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Knowledge, attitudes, and practices toward ticks and tick-borne diseases: a cross-sectional study in Rwanda

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Abstract

Background Ticks and tick-borne diseases pose significant global risks to humans and animals, leading to economic losses and health threats. This study aimed to assess the knowledge, attitudes, and practices toward ticks and tick-borne diseases among adults in Rwanda.

Methods The sample size was determined using a single-population proportion formula. Binary logistic regression was used to identify the factors influencing attitudes and practices. In contrast, multinomial logistic regression was applied to assess the factors affecting the level of knowledge about ticks and tick-borne diseases. Variables with a *p*-value < 0.05 were considered statistically significant.

Results This study included 377 participants, with an average age of 35.38 years and a standard deviation of 10.58. Most participants were male (56.2%) and lived in rural areas (51.7%). Nearly one-third (32.1%) were healthcare professionals. A significant proportion of the participants (64.7%) reported having prior tick bites, while 46.7% experienced related symptoms, and 41.4% had relatives affected by tick-borne diseases. The knowledge levels of the participants varied; 49% demonstrated a good understanding of ticks and TBDs. However, only 28% of the respondents reported positive attitudes towards tick-borne diseases, and 56% reported good preventive practices. Regression analyses indicated that participants aged 45 years or older had significantly greater odds of possessing moderate (AOR = 3.81, 95% CI: 0.001–2.6) and high knowledge (AOR = 5.24, 95% CI: 0.34–2.96) than younger participants. In contrast, males presented lower odds of having moderate knowledge (AOR = 0.43, 95% CI: 0.10–1.56) and high knowledge (AOR = 0.52, 95% CI: 0.81–1.37) than females did. Healthcare professionals were more likely to possess high knowledge (AOR = 3.24, 95% CI: 0.32–2.83) than those outside the healthcare field. Furthermore, positive attitudes were significantly associated with older age (AOR = 2.54, 95% CI: 1.137–5.654), urban residence (AOR = 0.56, 95% CI: 0.335–0.920), and living in western provinces (AOR = 0.38, 95% CI: 0.186–0.770). Notably, participants with moderate (AOR = 0.25, 95% CI: 0.109–0.582) or high knowledge (AOR = 0.17, 95% CI: 0.056–0.297) and positive

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attitudes (AOR = 0.53, 95% CI: 0.306–0.928) were at lower odds to engage in poor preventive practices. Conversely, urban residents had higher odds of exhibiting sub-optimal preventive practices (AOR = 1.79, 95% CI: 1.09–2.90) than their rural counterparts.

Conclusions Our study reveals key knowledge gaps and negative attitudes about ticks and TBDs in Rwanda, especially among youth, males, and urban populations. Targeted education, healthcare training, and community-driven surveillance are needed to improve prevention and monitoring. Strengthening TBD surveillance and integrating education into health programs will help reduce disease burden and enhance resilience, requiring multisectoral collaboration to safeguard public health.

Keywords Ticks, Tick-borne diseases, Knowledge, Attitudes, Practices, Rwanda

Introduction

Ticks are blood-feeding arthropods that serve as vectors for various pathogens [1–3], leading to tick-borne diseases (TBDs). These ectoparasites can affect human health through bites or the transmission of infectious agents that cause TBDs, such as tick-borne encephalitis, rocky mountain spotted fever, and Crimean hemorrhagic fever. Tick-borne diseases, such as East Coast fever (theileriosis), anaplasmosis, and babesiosis, have been reported in most animals and cause substantial economic losses, including decreased production of skin and hides [4]. The prevalence of TBDs has increased in recent decades, indicating a global public health risk associated with factors such as population movement, climate change, and animal migration [5]. Ticks are now found in human-inhabited areas, particularly those with abundant vegetation and farms [6].

In East Africa and Rwanda, agricultural productivity is significantly impeded. TBDs present a considerable economic challenge to livestock farming. For example, Theileria parva, which causes East Coast fever, has been reported to be responsible for the death of more than 1 million cattle annually in sub-Saharan Africa alone, leading to an annual economic loss of approximately 300 million dollars, considering the decreases in milk production, livestock deaths, and stunted growth [7]. The economic costs of managing these diseases are even more remarkable because of the heavy expenses incurred through treatment and control, especially acaricides, highlighting farmers' dependency on chemicals to keep ticks at bay [8]. In East Africa, the overall cost attributed to tick-related issues is claimed to be approximately 18.7 billion dollars annually. This is a massive setback for smallholder and commercial farmers, as livestock growth, milk production, and fertility are adversely affected [9]. In Rwanda, agriculture and farming are the mainstays of the country's economy. TBDs pose risks not only to productivity but also to the income of these livestock-dependent communities, highlighting the need for efficient management policies to control and prevent these losses [10]. Rwanda is among the regions with various tick species, such as *Rhipicephalus appendiculatus and Boophilus decoloratus. S*ome TBDs have been reported, including Theileria parva. The abundant hosts and suitable habitats in Rwanda's rural areas, which are rich in livestock, wildlife, and vegetation, increase the reproduction of ticks. Green spaces within urban areas are sparse, and while ticks are less common there, some localized infestations persist around human habitats. Intermediate tick density is observed in peri-urban areas, which mark the transition between rural and urban ecosystems because of mixed land use and synanthropic hosts. The previously mentioned human activities, such as deforestation, livestock management, and climate, shape these patterns and regions across various ecological gradients and spatially delineate the risk for tick-borne disease transmission [11, 12].

