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Social Structure, Awareness and Practice on Risk of Exposure to Ticks and Tick-borne Diseases in Ol Pejeta Conservancy, Kenya

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Abstract: *Human tick-borne diseases are generally neglected but they are expanding in scope and emerging as a significant public health problem. This study sought to determine relationship among socio-demographic factors, awareness and practices in a rural community in Kenya towards ticks and human tick borne diseases. A cross sectional study involving 307 respondents living within and around Ol-Pejeta Conservancy in Laikipia County, Kenya was carried out using semi-structured questionnaire to survey the socio-economic factors, level of awareness and practices surrounding ticks and tick-borne diseases. Data was analyzed using SPSS Version 23 and the test statistics utilized was Chi-square. The results showed that the majority of the respondents (44.3%) belonged to (18- 30 years) age group. A proportion of 99.67% of the respondents positively identified a tick while 97.4% were aware that ticks spread diseases to animals; however, the number drastically decreased when asked if ticks spread diseases to humans at 67.7%. Many of the respondents (46.91%) mentioned tick fever as one of the human tick borne diseases. The most common symptom associated with tick bites in humans was skin rashes at 71.7% followed by general weakness (43.0%) and muscle pain at 36.2%. Significant factors associated with awareness were level of education ($\chi 2$ – 31.337, P = 0.0001), occupation ($\chi 2$ - 22.592, p = 0.031), location ($\chi 2$ – 12.699, P = 0.013) and gender ($\chi 2$ - 8.477, P = 0.016) while the significant factor associated with good practice was occupation ($\chi 2$ - 23.340, P = 0.019). In summary, higher levels of education, gender and animal based occupations shaped the community awareness about ticks and tick borne diseases and drove specific practices of prevention to tick bites and tick borne diseases. The respondents strongly advocated for public health awareness campaign, which should encourage gender participation to enhance community awareness parity.*

Keywords: Emerging infectious diseases, Arboviruses, Febrile illnesses, Zoonoses

1. Introduction

Ticks are ubiquitous arthropods that feed on the blood of livestock, wild animals and humans. They are grouped as soft (Argasidae) and hard ticks (Ixodidae), with the medically important soft ticks being in the genus Ornithodoros [1]. The bite of ticks exposes the human hosts to toxins, allergens and a great diversity of pathological viruses (e.g., Crimean-Congo hemorrhagic fever, tick-borne encephalitis and Powassan viruses), bacteria (e.g. Lyme disease), rickettsia (e.g., African tick fever, Q-fever, Rocky Mountain spotted fever and Anaplasmosis) and protozoans (e.g. Babesiosis). Human tick-borne diseases are globally neglected, misdiagnosed and underdiagnosed and yet ticks and tick-borne diseases are rapidly expanding and invading new areas [2]. Ticks are also transmitting arboviruses previously thought to be vectored by mosquitoes only [3, 4].

The convergence of factors such as high density of wildlife and livestock as well as tropical climate sustains the high numbers and influences distribution of diverse tick species across Africa characterized with fever, muscle aches and generalized weakness and owing to endemicity of Malaria, most tick-borne diseases in humans are likely misdiagnosed and treated as Malaria, resulting in more patient hospitalization days and higher medical costs [9,10,11].

Tick-borne diseases can be averted through preventing tick bites. In the health behavior model, socio-economic status of an individual has been linked to both the health status and health behavior [12]. This implies that for tick-borne diseases, outdoor socio-economic activities and tourism-associated leisure activities are high risk behaviors that predispose humans to tick bites [11,13,14]. According to Stefanoff et al., the risk of acquiring human tick-borne diseases decreases with increase in educational level and income per household[15]. Further, it has been postulated that level of knowledge on a health related risk has a direct influence on perception (attitude) of the risk associated with exposure [16,17] and the health related behaviors [18]. This implies that individuals who have better understanding of a health risk are likely to take precautions while dealing with a risk as compared to the unaware group.

Formulation of comprehensive, integrative and participatory public health control measures on human tick-borne diseases would therefore require information on community risk drivers, perceptions, awareness and practices. The community living within and around Ol Pejeta conservancy was suitable for this study because it interacted with wildlife and livestock daily and the objective of the study was to determine whether there was an association between socio-demographic factors, awareness and practices on issues relating to ticks, tick bites and human tick-borne diseases.

