposure.

Introduction

Rabies is one of the oldest known zoonotic diseases caused by a virus, and death nearly always follows once an animal or human has been clinically ill[1]. Rabies affects the central nervous system of all endothermic animals, including humans[2]. Carnivorous animals such as dogs, cats, foxes, jackals, bats, raccoons and skunks (depending on the continent) are rabies reservoirs[3]. Rabies transmits to humans through close contact with the saliva (from a bite or scratch) of infected animals. The effect of rabies virus exposure depends on a number of factors, including the severity of the wound(s), the anatomical site of the bite on the body, the viral quantity and variant (genotype) inoculated into the wound(s), and the timeliness of post-exposure prophylaxis[4]. In 99% of human cases, domestic dogs are responsible for rabies virus transmission. However, other domestic animals, and wild animals, may also be the victims of the disease[5].

Rabies is of significant economic and public health importance in areas where it is endemic. It is included in the list of transmissible diseases considered to be of socioeconomic and/or public health importance within countries[6]. Despite this, rabies is considered one of the neglected tropical diseases. The main reason for rabies to remain a neglected zoonotic disease in many developing countries, including those in Asia and Africa, is a lack of specific diagnostic and surveillance techniques[7].

Rabies affects mainly low- and middle-income countries[8]. The disease has worldwide distribution, except in some countries where there is a strict quarantine system, a rigorous eradication program, or natural barriers like mountains and rivers[7]. Rabies occurs in more than 150 countries and territories. Canine rabies causes an estimated 61,000 deaths per year within the wider international community, of which 56% and 44% of the deaths occur in Asia and Africa, respectively[4]. According to WHO, dog-mediated rabies causes costs of A$6.23 (US$8.6) billion each year[9]. Rabies remains a very serious public health concern in most developing countries, where urban and suburban rabies are more prevalent and dogs (especially stray dogs) appear to be the main reservoir for disease transmission[10].

In Ethiopia, a retrospective review of human rabies exposure cases revealed significant regional variation. In the Tigray Regional State (2012–2015) in northern Ethiopia, incidence rates ranged from 35.8 to 89.8 per 100,000 inhabitants per year[11], while in subcities of the Ethiopian capital, Addis Ababa (2015–2019), cumulative incidence ranged from 0.1 to 24.8 per 100,000 inhabitants per year[12]. However, the actual burden of the disease is likely much higher due to substantial underreporting. Many cases go unreported or are not brought to health centers, primarily due to low public awareness of rabies and limited access to healthcare services[13,14].

A systematic and meta-analysis of rabies incidence in Ethiopia reported an annual pooled incidence rate of human exposure to suspected rabid animals of 33.65 (95% confidence interval (CI)=31.82–35.49) per 100,000 humans and suspected rabies deaths in humans of 4.57 (95%CI=2.93–6.21) per one million humans annually[15]. Moreover, a retrospective study (1990–2000) indicated that, of 1936 laboratory-confirmed rabies cases in Addis Ababa, 1724 were dogs, 116 cats, 37 cattle, 13 horses, 19 donkeys, 13 sheep and goats, 7 hyenas, and 7 monkeys[16].

In the North Western Zone of Tigray, a 4-year (2012–2015) retrospective study reported 2180 human rabies exposure cases in Suhul General Hospital. The majority were males (63%) aged >15 years. The calculated incidences per 100,000 population were 35.5, 63, 89.9 and 73.1 for the years of 2012, 2013, 2014, and 2015, respectively[11]. Furthermore, a 5-year (2014–2018) retrospective study conducted in Axum General Hospital, Central Zone of Tigray, showed a total of 2404 human rabies exposure cases out of which 59% were males aged >15 years[17].

In the control and prevention of rabies, among other factors such as vaccination, surveillance, and dog management, the awareness of the community plays important role. Knowledge, attitudes, and practices (KAP) studies have been used widely to enhance community knowledge and thus change attitude and improve practices that may aid in disease prevention and control[18]. Hence, assessing the KAP of the community on rabies is an essential intervention in the control and prevention of rabies. However, generally in Ethiopia and specifically in the project area, there are few public KAP studies on rabies. A cross-sectional study conducted in and around Gondar, north-western Ethiopia, reported that out of the total (N=384) respondents, 51% had poor KAP on rabies. Educational status (χ^2=21.152), monthly income (χ^2=23.059), sex (χ^2=11.249), source of information (χ^2=8.594) and residence (χ^2=4.109) were significantly associated with KAP scores ($p<0.05$)[19]. Another study, conducted in Addis Ababa, reported the levels of KAP of the community concerning rabies as follows. Out of the total (N=1260) respondents, 75% had a moderate level of knowledge, 52% had an intermediate attitude towards rabies, and 67% had an intermediate level of knowledge of practices towards rabies[20].

Mapping the knowledge, perceptions, and existing practices regarding rabies is considered an important milestone in the control and prevention of the disease. As indicated above, although the magnitude and distribution of rabies exposure – both generally in Ethiopia and specifically in Tigray – is high, there has been no coordinated study on the community's KAP concerning rabies in the Tigray Region.