On the other hand, knowledge gaps related to ticks and their accompanying diseases, i.e., TBDs, still exist. Several studies have reported that a specific population is unaware of the diseases and pathogens associated with ticks and how they can harm humans and animals [13]. Moreover, there is a gap in knowledge regarding prevention mechanisms, and several studies have connected the increase in TBDs to a lack of awareness of ticks and the ability to prevent such diseases [14]. To address the complexities of ticks and TBDs, researchers and health professionals must explore various sociocultural landscapes and analyse knowledge, attitudes, and practices (KAPs). This helps researchers understand how people view ticks and TBDs, allowing for more targeted interventions, public health strategies, and prevention methods [15]. By evaluating KAP within different populations, researchers can detect misunderstandings, cultural beliefs, and behavioral patterns that may influence disease transmission and healthcare-seeking practices [15]. To our knowledge, no comprehensive study has been conducted on the current KAP of ticks and TBDs in Rwanda, resulting in scant, outdated, and unusable data on the topic. Additionally, in the absence of reported data on KAP towards ticks and TBDs in Rwanda, the present study's findings will serve as a baseline for future research in different population groups across the country.

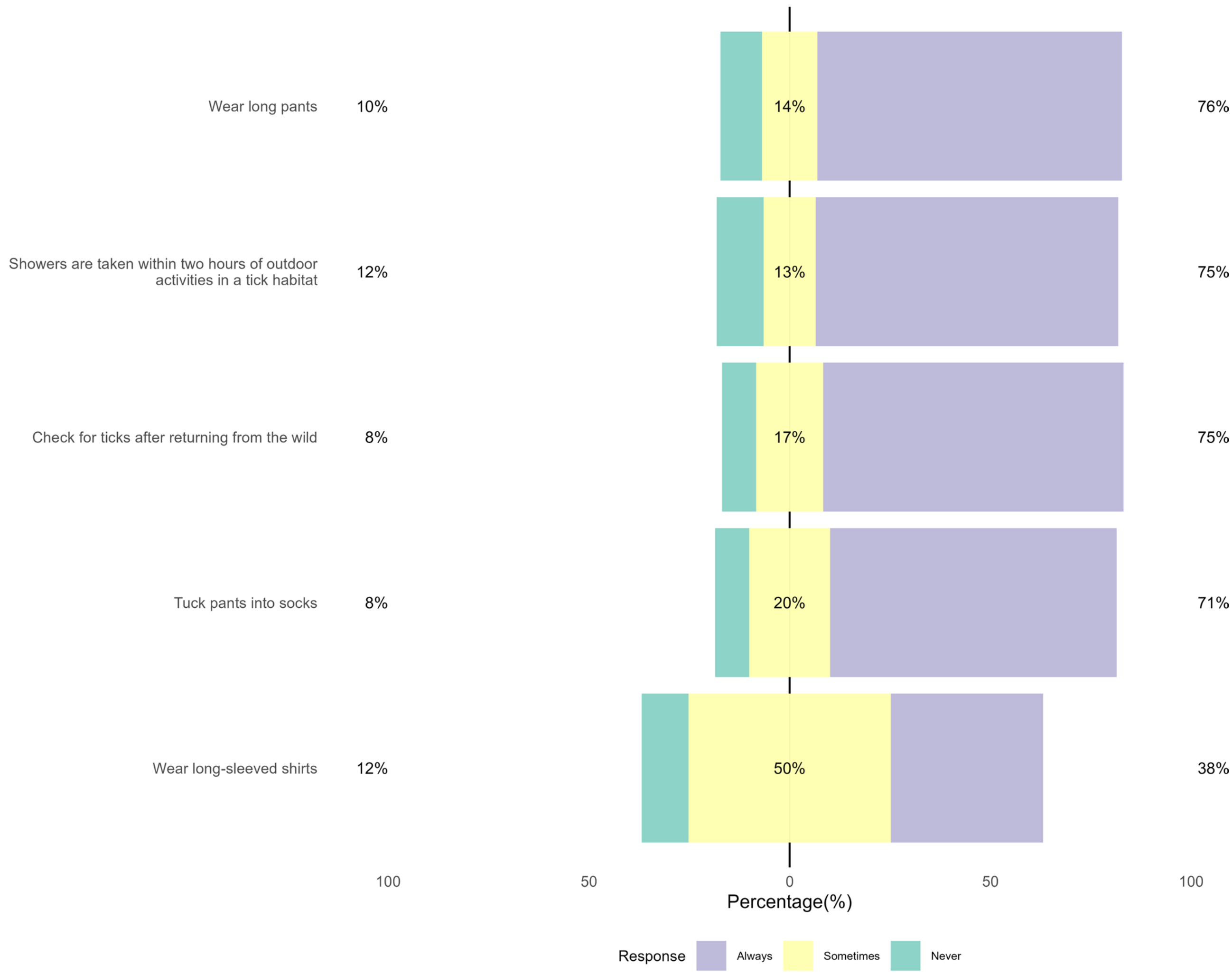

Fig. 1 Tick bite prevention practices among participants

Methods

Settings, study design, and participants

This study was conducted in Rwanda. We conducted a cross-sectional study to assess KAP in ticks and TBDs. Rwanda, a landlocked nation in East Africa, has a diverse population marked by youthful people, a considerable percentage of 78% aged 35 or below. The total population is estimated to be approximately 13 million, with the majority living in rural areas despite a steady increase in urbanization [16]. The study population included all individuals aged 18 and older living in Rwanda. The Raosoft® (Sample Size Calculator) was used to estimate the sample size using a single population proportion formula [17]. The sample size calculation used a 95% confidence interval, 50% population representation, a 5% margin of error, and a 10% non-response rate, resulting in 421 participants [18]. We obtained animal population density data from local veterinarians to identify high-density districts for assessing KAP in ticks and TBDs. Proportional allocation was used to distribute the sample, and systematic sampling ensured random participant selection at regular intervals.

Variables

The main explanatory variables were age, sex, education level, residence, and profession, whereas the outcome variables were knowledge level, attitude status, and practices.

Data collection