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2. Materials and Method

2.1 Study area

The study was carried out among the people living in and around the Ol Pejeta Conservancy (OPC) about 20 km West of Nanyuki town, and lies at the equator between the Aberdare Range and Mount Kenya at an altitude of 1800 m (0^0 N 36^0 56'E) in Laikipia County (Figure 1). OPC covers 90,000 acres and is completely fenced off from the surrounding human settlements. The conservancy practices mixed ranching of wildlife and cattle with a rich diversity of wild animals that include African buffalos, Elephants, Giraffes, Black and White Rhinos, Impalas, Elands, Gazelles, Hyenas, Lions, Foxes, and leopards.

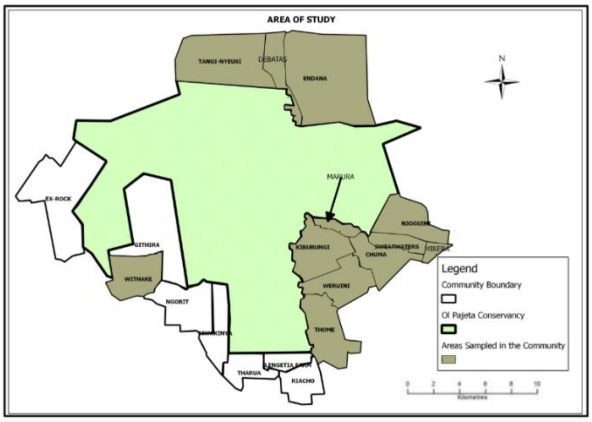

Figure 1. Map of the study area showing Ol Pejeta Conservancy and the adjacent human settlement.

2.2 Study design and sampling procedure

The human sample size for awareness and practice objective was determined using the Cochran formula [19]. The respondents inside Ol Pejeta Conservancy (OPC) were selected through systematic random sampling at convergence points within the conservancy with a skip interval of 4, which resulted into 152 individuals from OPC. From the adjacent community in the Eastern and Southern part of the conservancy (Figure 1), 100 heads of households who were 18 years old and willing to participate in the study were selected for the interviews through systematic random sampling of households with a skip interval of 40. This was determined after the households in the villages were listed and assigned numbers. From the North (Endana, Debatas and Tangi Nyeusi), Consecutive sampling method was used to obtain participants. All household heads that were available, willing to participate in the study and met the inclusion criteria were interviewed and a total of 55 people were interviewed in the North. The total number of respondents interviewed for this study was 307 people.

2.3 Data collection and analysis

Data was collected from February to April 2017 using semi-structured questionnaires administered to participants who gave written consent. The research assistants administering questionnaires used English, Swahili or native language to gather information from the respondents. The questionnaire was designed to gather information on the following areas (i) socio-demographic and economic characteristics (ii) awareness on ticks and tick borne diseases (iii) practices against tick-bites and tick borne diseases.

The socio-demographic and economic information included location of residence, age, level of education and occupation. In regard to economic characteristics, the respondents indicated whether they owned livestock, type of housing for their families, type of toilet, their source of domestic water and source of cooking and lighting energy.

Fourteen (14) questions were asked to gauge the respondents' awareness through the ability to (i) identify a tick, (ii) knowledge of ticks as vectors of diseases to livestock, wildlife and humans (iii) knowledge of least one human tick-borne disease (iv) Select from a list the symptoms associated with tick bites in humans and (v) Identify measures one could take to prevent tick bites and human tick-borne diseases. For each question a correct response was awarded two (2) points while a wrong response or I don't know was awarded one (1) point. The questions that evaluated the respondents awareness of their risk of acquiring tick borne diseases and preventive measures available was measured using six (6) statements on a 5-point Likert scale [20]. The statements were awarded points in a descending order from strongly agree (5 points) to strongly disagree (1 point). The scores were calculated for each category of the basic measure of awareness such as the ability to identify a tick, knowledge on ticks as vectors and knowledge on human tick-borne diseases. The awareness score for each participant was compiled by summing the scores from the correct responses and the scores from the Likert data out of 42 points (the maximum a participant could score in this section). This was then converted into a percentage for each participant. The total score of the respondents was then categorized according to Bloom's cut-off points as either poor (below 60%), fair (60% to 80%) or good (Above 80%). However responses to the question on symptoms that respondents associated with tick bites in humans that required the respondents to pick from multiple choices was not weighted into scores, hence not included in the total awareness score. This question was analyzed as qualitative data and presented as proportions.