Therefore, this study was designed to assess the community's level of KAP towards rabies, as well as to retrospectively analyze human and animal rabies exposure cases over the past 5 years in the project area.

Methods

Study area

The study was conducted in Raya-Alamata *woreda* and Ofla/Korem *woreda* of the Southern Zone of Tigray Regional State (Fig1), northern Ethiopia. Raya-Alamata and Ofla/Korem *woredas* are located at 577 km and 615 km north of the Ethiopian capital Addis Ababa, respectively.

Raya-Alamata *woreda* is a lowland area located at 12°25′ north and 39°33′ east, with an elevation of 1520 m above sea level. Out of the total population 33,876 (28.4%) are urban, and 85,403 (71.6%) are rural residents[21]. In the *woreda* there is one general hospital, which provides health services to the general population. There is also one medium-level veterinary clinic, which provides veterinary services to animal owners of the *woreda*.

Ofla/Korem *woreda* is located at 12°30′ north, 39°31′ east, and an elevation of 2539 m above sea level. During 2007, the national census of Ethiopia reported a human population of 16,856 (11.7%) urban and 126,889 (88.3%) rural[22]. In the *woreda* there is one general hospital and one medium-level veterinary clinic, which give health services to the human and animal populations, respectively.

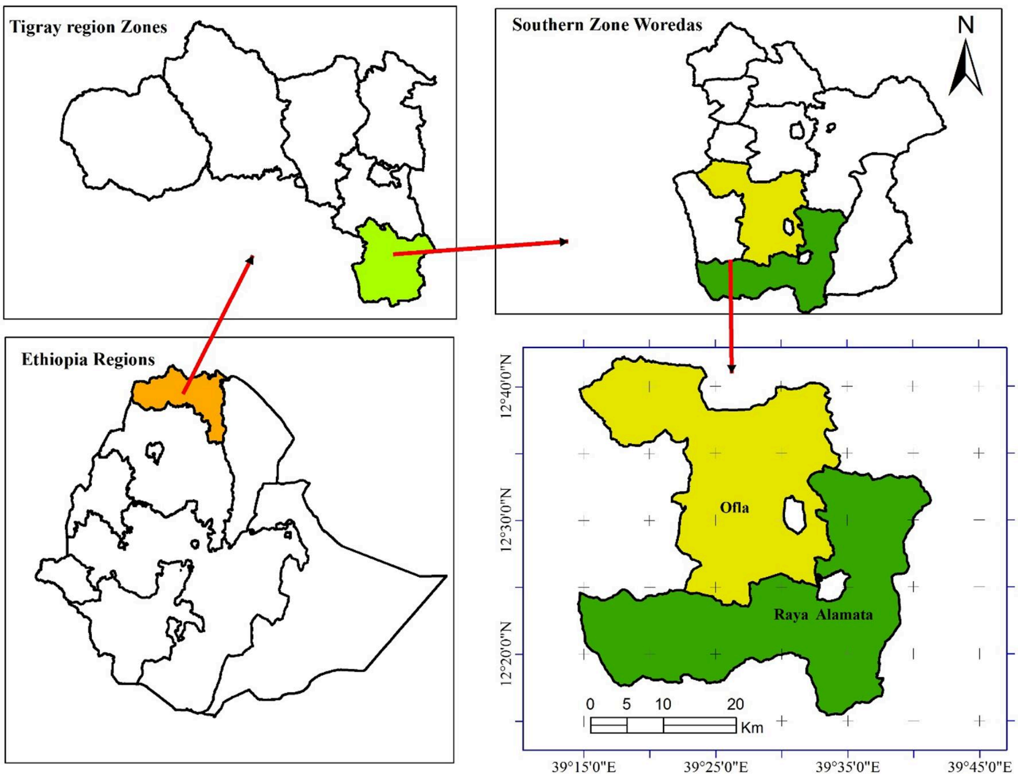

Figure 1: Map of the study area (created by ArcGIS_WGS_1984), Tigray, northern Ethiopia.

Study population

The study population for the KAP study was the human population at household level. For the retrospective study, the population was human and animal rabies cases (2017–2021) from the registration logbook of the general hospitals and medium-level veterinary clinics of the respective *woredas*.

Study design

A quantitative cross-sectional study, from September 2021 to August 2023, was conducted in the study area. A structured and close-ended questionnaire was developed to collect data for the KAP of the community on rabies, and various demographic data (sex, residence, age, occupation, educational status, and dog ownership) of the respondents. Retrospective 5-year (2017–20210) records of human and animal rabies exposures were collected from the registration logbooks of the hospitals and veterinary clinics of the respective *woredas*.

Sample size determination

For the KAP study, the required sample size determination was calculated as per Yamane's recommendation considering 95% confidence interval and 5% absolute precision levels[23], and 10% non-response rate. The calculated sample size was 437.

Sampling methods

A multistage sampling technique was employed for this study. Out of the total five *woredas* in the Southern Zone of Tigray, two (Raya-Alamata and Ofla/Korem) were purposively selected based on their geographical characteristics (highland and lowland) and the presence of relatively large veterinary clinics and human general hospitals. From each selected *woreda*, three *kebeles* (the lowest administrative units) were randomly selected. The selected *kebeles* and their respective populations were as follows:

- Raya-Alamata *woreda*: Waja-Timuga (*n*=14,284), Kebele 1 (*n*=11,204), and Kebele 2 (*n*=14,180)
- Ofla/Korem *woreda*: Adigolo (*n*=12,060), Hashenge (*n*=8322), and Harle (*n*=6239).