Data were collected between June 1, 2023, and August 30, 2023, through questionnaires designed based on a review of relevant literature sources [14, 19, 20]. Data was collected by health professionals who underwent two days of training on questionnaire administration and tick identification. A pretest was conducted with a 5% study population sample to ensure similar socio-demographic characteristics. Feedback from the pretest was incorporated into the final version of the questionnaire (see Supplementary Material File S1). The questionnaire contained multiple-response, multiple-choice, Likert-type, and free-response questions. The questionnaire was divided into five sections to assess the participants' characteristics and experiences. These sections covered demographic information, knowledge, attitudes, practices related to ticks and TBDs, and participants' history of TBDs. To ensure the comprehensiveness of the survey, several questions were adopted from previous studies that focused on KAP related to TBDs. The knowledge component involved calculating the scores for each question item. Responses indicating "None" or "Do not know" received a score of zero. Each correct answer selected from the multiple-choice questions received one point. For questions with multiple correct options, participants received one point for each option. For example, selecting only the two correct options would earn 2 points in a question with five options where two were correct. Responses with extra choices, such as the "other option," received different scores. The cumulative score was calculated using a total score of 46. We used a 5-point Likert scale. The available options were scored as follows: "strongly agree" (2) and "agree" (1), while "disagree," "strongly disagree," and "neutral" were scored 0. For questions that used a 3-point scale, the descriptors were "concerned" (1), 0 for "not concerned," and "I do not know". The questions were scored as follows: "very confident" (2), "moderately" (1), and "little" (1), while "not at all" was (0). The total attitude score was 12, which was determined by summing the scores of the attitude-related questions. For the practice section, scores were assigned based on specific responses to the questions because the answers were not uniform. This resulted in a cumulative score of 22, which was calculated by summing the raw scores of the practice-related questions. Bloom's cut-off criteria assessed knowledge, and scores were categorized as high if they ranged between 80% and 100%, moderate if they fell between 60% and 79%, and low if they were below 60% [21, 22]. The participants were categorized based on their scores as having either a positive or negative attitude, with a positive attitude score at or above the mean and a negative attitude score below the mean. Similarly, practices were classified as good or poor, with good practices corresponding to scores at or above the mean and poor practices below the mean [23].

Table 1 Socio-demographic characteristics

Variables	*n* = 377	(%)
Age in years	Mean = 35.38, SD = 10.58	
18–24	60	15.9
25–34	138	36.6
35–44	101	26.8
45^{+}	78	20.7
Gender		
Female	165	43.8
Male	212	56.2
Education		
Higher education	190	50.4
secondary and below	187	49.6
Residence		
Rural area	182	48.3
Urban area	195	51.7
Region		
Eastern Province	113	30.0
Kigali City	54	14.3
Northern Province	62	16.4
Southern Province	87	23.1
Western Province	61	16.2
Profession		
Others	256	67.9
Health professionals	121	32.1

Data analysis

Data analysis was performed using R software version 4.4. Categorical variables are summarized as counts and percentages. Fisher's exact and chi-square tests were used to compare knowledge, attitudes, and practices concerning ticks and tick-borne diseases among the various groups. Three models were developed for each outcome variable: knowledge, attitudes, and practices. For attitudes and practices, we used binary logistic regression analyses to identify factors related to attitudes and practices, whereas multinomial regression was used for the level of knowledge. All variables exhibiting a *P* value of ≤ 0.25 in the bivariate analyses were incorporated into the final multivariate model. Model fitness for attitudes and practices was checked through Hosmer and Lemeshow, whereas for multinomial analysis, we used the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) to compare the models. Multicollinearity was evaluated via the variance inflation factor (VIF), which employs a median VIF threshold of < 5 to guarantee reliable outcomes. Associations were evaluated by adjusted odds ratios (AORs) accompanied by 95% confidence intervals (CIs), with statistical significance set at $P \leq 0.05$. The participants' characteristics were summarized using outcome and explanatory variables, such as age, sex, education level, residence, profession, knowledge, and attitudes and practices related to ticks and TBDs.

Ethical consideration

All procedures followed the ethical standards of the 1964 Declaration of Helsinki and subsequent amendments. This study was approved by the Institutional Ethics Committee of the School of Public Health, Cheeloo College of Medicine, Shandong University (LL20230705). All the respondents provided informed consent before the study.

Table 2 Knowledge responses for ticks and TBDs

Statements	Total *n* (%)
Ticks are commonly found	
Don't know	4 (1.1)
In the forest	62 (16.4)
In the grasses	41 (10.9)
On an animal's skin or coat	270 (71.6)
Are ticks common in your area?	
Don't know	32 (8.5)
No	91 (24.1)
Yes	254 (67.4)
Do you know how many developmental stages ticks have?	
Don't know	106 (28.1)
No	93 (24.7)
Yes	178 (47.2)
In which specific environments or locations are ticks most commonly found?	
Don't know	18 (4.8)
Cold places	67 (17.8)
Warm places	199 (52.8)
Both	93 (24.7)
What season are people most at risk of being bitten by ticks?	
Don't know the season	15 (4.0)
Short rainy season	97 (25.7)
Long rainy season	58 (15.4)
Long dry season	207 (54.9)
Only one type of tick is thought to feed on humans	
Don't know	55 (14.6)
No	140 (37.1)
Yes	182 (48.3)
What pathogens do you know that are carried by ticks?	
Don't know	15 (4.0)
Bacteria	139 (36.9)
Parasites	116 (30.8)
Viruses	107 (28.4)
Do you know that ticks transmit TBDs	
Don't know	32 (8.5)
No	72 (19.1)
I know	273 (72.4)
Which of the following diseases are transmitted by ticks	
Don't know	6 (1.6)
African tick bite fever	19 (5.0)
Anaplasmosis	82 (21.8)
Babesiosis	3 (0.8)
Crimean-Congo haemorrhagic fever	1 (0.3)
East Coast fever	11 (2.9)
Lyme disease	104 (27.6)
Rocky Mountain spotted Fever	1 (0.3)
Tick-Borne Relapsing Fever	150 (39.8)
Do you know symptoms associated with TBDs	
Don't know	5 (1.3)
Fatigue	90 (23.9)
Headache	192 (50.9)
Itchy skin	2 (0.5)
Muscle aches	77 (20.4)

Table 2 (continued)

Statements	Total n (%)
Skin rashes	11 (2.9)
Do you know that tick-borne diseases can lead to death?	
Don't know	42 (11.1)
No	279 (74.0)
Yes	56 (14.9)
Do you know tick prevention measures?	
Don't know	3 (0.8)
Avoid typical ticks' habitat	169 (44.8)
Not touching the infected animal	2 (0.5)
Tack in pants or boots	24 (6.4)
Use a repellent	142 (37.7)
Wear a hat	37 (9.8)
Do you know what measures can be taken to prevent TBDs?	
Don't know	37 (9.8)
Avoid risk areas	148 (39.3)
Vaccines	188 (49.9)
Other	4 (1.1)

The study was conducted following the applicable guidelines and regulations.

Results

Respondents' demographics

A total of 377 participants were assessed, resulting in a 90% response rate. Participants had a mean age of 35.4 years (SD = 10.6). A total of 56.2% were male, and 43.8% were female. Half of the participants had higher educational levels, 51.7% lived in rural areas, and 32.1% were health professionals. Notably, 64.7% of the participants reported experiencing tick bites, whereas 46.7% exhibited symptoms. Additionally, 70% of the participants owned livestock. Only 17.5% of the participants engaged in farming as their primary profession. Of these, 43.8% owned at least one cow. Surprisingly, 41.4% of the participants reported that their relatives had experienced TBDs (Table 1 and Supplementary Table 1).