The predetermined sample size (*N*=437) was proportionally distributed among the selected *kebeles* based on their population sizes. Referring to the above proportion of urban and rural population of the studied area, at least 71.6% of the samples were drawn from the rural population. Within each selected *kebele*, households were chosen using a systematic random sampling technique. In each household, the household head was selected for the face-to face interview, provided that he/she was aged >15 years and had resided in the *woreda* for at least 6 months. If no eligible respondent was found in a selected household, the next household was approached until the required sample size was reached.

Data collection

To assess the community KAP about rabies, each respondent was asked, face-to-face, seven questions regarding knowledge, seven questions regarding attitude, and six questions regarding practices. The questionnaires were pretested before administration and adjusted accordingly. The procedure for pretesting the questionnaire included several steps. First, the draft questionnaire was reviewed and commented on by subject-matter experts. Second, it was administered to a small representative group to evaluate its clarity, flow, length, and response options. Third, the questionnaire was assessed for its simplicity and suitability for data entry.

For knowledge study

For the knowledge study, respondents received one mark for each question answered correctly and zero marks for each incorrect response. The responses for which respondents gave the correct answer were counted, and total knowledge was scored. The score varied from 1 to 7, and the mean score was computed by determining the total knowledge score of all respondents. Respondents who scored greater than or equal to the mean value of 4.5 were grouped as having good knowledge and coded as 0, whereas those who scored less than the mean value were grouped as having poor knowledge and coded as 1.

For attitude study

For attitude, there were seven positive statements with five choices: 'strongly agree', 'agree', 'neutral', 'disagree', and 'strongly disagree', with scores of 5, 4, 3, 2, 1, respectively. The score varied from 17 to 35, and all individual answers were summed for the total score and calculated for the mean value (26.25). Respondents who scored greater than or equal to the mean value were grouped as having a positive attitude level and coded as 0, whereas the respondents who scored less than the mean value were grouped as having a poor attitude level and coded as 1.

For practice study

Regarding practice, respondents received one mark for each question answered correctly and zero marks for each incorrect response. The responses for which respondents gave the correct answer were counted, and the total practice was scored. The score varied from 0 to 7, and the mean score was computed by determining the total practice score of all respondents. Respondents who scored greater than or equal to the mean value of 3.11 were grouped as having good practice and coded as 0, whereas those who scored less than the mean value were grouped as having poor practice and coded as 1.

For overall knowledge, attitude, and practice

To determine the overall KAP of respondents' total knowledge scores, the total attitude score and total practice score were summed together, and the mean score was computed. Respondents who scored greater than or equal to the mean value of 33.8 were grouped as having good KAP and coded as 0, whereas those who scored less than the mean value were grouped as having poor KAP and coded as 1.

Data collection for retrospective study

For the retrospective study, data on human and animal rabies cases from the previous 5 years (2017–2021) were collected from the registration logbooks of general hospitals and medium-scale veterinary clinics in the respective *woredas*.

Data management and analysis

The data on KAP from the questionnaire survey, as well as from the rabies post-exposure prophylaxis registration book in human hospitals and animal rabies exposure records from veterinary clinics, were entered into an Excel sheet. The data were then exported to the Statistical Package for the Social Sciences v20 (IBM Corp; https://www.ibm.com/products/spss-statistics) for analysis. Descriptive statistics (frequency and percentage) were performed and presented in tables to summarize the data. Logistic regression was used to assess the association between independent variables and the dependent variable (KAP) of the community regarding rabies. In the bivariate analysis, variables with *p*-values less than 0.25 were selected for multivariate regression analysis because they were considered to have potential predictive effects on the response variable, as their associations may be masked by confounding or suppression effects. Therefore, this threshold was used as a screening criterion to allow variables to be included in the multivariate regression analysis. In the multivariate regression analysis, at 95% confidence interval (CI), variables with a *p*-value less than 0.05 were considered as statistically significant.

Ethics approval

This study was approved by the institutional review board (MU-IRB 1898/2021, July 01/20210) hosted at College of Health Sciences, Mekelle University, Ethiopia. Informed consent was obtained from all study participants after explaining the purpose and objectives of the study.

Results

Sociodemographic information of the community

During the study, a total of 437 respondents were interviewed. The majority of the respondents were males (351, 80.3%). The ages of respondents were classified as ≤30, 31–45, and ≥46 years, comprising about 49 (11.2%), 194 (44.4%), and 194 (44.4%) respondents, respectively. The majority of the respondents lived in rural areas (270, 61.8%). The majority of the respondents (301, 68.9%) had no formal education, followed by those with only primary education (57, 13.0%). Most of the respondents (243, 55.6%) were farmers. Of the total respondents, 115 (26.3%) had dogs (Table 1).