General knowledge of ticks and TBDs

Overall, 49% of the participants had a high knowledge of ticks and TBDs (Supplementary Table 2). Most participants (71.6%) recognized that ticks were commonly found on the skin or coats of animals, and 67.4% believed that ticks were prevalent in their area. Additionally, nearly half (47.2%) knew that ticks underwent multiple developmental stages, whereas 52.8% identified warm places as typical habitats for ticks. The long dry season was perceived by 54.9% of the participants as when individuals were most at risk of tick bites. Furthermore, 72.4% of the respondents acknowledged that ticks transmit TBDs, with Lyme disease (27.6%) and tick-borne relapsing fever (39.8%) being the most recognized diseases. Despite this awareness, there are notable gaps in knowledge regarding the severity of TBDs and potential consequences. Although many respondents recognized symptoms associated with TBDs, such as headaches, 50.9%, and 74.0% did not believe that tick-borne diseases could lead to death. The knowledge level regarding prevention measures varied, with 44.8% avoiding typical tick habitats and 49.9% being aware of vaccines as a preventive strategy (Table 2).

Attitudes toward ticks and TBDs

According to our scores, only 28% of the participants had a positive attitude toward ticks and TBDs (Supplementary Table 3). Additionally, the results indicated pronounced concern among respondents regarding tick bites, with 71.6% expressing concern about potential exposure in their area. Moreover, nearly half (47.7%) of participants reported confidence in removing the tick. The influence of tick-borne diseases on outdoor recreational activities was significant, as 49.6% of the participants acknowledged that these diseases detracted from their enjoyment of such pursuits. Moreover, 36.6% strongly agreed that tick-infested areas across the region should be avoided, whereas 39.5% disagreed with the reduction in visits to natural areas infested with ticks and tick-borne disease concerns. There was a strong consensus on the necessity of educational initiatives, with 79.6% of participants underscoring the importance of increasing awareness of ticks and tick-borne diseases (Table 3).

Practices related to ticks and tick-borne diseases

56% of the participants had good protection practices (Supplementary Table 4). To protect themselves from tick

Table 3 Attitude responses for both ticks and TBDs

Statements	Total *n* (%)
Worried about getting bitten by ticks in the area	
Yes	270 (71.6)
no	66 (17.5)
Neutral	41 (10.9)
Confident to remove a tick that is attached to a person	
Not at all	92 (24.4)
A little	60 (15.9)
Moderately confident	45 (11.9)
Very	180 (47.7)
Tick-borne diseases have negatively affected my feelings about the outdoors	
Strongly disagree	66 (17.5)
Disagree	69 (18.3)
Neutral	55 (14.6)
Agree	48 (12.7)
Strongly Agree	139 (36.9)
I would not want to visit a vacation destination if they have a tick problem	
Strongly disagree	60 (15.9)
Disagree	80 (21.2)
Neutral	59 (15.6)
Agree	40 (10.6)
Strongly agree	138 (36.6)
I am less likely to go to nature parks and hiking trails because I do not want to get a tick-borne disease	
Strongly disagree	51 (13.5)
Disagree	74 (19.6)
Neutral	70 (18.6)
Agree	33 (8.8)
Strongly agree	149 (39.5)
People's education on ticks and tick-borne diseases is important	
No	53 (14.1)
Unsure	24 (6.4)
Yes	300 (79.6)

biting, most participants never wore long pants (76%) or took showers within two hours of outdoor activities (75%). Similarly, 75% of the participants never checked for ticks, and 71% never tucked their pants into their socks. Wearing long-sleeved shirts was the most common behavior, with 50% doing so sometimes (Fig. 1). Most participants favoured tick removal by medical staff, and their preferences varied by region ($P = 0.025$) (Supplementary Fig. 41a). In contrast, liquid acaricides applied through animal spraying were the most common tick control methods, with the southern province having the highest use. Significant regional variations were observed ($P = 0.031$) (Supplementary Fig. 1b). Our findings indicated that 75% of the respondents were willing to pay for tick control services, whereas 77% sought medical attention if ticks bit them. In addition, 51% of the participants preferred to visit the nearest health center for treatment, 21% preferred to seek medical care only when they felt sick, and 19% preferred to remain at home (Supplementary Table 5).

Factors associated with knowledge level

Multinomial logistic regression analysis revealed multiple factors affecting low (reference), moderate, and high knowledge levels. The factors associated with a moderate level of knowledge included age, gender, region, and attitude, whereas those related to a high level of knowledge included age, profession, and attitude. The participants aged 45 years and older were 3.81 times more likely to have a moderate understanding of ticks and TBDs than those aged 18–24 (AOR, 3.81; 95% CI, 0.001–2.6; $P = 0.050$). Similarly, they were 5.24 times more likely to have a high knowledge level about ticks and TBDs (AOR: 5.24; 95% CI: 0.34–2.96, $P = 0.013$) than those in the 18–24 age group. The likelihood of a moderate level of knowledge regarding ticks and TBDs was 57% lower in males than in females (AOR: 0.43, 95% CI: 0.10–1.56, $P = 0.025$). Similarly, males were 48% less likely than females to have a high level of knowledge, although this association was not statistically significant (AOR: 0.52, 95% CI: 0.81–1.37, $P = 0.082$). Compared with non-health professionals, health professionals were 3.24 times more likely to possess high knowledge about ticks and TBDs (AOR: 3.24, 95% CI: 0.32–2.83, $P = 0.007$). A negative attitude was associated with a 60% lower chance of having a moderate knowledge level about ticks and TBDs than a positive attitude (AOR: 0.40, 95% CI: 0.008–1.83, $P = 0.050$). Additionally, negative attitudes were associated with a 69% lower likelihood of having a high level of knowledge about ticks and TBDs (AOR: 0.31, 95% CI: 0.28–2.42, $P = 0.013$) (Table 4).