Table 1: Sociodemographic information of respondents in study area (*N*=437)

Variable		Frequency	%
Sex	Female	86	19.7
	Male	351	80.3
Residence	Urban	167	38.2
	Rural	270	61.8
Age group (years)	≤30	49	11.2
	31–45	194	44.4
	≥46	194	44.4
Occupation	Civil servant	26	5.9
	Farmer	243	55.6
	Woman working at home	67	15.5
	Other	101	23.1
Educational status	No formal education	301	68.9
	Primary education	57	13
	Secondary education	49	11.2
	Higher education	30	6.9
Dog ownership	Did not have dog	322	73.7
	Had dog	115	26.3

Community knowledge regarding rabies

According to this study, more than half of the respondents (229, 52.4%) had poor knowledge of rabies. All respondents had heard about rabies. However, the majority (333, 76.2%) were found to have misconceptions about the causative agent, believing that thirst and starvation cause rabies. Most study respondents (293, 67.0%) knew that the species affected by rabies include canines, cattle, equines, and humans, and 400 (91.5%) recognized that rabies can be transmitted from animals to humans (Table 2).

Table 2: Frequency of respondent knowledge regarding rabies in study area (*N*=437)

Question/statement	Response	Frequency	%
Have you heard about rabies?	Yes	437	100
	No	0	0
What is the cause of rabies?	Virus	103	23.6
	Thirst and starvation	333	76.2
Species affected by rabies are canines, cattle, equines, and humans.	Yes	293	67.0
	No	144	33.0
Sources of rabies are domestic dogs, cats, bats, and wild canines.	Yes	238	54.5
	No	199	45.5
Clinical signs and symptoms of rabies are salivation and change in behaviour, biting, cease eating and drinking.	Yes	220	50.3
	No	217	49.7
Rabies can be transmitted from animals to humans.	Yes	400	91.5
	No	37	8.5
Rabies can be transmitted by biting, contact of saliva with wounds and open mucous membrane.	Yes	284	65
	No	153	35

Community attitudes regarding rabies

According to this study, more than half (240, 54.9%) of respondents had a negative attitude towards rabies. The results of the study revealed that community attitudes regarding the statement 'Rabies is fatal' were as follows: 110 (25.2%) strongly agreed, 206 (47.1%) agreed, 15 (3.4%) were neutral, 101 (23.1%) disagreed, and 5 (1.1%) strongly disagreed. For the statement 'Stray dogs are dangerous', 43 (9.8%) strongly agreed, 290 (66.4%) agreed, 97 (22.2%) were neutral and 7 (1.6%) disagreed.

Regarding the statement 'Rabies can be prevented by educating people', 83 (19.0%) strongly agreed, 249 (57.0%) agreed, 59 (13.5%) were neutral, and 46 (10.5%) disagreed. For the statement 'Rabies is prevented by the killing of stray dogs', 72 (16.5%) strongly agreed, 269 (61.6%) agreed, 85 (19.5%) were neutral, 17 (3.9%) disagreed, and 1 (0.2%) strongly disagreed.

For responses to the statement 'Rabies can be prevented by mass vaccination of dogs', 77 (17.6%) respondents strongly agreed, 196 (44.9%) agreed, 31 (7.1%) were neutral, 132 (30.2%) disagreed, and 1 (0.2%) strongly disagreed. For the statement 'After being bitten by a rabid animal, washing with soap and water and going to a medical center is necessary', 45 (10.3%) respondents strongly agreed, 349 (79.9%) agreed, 3 (0.7%) were neutral, and 40 (9.2%) disagreed. Regarding the statement 'A bitten human cannot be cured after showing clinical signs', 57 (13.1%) respondents strongly agreed, 240 (54.9%) agreed, 4 (0.9%) were neutral, 135 (30.9%) disagreed, and 1 (0.2%) strongly disagreed (Table 3).

Table 3: Frequency of community attitudes regarding rabies in study area (*N*=437)

Statement	Response	Frequency	%
Rabies is fatal.	Strongly agree	110	25.2
	Agree	206	47.1
	Neutral	15	3.4
	Disagree	101	23.1
	Strongly disagree	5	1.1

Stray dogs are dangerous.	Strongly agree	43	9.8
	Agree	290	66.4
	Neutral	97	22.2
	Disagree	7	1.6
Rabies can be prevented by educating people.	Strongly agree	83	19.0
	Agree	249	57.0
	Neutral	59	13.5
	Disagree	46	10.5
Rabies is prevented by killing stray dogs.	Strongly agree	72	16.5
	Agree	269	61.6
	Neutral	85	19.5
	Disagree	17	3.9
	Strongly disagree	1	0.2
Rabies can be prevented by mass vaccination of dogs.	Strongly agree	77	17.6
	Agree	196	44.9
	Neutral	31	7.1
	Disagree	132	30.2
	Strongly disagree	1	0.2
After being bitten by a rabid animal, wash with soap and go to the medical center.	Strongly agree	45	10.3
	Agree	349	79.9
	Neutral	3	0.7
	Disagree	40	9.2
A bitten human can't be cured after showing clinical signs of rabies.	Strongly agree	57	13.1
	Agree	240	54.9
	Neutral	4	0.9
	Disagree	135	30.9
	Strongly disagree	1	0.2

Community practices regarding rabies

Results for respondents' practice regarding rabies revealed that more than half (245, 56.1%) had poor practice. The study showed that 80 (18.3%) of respondents vaccinated their dog, 57 (13.0%) had a vaccine certificate, and 327 (74.8) of the respondents did not keep their dog indoors. A total of 332 (76.0%) had a willingness to take training, and 350 (80.1%) replied that they would kill an animal after it became rabid. A total of 199 (45.5%) respondents said they used traditional treatments for those exposed to rabies (Table 4).