Factors associated with high attitudes

The odds of having a positive attitude toward ticks and tick-borne diseases were significantly greater among individuals aged 45 years than those aged 18–24 (AOR = 2.54; 95% CI: 1.137–5.654; $P = 0.023$). Similarly, urban residents had 44% lower odds of having positive attitudes than rural residents (AOR = 0.56; 95% CI: 0.335–0.920; $P = 0.022$). Regional differences were also observed, with individuals in the western province having 62% lower odds of having a positive attitude than those in the eastern province (AOR = 0.38; 95% CI: 0.186–0.770; $P = 0.007$). Additionally, health professionals demonstrated 49% lower odds of having a positive attitude than non-health professionals (AOR = 0.51; 95% CI: 0.291–0.878; $P = 0.016$). Furthermore, individuals with higher knowledge scores had significantly greater odds of maintaining a positive attitude than those with lower knowledge scores (AOR = 0.15; 95% CI: 0.76–1.13; $P = 0.021$) (Table 5).

Table 4 Multinomial logistic regression results for factors of high knowledge level of ticks and TBDs

Knowledge Level		Variable	OR (95%CI)	*P* value
Low(reference)				
Moderate				
	Age in years			
		18–24	Ref	
		25–34	1.51(0.52, 1.3)	0.387
		35–44	2.05(0.32, 1.77)	0.178
		45+	3.81(0.001, 2.67)	0.050
	Gender			
		Female	Ref	
		Male	0.43(-1.56, -0.10)	0.025
	Education			
		Secondary and below	Ref	
		Higher	0.99(-0.75, 0.74)	0.996
	Residence			
		Rural	Ref	
		Urban	0.66 (-1.13, 0.32)	0.276
	Region			
		Eastern Province	Ref	
		Kigali City	0.31(-2.25, -0.86)	0.034
		Northern Province	0.45(-1.31, 1.14)	0.160
		Southern Province	0.73((-1.33, 0.78))	0.583
		Western Province	0.38(-2.08, 1.27)	0.084
	Profession			
		Others		
		Health professionals	1.81(-0.27, 1.47)	0.182
	Attitude			
		Positive attitude	Ref	
		Negative attitude	0.40(-1.83, -0.008)	0.050
High				
	Age Group			
		18–24	Ref	
		25–34	1.33(-0.63, 1.21)	0.540
		35–44	2.17(-0.25, 1.80)	0.139
		45–54	5.24(0.34, 2.96)	0.013
	Gender			
		Female	Ref	
		Male	0.52(-1.37, 0.81)	0.082
	Education			
		Secondary and below		
		Higher	0.71(-1.072, 0.48)	0.368
	Residence			
		Rural area	Ref	
		Urban area	0.65(1.13, 0.34)	0.258
	Region			
		Eastern Province	Ref	
		Kigali City	0.37(-2.60, 1.08)	0.078
		Northern Province	0.69(-1.42, 0.98)	0.453
		Southern Province	1.19(-0.89, 1.25)	0.745
		Western Province	0.53(-1.88, 0.45)	0.259
	Profession			
		Others	Ref	
		Health	3.24(0.32, 2.83)	0.007
	Attitude			

Table 4 (continued)

Knowledge Level	Variable	OR (95%CI)	*P* value
	Positive attitude	Ref	
	Negative attitude	0.31(-0.28, -2.42)	0.013
	AIC:748.38	BIC:850.62	

Table 5 Binary logistic regression for factors for positive attitude towards ticks and TBDs