Table 4: Frequency of community practices regarding rabies in study area (*N*=437)

Question/statement	Response	Frequency	%
Do you vaccinate your dog?	Yes	80	18.3
	No	357	81.7
Do you have a vaccination certificate for your dog?	Yes	57	13.0
	No	380	87.0
Do you keep your dog indoors or tied up?	Yes	110	25.2
	No	327	74.8
Are you willing to take training?	Yes	332	76.0
	No	105	24.0
Action-taking for rabid dogs	Tie	87	19.9
	Euthanasia	350	80.1
Action-taking for exposed human	Traditional treatment	199	45.5
	Post-exposure vaccine	238	54.5

Factors associated with community knowledge regarding rabies

The adjusted odds ratio of the present study of the multivariate logistic regression of knowledge in relation to sociodemographic factors revealed that living in a rural area (adjusted odds ratio (AOR)=5.08; p=0.002), being a farmer (AOR=3.99; p=0.022), being a woman working at home (AOR=48.70; p=0.003) and who did not own dog (AOR=473.20; p<0.001) were independent predictors of poor knowledge (Table 5).

In the present study, respondents who lived in rural areas were 5.08 times (95%CI=1.86–13.92) less likely to be knowledgeable than urban residents. Women at home were 48.70 times (95%CI=3.70–640.51) less likely to be knowledgeable than civil servants. Farmer respondents were 3.99 times (95%CI=1.46–134.25) less likely to be knowledgeable than civil servants. Respondents who did not have a dog were 473.20 times (CI=62.55–3579.84) less likely to be knowledgeable than dog owners.

Although the associations were not statistically significant ($p>0.05$), both sex and age showed potential effects on respondent level of knowledge. Female respondents had lower odds of having good knowledge compared to males (OR=0.79). Respondents aged 31–45 years had 20% lower odds (OR=0.80) of good knowledge compared to those aged ≥46 years, while those aged ≤30 years had 31% lower odds (OR=0.69) than those aged ≥46 years.

Table 5: Logistic regression results of community knowledge in relation to sociodemographic factors in study area (*N*=437)

Variable		Knowledge		COR (95%CI)	*p*-value	AOR (95%CI)	*p*-value
		Good (%)	Poor (%)				
Sex	Female	25 (12)	61 (26.6)	2.61 (1.59–4.43)	<0.001	1.27 (0.36–4.53)	0.714
	Male	183 (88)	168 (73.4)				
Residence	Urban	122 (58.7)	45 (19.7)				
	Rural	86 (41.3)	184 (80.3)	15.80 (3.78–8.89)	<0.001	5.08 (1.86–13.92)	0.002
Occupation	Civil servant	25 (12)	1 (0.4)				
	Farmer	90 (43.3)	153 (66.8)	142.5 (5.66–318.99)	<0.001	3.99 (1.46–134.25)	0.022
	Woman working at home	9 (4.3)	58 (25.3)	161 (19.37–1340.27)	<0.001	48.70 (3.70–640.51)	0.003
	Other	84 (40.4)	17 (7.4)	5.06 (0.64–39.92)	0.124	4.27 (0.50–36.27)	0.184
Dog ownership	Did not have dog	94 (45.2)	228 (99.6)	273.14 (40.34–2130.11)	<0.001	473.20 (62.55–3579.84)	<0.001
	Had dog	114 (54.8)	1 (0.4)				

AOR, adjusted odds ratio. CI, confidence interval. COR, crude odds ratio.

Factors associated with community attitudes regarding rabies

The AOR analysis revealed that being female (AOR=4.43; 95%CI=2.07–9.49; $p<0.001$), living in a rural area (AOR=17.89; 95%CI=9.34–34.66; $p<0.001$), and not owning a dog (AOR=215.31; 95%CI=61.28–756.46; $p<0.001$) were significantly associated with higher odds of having a poor attitude.

Although not statistically significant, respondents aged 31–45 years had lower odds (AOR=0.741; 95%CI=0.40–1.38) of having a poor attitude compared to those aged ≥46 years. Conversely, respondents aged ≤30 years had 1.6 times higher odds of having a poor attitude compared to those aged ≥46 years, though this result was also not statistically significant (Table 6).

Table 6: Logistic regression results of community attitudes in relation to sociodemographic factors in study area (*N*=437)

Variable		Attitude		COR (95%CI)	*p*-value	AOR (95%CI)	*p*-value
		Good (%)	Poor (%)				
Sex	Female	24 (12.2)	62 (25.8)	2.51 (1.49–4.20)	<0.001	4.43 (2.07–9.49)	<0.001
	Male	173 (87.8)	178 (74.2)				
Age group (years)	≤30	13 (6.6)	36 (15)	2.07 (1.03–4.14)	0.042	1.60 (0.47–5.44)	0.454
	31–45	101 (51.3)	93 (38.8)	0.66 (0.44–0.97)	0.064	0.741 (0.40–1.38)	0.344
	≥46	83 (42.1)	111 (46.2)				
Residence	Urban	221 (61.4)	46 (19.2)				
	Rural	76 (38.6)	194 (80.8)	6.36 (4.14–9.76)	<0.001	17.89 (9.34–34.66)	<0.001
Dog ownership	Did not have dog	86 (43.7)	236 (98.3)	76.1 (27.25–212.79)	<0.001	215.31 (61.28–756.46)	<0.001
	Had dog	111 (56.3)	4 (1.7)				

AOR, adjusted odds ratio. CI, confidence interval. COR, crude odds ratio.

Factors associated with community practices regarding rabies

The AORs from the multivariate logistic regression analysis revealed that secondary education status (AOR=0.03; $p=0.035$), not owning a dog (AOR=53.02; $p=0.013$), poor knowledge (AOR=10.30; $p=0.03$), and poor attitudes (AOR=614.67; $p<0.001$) were independent predictors of poor practice. Respondents who had completed secondary education had odds of better practices that were 0.03 (95%CI=0.001–0.778) times those of respondents who had higher education.

Those who did not own a dog had odds of better practices that were 53.02 (95%CI=2.32–1209.50) times lower than for those who owned a dog. The odds of poor practice were 10.30 (95%CI=1.22–87.14) times higher in respondents with poor knowledge than those having good knowledge. Furthermore, attitude was found to determine the practices of respondents. People having poor attitudes towards rabies management practices had odds that were 614.67 (95%CI=75.43–5008.86) times lower than their counterparts with good attitudes towards rabies management.

Both residence and age of respondents were found to affect practices of respondents on prevention and control of rabies, though it was not statistically significant ($p>0.05$). People residing in rural areas had odds of poor practice that were 3.5 (95%CI=0.40–31.21) times higher than their urban resident counterparts. According to age group, respondents aged ≤30 years were found to have odds of better practice that were 4.2 (95%CI=0.13–137.95) times lower than those aged 46 years or more. Furthermore, respondents aged 31–45 years had odds of better practice that were 0.89 (95%CI=0.14–5.59) times higher than respondents aged ≥46 years (Table 7).

Table 7: Logistic regression results of community practice in relation to sociodemographic factors (*N*=437)

Variable		Practices		COR (95%CI)	*p*-value	AOR (95%CI)	*p*-value
		Good (%)	Poor (%)				
Sex	Female	24 (12. 5)	62 (25.3)	2.34 (1.42–4.1)	<0.001	1.67 (0.22–12.94)	0.623
	Male	168 (87.5)	83 (74.7)				
Age group (years)	≤30	13 (6.8)	36 (14.7)	1.79 (0.91–3.55)	0.090	4.20 (0.13–137.95)	0.421
	31–45	102 (53.1)	92 (37.6)	0.61 (3.97– 8.88)	0.011	0.89 (0.14–5.59)	0.901
	≥46	77 (40.1)	117 (47.8)				
Residence	Urban	118 (61.5)	49 (20)				
	Rural	74 (38.5)	196 (80)	6.378 (4.16–9.77)	<0.001	3.52 (0.40–31.21)	0.258
Educational status	Secondary education	4 (22.9)	5 (2)	3.295 (0.366–29.67)	0.280	0.03 (0.001–0.778)	0.035
	Primary education	54 (28.1)	3 (1.2)	1.61 (0.60–16.19)	0.685	0.13 (0.01–2.27)	0.160
	No formal education	65 (33.9)	236 (96.3)	105.29(14.08–787.627.29)	<0.001	0.00 (0.00–∞)	0.998
	Higher level	29 (15.1)	1 (0.4)				
Dog ownership	Did not have dog	79 (41.1)	243 (99.2)	173.79 (41.96–719.694)	<0.001	53.02 (2.32–1209.50)	0.013
	Had dog	113 (58.9)	2 (0.8)				
Knowledge	Good	190 (99)	18 (7.3)				
	Poor	2 (1)	227 (92.7)	1198 (274–5229)	<0.001	10.30 (1.22–87.14)	0.03
Attitudes	Good	188 (97.9)	9 (3.7)	3042 (717.92–12889.74)	<0.001	614.67 (75.43–5008.86)	<0.001
	Poor	4 (2.1)	236 (96.3)				

AOR, adjusted odds ratio. CI, confidence interval. COR, crude odds ratio.

Factors associated with community overall KAP regarding rabies

The overall KAP of the participants was found to be below average. A total of 53.1% of respondents had poor overall KAP, while the remaining 46.9% had good overall KAP. Being female (AOR=4.59; $p<0.001$) and living in a rural area (AOR=8.02; $p<0.001$) were identified as independent predictors of poor KAP. However, age showed no statistically significant association with overall KAP ($p>0.05$) (Table 8).

Some independent variables were omitted because some factors did not have any significant influence on overall KAP ($p>0.05$).