Variables	COR (95% CI)	*P*-value	AOR (95% CI)	*P* value
Age in years				
18–24	Ref		Ref	
25–34	1.32(0.706,2.497)	0.379	1.42(0.71, 2.82)	0.31
35–44	2.23(1.105, 4.508)	0.025	2.57(0.17, 5.55)	0.67
45+	2.07(0.988, 4.344)	0.054	2.53(1.13, 5.56)	0.023
Gender				
Female	Ref		Ref	
Male	0.90(0.576, 1.426)	0.673	0.86(0.48, 1.32)	0.39
Education				
Secondary and below	Ref		Ref	
Higher education	1.29(0.825, 2.027)	0.261	1.84 (0.97, 2.79)	0.063
Residence				
Rural area	Ref		Ref	
Urban area	0.63(0.402, 0.997)	0.049	0.55(0.33, 0.92)	0.022
Region				
Eastern province	Ref		Ref	
Kigali City	1.89(0.827, 4.319)	0.131	1.88(0.74, 3.99)	0.191
Northern Province	0.97(0.404, 1.557)	0.502	1.57(0.26, 1.16)	0.123
Southern Province	1.26(0.662, 2.421)	0.475	1.41(0.72, 2.77)	0.602
Western Province	0.47(0.247,0.914)	0.026	1.30(0.78, 3.77)	0.529
Profession				
Non health	Ref		Ref	
Health professionals	0.67(0.423, 1.083)	0.104	0.56(0.378, 0.87)	0.016
Knowledge				
Low	Ref		Ref	
Moderate	0.49(0.214, 1.148)	0.102	1.18(0.15, 2.15)	0.152
High	0.38(0.168, 0.861)	0.020	1.13(0.15, 0.76)	0.021

Factors associated with prevention practices

Participants in urban regions were 1.79 times more likely to exhibit poor practices related to tick and TBDs prevention than those in rural areas (AOR: 1.79, 95% CI: 1.09–2.90; $P=0.019$). Compared with health professionals, non-health professionals were 3.20 times more likely to demonstrate poor practices in preventing ticks and TBDs (AOR: 3.20, 95% CI: 1.82–5.59; $P=0.020$). When considering knowledge levels, participants with moderate knowledge were 75% less likely to engage in poor practices to prevent ticks and TBDs than those with low knowledge (AOR: 0.25, 95% CI: 0.109–0.582; $P=0.001$). Similarly, participants with high knowledge were 83% less prone to poor ticks and TBDs prevention practices than those with low knowledge (AOR: 0.17, 95% CI: 0.056–0.297, $P<0.001$). We also found that participants who held a positive attitude toward preventing ticks and TBDs were 47% less likely to have poor prevention practices than those with a negative attitude (AOR: 0.53, 95% CI: 0.306–0.928, $P=0.026$) (Table 6).

Discussion

Our findings demonstrated that nearly half of the participants understood ticks and TBDs well, which is consistent with studies in North Africa [24] and higher than the results from Tanzania [25]. However, many participants mistakenly believed that only one tick species feeds on humans. This belief contradicts evidence indicating that multiple species can feed on humans, highlighting a significant knowledge gap [26]. This misconception stems from limited educational outreach, emphasizing the need for targeted initiatives to improve tick species' knowledge and interactions with various hosts [27]. Knowledge levels were influenced by age, gender, region, and attitude, with older individuals being three times more likely to have moderate knowledge and five times more likely to have high knowledge of ticks and TBDs than

Table 6 Binary regression results for factors of poor prevention practices

Variable	COR (95% CI)	*P* value	AOR (95% CI)	*P* value
Age in years				
18–24	Ref		Ref	
25–34	1.28 (0.70, 2.36)	0.421	1.40 (0.69–2.81)	0.344
35–44	0.78 (0.41, 1.49)	0.452	0.88 (0.47–1.41)	0.755
45–54	0.54 (0.27, 1.08)	0.082	0.72 (0.32–1.58)	0.412
Gender				
Female	Ref		Ref	
Male	1.14 (0.76, 1.73)	0.518	1.02 (0.63–1.64)	0.934
Education				
Secondary and below	Ref		Ref	
High education	0.74 (0.50, 1.12)	0.157	0.65 (0.39–1.09)	0.105
Residence				
Rural	Ref		Ref	
Urban area	1.89 (1.25, 2.85)	0.003	1.79 (1.09–2.90)	0.019
Region	Ref			
Eastern Province				
Kigali City	1.83 (0.95, 3.54)	0.071	1.15 (0.72–1.52)	0.722
Northern Province	0.74 (0.39, 1.40)	0.359	0.57 (0.21–1.56)	0.350
Southern Province	0.81 (0.46, 1.43)	0.463	0.84 (0.44–1.57)	0.593
Western Province	1.07 (0.57, 2.00)	0.834	1.64 (0.87–3.07)	0.124
Profession				
Other	Ref			
Health professionals	2.77 (1.74, 4.41)	0.001	3.20 (1.82–5.59)	0.001
Knowledge Level				
Low				
Moderate	0.21 (0.09, 0.45)	0.001	0.25 (0.10–0.58)	0.001
High	0.09 (0.04, 0.20)	0.001	0.12 (0.56–0.29)	0.001
Attitude Status				
Negative attitude				
Positive attitude	0.51 (0.32, 0.81)	0.005	1.9 (0.57–6.25)	0.026

younger individuals, aligning with findings from Cameroon [28] and south-western Connecticut [29]. This can be attributed to the fact that older individuals are often responsible for livestock care, which provides them with greater exposure to information on ticks and TBDs. Male participants demonstrated significantly lower levels of knowledge than female participants, which contradicts findings from Ghana [30], and this discrepancy may be due to gender-based differences in exposure to tick-related information or engagement in high-risk activities.

Only 28% of the participants had positive attitudes toward ticks and TBDs, significantly lower than the rates reported in Bhutan [14]. Our observations further support this finding, as many participants dismissed restricting access to natural areas due to tick concerns despite their role as zoonotic disease vectors. Moreover, fear and risk perceptions varied, similar to findings from Tanzania [31, 32]. Older individuals were two times more likely to possess positive attitudes than young participants, and these findings indicate that positive attitudes tend to increase with age, likely because of the accumulated experiences that older participants may have regarding ticks and TBDs [33]. Similarly, urban residents were more likely to hold positive attitudes than rural residents were, likely due to their better access to information [34]. In contrast, health professionals had a statistically significant 44% lower odds of having positive attitudes than non-healthy professionals did, contradicting previous findings [35]; this may stem from the general neglect of ticks and TBDs in the region [36], emphasizing the need for improved awareness and training.

Although inconsistencies in protective measures were a significant concern, acaricides have emerged as the predominant method of tick control in all five regions of Rwanda, and our findings were consistent with those of similar studies conducted in Kenya [37] and Ethiopia [25, 38]. Nonetheless, recent studies have highlighted the resistance of ticks to certain acaricides currently available in local markets in Kenya and South Africa [37, 39]. Further investigations and targeted community training on the appropriate use of acaricides are needed to address this issue. On the other hand, when asked about their preferred method of tick removal, most participants expressed their intention to consult a healthcare professional, which is an uncommon practice; however, comparable results were reported in a previous study [40]. Therefore, instructing people on proper tick removal methods is necessary to reduce the likelihood of tick-related infections, which involves using tweezers or forceps to grasp the tick close to the skin surface and pull it steadily [41, 42].

Furthermore, our findings indicated that most participants sought medical assistance only after becoming sick after experiencing a tick bite; this is alarming because ticks can transmit some pathogenic agents that can cause TBDs, and delayed diagnosis of some pathogenic tick-borne pathogens can lead to serious health complications [43]. We also found that urban residents engage in poorer tick-prevention practices than rural residents do, a finding supported by studies conducted in the U.S [44]. This can be attributed to the reduced exposure to ticks in urban areas. Additionally, non-health professionals had three higher odds of having poorer tick- and TBDs prevention practices than health professionals; this can be attributed to the differences in knowledge and awareness [29]. Importantly, participants with moderate-to-high knowledge and positive attitudes were at lower odds of engaging in prevention practices than those with low knowledge levels and negative attitudes, highlighting a critical gap in awareness. This finding aligns with a study from South Africa, emphasizing the need for targeted educational interventions [45]. Strengthening educational initiatives and public health strategies will increase awareness and improve preventive practices, ultimately reducing the burden of TBDs in Rwanda and beyond.

Conclusions

While there are several limitations, such as the dependence on self-reported data, which can lead to biases in participants' understanding and behaviors related to TBDs, this study offers valuable insights into the significant knowledge gaps and negative attitudes surrounding ticks and TBDs in Rwanda. This is particularly evident among younger individuals, males, and urban residents. Addressing these issues demands urgent and strategic measures. Tailored educational initiatives in rural and urban locations should focus on the variety of tick species and effective prevention methods to increase community awareness. Furthermore, training healthcare providers to recognize and manage TBDs is crucial for enhancing early detection, diagnosis, and treatment. Implementing community-driven tick surveillance programs through a One Health approach, which includes human, animal, and environmental health, will bolster disease monitoring and control efforts. The findings underscore important policy considerations, emphasising the necessity for increased national investment in TBDs surveillance and prevention, especially in areas of high risk. Integrating TBDs education into current community health initiatives offers a practical way to enhance preventive practices, lessen the disease burden, and build resilience against tick-borne threats. A proactive and coordinated effort is essential to protect public health and mitigate the long-term effects of TBDs in Rwanda.

Supplementary Information

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Supplementary Material 1

Supplementary Material 2

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Author contributions

ANAG drafted the manuscript, performed the analyses, and interpreted the results. XYW, GYZ, LJ, MSS, BI, MNG, and BBG, NT were pivotal to shaping the methodology and analysis during the revision phase. LZ and WCC edited and supervised the manuscript. All authors revised the manuscript and approved the submitted version.

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Data availability

The datasets analyzed during the current study are not publicly available because of an ongoing project but are available from the corresponding author upon reasonable request.

Declarations

Ethical approval and consent to participate

All procedures followed the 1964 Declaration of Helsinki's ethical standards and later amendments. This study was approved by the Institutional Ethics Committee of the School of Public Health, Cheelo College of Medicine, Shandong University (LL20230705). All the respondents provided informed consent before the study, which was conducted following the applicable guidelines and regulations.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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