Table 8: Logistic regression results of community overall KAP in relation to sociodemographic factors in study area (*N*=437)†

Variable		Overall KAP		COR (95%CI)	*p*-value	AOR (95%CI),	*p*-value
		Good (%)	Poor (%)				
Sex	Female	25 (12.2)	61 (26.3)	2.57 (1.54–4.28)	<0.001	4.59 (2.5–8.43)	<0.001
	Male	180 (87.8)	171 (73.7)				
Age group (years)	≤30	15 (7.3)	34 (14.7)	1.77 (0.9–3.46)	0.096	1.32 (0.63–2.76)	0.464
	31–45	105 (51.2)	8 (38.4)	0.66 (0.44–0.99)	0.043	0.68 (0.43–1.07)	0.09
	≥46	85 (41.5)	10 (47.8)				
Residence	Urban	123 (60)	44 (19)				
	Rural	82 (40)	188 (81)	6.41 (4.17–9.86)	<0.001	8.02 (4.95–13.01)	<0.001

† Despite acceptable model discrimination, some predictors showed unstable estimates with wide confidence intervals, possibly due to strong associations between predictors and outcome.

AOR, adjusted odds ratio. CI, confidence interval. COR, crude odds ratio. KAP, knowledge, attitudes, and practices.

Retrospective data of human rabies exposure

In the studied area, 375 human rabies exposures were recorded. The sex-specific distribution of the data showed that the majority of rabies exposures were males, accounting for 303 cases (80.8%). Children aged <13 years were the most affected age group, with 162 cases (43.2%). This study showed that a greater number of human rabies exposures, 323 cases (86.1%), occurred among people from rural areas. The majority of human rabies exposure cases, 372 (99.2%), were caused by dogs, while 3 cases (0.8%) were caused by donkeys. A significant number of rabies exposures were reported during the summer and spring, with 269 cases (71.7%) and 68 cases (18.1%), respectively. In contrast, a lower proportion of exposures occurred during the fall (30 cases, 8%) and winter (8 cases, 2.1%). A total of 42 individuals (11.2%) did not receive post-exposure prophylaxis (Table 9).

Table 9: Retrospective data for human rabies exposure in study area (2017–2021) (*N*=375)

Variable		Frequency	%
Hospital	Raya-Alamata	321	85.6
	Ofla/Korem	54	14.4
Residence	Rural	323	86.1
	Urban	52	13.9
Sex	Male	303	80.8
	Female	72	19.2
Age group (years)	0–12	162	43.5
	13–24	88	23.5
	25–64	56	15.0
	>65	69	18.0

Occupation	Employed	3	0.8
	Unemployed	46	12.3
	Farmer	154	41
	Student	147	39.2
	Woman working at home	25	6.7
Post-exposure prophylaxis taken	Yes	333	88.8
	No	42	11.2
Type of exposure	Bite	369	98.4
	Contact	6	1.6
Responsible animal	Dog	372	99.2
	Donkey	3	0.8
Site of exposure	Hand	53	14.1
	Other body part	14	3.7
	Leg	307	81.9
	Face	1	10.3
Season of bite	Summer	269	71.7
	Autumn	30	8
	Winter	8	2.1
	Spring	68	18.1

Retrospective data of animal rabies exposure

In the present study, 71 animal exposure cases were obtained from the medium level-veterinary clinics of the two *woredas*. The majority affected animals were canines (45, 63.4%) followed by bovines (17, 23.9%) (Table 10). Animal rabies cases were not confirmed by a laboratory test examination due to lack of laboratory facilities.

Table 10: Retrospective data for animal rabies exposures in study area (2017–2021(*N*=71)

Species	District		Total *n* (%)
	Raya-Alamata *n* (%)	Ofla/Korem *n* (%)	
Canine	25 (62.5)	20 (64.5)	45 (63.4)
Bovine	10 (25)	7 (22.6)	17 (23.9)
Equine	5 (12.5)	3 (9.7)	8 (11.3)
Ovine	–	1 (3.2)	1 (1.4)

Discussion

In this study, more than half (53.1%) of the respondents demonstrated poor KAP regarding rabies. This aligns with a study by Yalemebrat et al[24] who reported 60.3% poor KAP in Debark District, north-western Ethiopia. The low KAP levels may stem from limited community awareness, cultural beliefs, low education levels, personal experience, and lack of access to information. Female respondents were also found to be 4.59 times more likely to have lower KAP than males (95%CI=2.5–8.43; $p<0.001$), consistent with findings from Jimma, south-western Ethiopia, by Abdela et al[18], who reported a value of 37.1 times. This could be because males are more involved in outdoor activities, which expose them to more rabies-related information. Moreover, urban residents demonstrated significantly better knowledge than rural residents. Rural dwellers were 8.02 times more likely to have lower KAP (95%CI=4.95–13.01; $p<0.001$), consistent with findings from Jimma, south-western Ethiopia, where urban residents were 4.35 times more likely to have better knowledge than those living rurally[18]. This is likely due to urban areas having better access to information, veterinary services, and health education.

The present study also found that 52.4% of respondents had poor knowledge, 54.9% had poor attitudes, and 56.1% had poor practices. Hagos[25] reported higher KAP in Mekelle (knowledge, 56.1%; attitude, 56.2%; practice, 61.3%). This could be attributed to Mekelle's urban status (as the capital of Tigray), where residents likely receive more informal and formal health education than the mostly rural and less-educated respondents in the present study.

In terms of treatment preferences, according to the present study 45.5% of respondents favored traditional treatment, while 54.5% preferred post-exposure vaccination. These findings are similar to those in south-western Ethiopia, where 30.4% preferred traditional remedies, 3.7% spiritual healers, and 65.9% vaccines[18]. Reasons for choosing traditional methods include lack of awareness about vaccination and poor accessibility to health services, emphasizing the need for health education and improving the health system coverage.

Women at home and farmers were 48.70 and 3.99 times more likely to have lower knowledge levels, respectively, than civil servants, likely due to literacy gaps. Civil servants, being more educated, have greater access to rabies-related information. Moreover, respondents without dogs were 473.20 times more likely to have poorer knowledge compared to dog owners. A previous study noted that non-dog owners were 2.9 times more likely to have poor knowledge[18]. Dog ownership often leads to more exposure to veterinary information, especially during vaccination.

Among those surveyed, 97% of respondents who completed secondary education demonstrated good practices, sometimes even better than those with higher education. This may be because many secondary school graduates own dogs and receive information directly from veterinarians during vaccination campaigns.

According to this study, participants with poor knowledge and attitude were 10.30 and 614.67 times more likely to demonstrate poor practices, respectively. This underscores the link between knowledge, attitudes, and practices, suggesting that better education can improve behavior.

In the study area, 375 human rabies exposures were reported in general hospitals, while 71 animal cases were recorded in veterinary clinics. Dogs were responsible for 98.4% (369 cases) of human exposures, consistent with studies by Yibrah and Damtie[26], and Teklu et al[11], who also found that all cases were dog-related. This reflects the high level of human–dog interaction in Ethiopia, particularly in rural areas where dog ownership is common. While the exact statistic (‘at least one dog per rural household’) is hard to find in census-level data, multiple peer-reviewed studies and reports do support the general observation that dog ownership in rural Ethiopian households is very high, often approaching or exceeding one dog per household. Additionally, despite the increasing number of stray dogs in the country, there is no regular or systematic vaccination program for dogs.

Most human rabies cases (303, 80.8%) occurred in males, aligning with studies in Tigray[11] and north-western Ethiopia[27]. This may be due to men’s involvement in outdoor work, whereas cultural and religious norms keep women indoors.

A large majority (85.6%) of rabies cases were reported from rural areas. Similar findings were observed by Aleme (59.4%)[6], Yizengaw et al (73.2%)[27] and Kankya et al[28]. These higher rural rates likely reflect limited knowledge, negative attitudes, and lack of veterinary services.

Seasonal distribution showed that most cases occurred during summer (269 cases, 71.7%) and spring (68 cases, 18.1%). This is consistent with studies in north-western Amhara, Ethiopia, which reported 26% and 39% during summer and spring[27]. The higher incidence is likely tied to the breeding season of dogs. However, a study in Gondar reported more cases in fall and winter[26], likely due to regional climatic differences.

None of the 375 human rabies cases were lab-confirmed due to the absence of diagnostic facilities, highlighting systemic issues. The lack of laboratory infrastructure and essential medical supplies like vaccines and post-exposure prophylaxis weakens rabies prevention efforts. Limited healthcare coverage and a lack of collaboration between human and animal health sectors further hinder control efforts. This underscores the need for a coordinated One Health approach to effectively manage zoonotic diseases like rabies.

Among animals, most rabies cases occurred in dogs (63.4%), followed by bovines (23.9%), confirming dogs as the main source of human rabies transmission. This finding aligns with Aleme's study, which found 70.78% of cases in dogs and 9.8% in bovines[6]. As with human cases, none of the 71 animal cases were lab-confirmed, again due to a lack of diagnostic facilities.

Conclusion

The study revealed that more than half of respondents had poor KAP towards rabies. Poor knowledge and attitudes were significantly associated with rural residence and lack of dog ownership, while poor practices were linked to secondary education, not owning dogs, and poor knowledge and attitudes. Overall KAP was poor, with female sex and rural residence identified as significant risk factors. Retrospective findings showed a high incidence of human rabies, mainly due to dog bites, particularly affecting males, children aged <15 years, and rural residents. In animals, most rabies cases occurred in dogs, alongside inadequate veterinary infrastructure and weak human–animal health integration.

Based on this conclusion the following recommendations are forwarded.

There is a need for an increased public education and awareness creation on rabies. Community-based education regarding rabies should be provided – especially for rural residents, women working at home, farmers, and those who do not own dogs. Government bodies should provide sufficient human and veterinary healthcare facilities. Regular mass vaccination of owned dogs and elimination of stray dogs are important interventions. Finally, to have successful rabies prevention and control strategies, there should be a strong intersectorial collaboration between public health, veterinary professionals, and local authorities in a One Health approach.

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The authors report no conflict of interest in this work.

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Data availability

The data regarding this study can be obtained from the corresponding author on reasonable request.

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