For the practice section, the questionnaire sought to evaluate the extent of personal preventive behaviors performed by the respondents towards tick-borne diseases. Ten (10) questions were asked with the option of any of the three (3) responses; Never, Sometimes and always. These questions assessed practice in 5 areas that include (i) tick habitat avoidance (ii) use of protective clothing (iii) use of tick repellent (iv) performance of visual tick checks on the body and (v) seeking medical attention after tick bites. Three (3) points was awarded for always, two (2) points for sometimes and one (1) point for never. A practice score for each participant was calculated by summing the scores under each type of practice such as tick habitat avoidance and use of protective clothing. The overall practice score of the participant was calculated by summing all the scores in each category out of 30 (the maximum score any participant could achieve) for the 10 questions. These scores were converted into percentages, then categorized according to original Bloom's cut-off points as either poor practice (below 60%), fair practice (60 to 80%) or good practice (Above 80%). The variables in the data were coded for easy entry and analysis. The data were entered into Microsoft Excel 2007, cleaned to detect any missing or invalid variables. Chi-square test of association and Fisher's exact tests were used to determine the association between socio-demographic characteristic, awareness and practice using Statistical Package for Social Sciences (SPSS for windows, version 23, Chicago, USA). A P value < 0.05 was considered significant for comparison. Qualitative data was presented using proportions and frequencies.

3. Results

The respondents were largely composed of a young population with (18-30 years) at 44 % (figure 2). A number of the respondents were illiterate (26.71%) but a majority had attained some level of primary schooling (41.7%) (Table 1). Majority of the respondents (99.02%) interacted with cattle and/or wild animals as part of their daily routine (Table1).

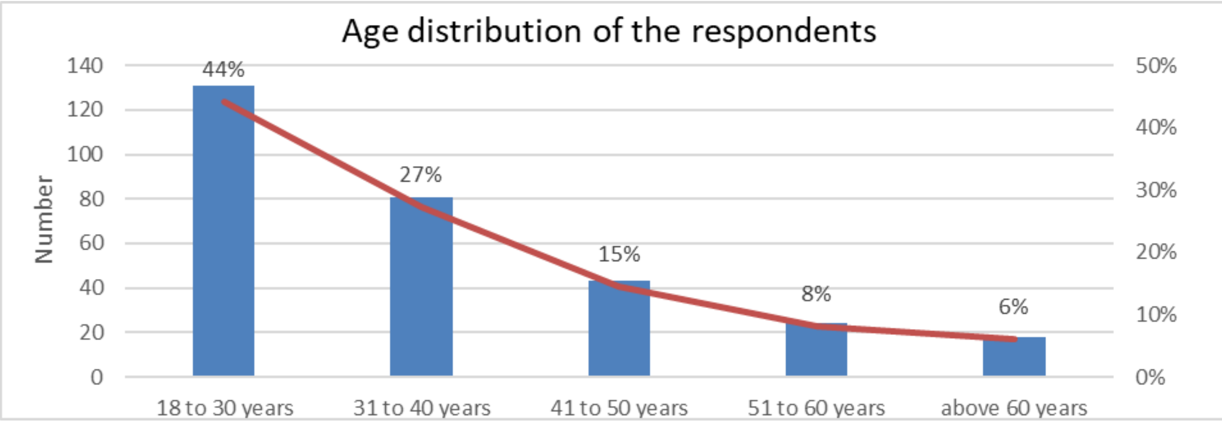

Figure 2. Age distribution of the respondents

Table 1. Socio-demographic characteristics of the respondents

Variable	Category	Number	Proportion (%)
Gender	Male	214	69.71
	Female	93	30.29
Location	North	55	17.92
	OPC	152	49.51
	South	100	32.57
Age	18-30	131	42.67
	31-40	81	26.38
	41-50	43	14.01
	51-60	24	7.82
	Above 60	18	5.86
	Non-response	10	3.26
Level of Education	No formal schooling	82	26.71
	Complete primary school	48	15.64
	Complete secondary school	80	26.06
	Incomplete primary school	22	7.17
	Incomplete secondary school	62	20.20
	Post-secondary certificate or diploma	8	2.61
	Degree and above	2	0.65
	Non-response	3	0.98
Occupation	Employed herders	78	25.41
	Mixed farmers	72	23.45
	Game wardens	55	17.92
	Pastoralists	49	15.96
	Office workers	22	7.17
	Business men	22	7.17
	Casual laborers	9	2.93
Interaction with animals	Cattle and wildlife	175	57.00
	Cattle only	125	40.72
	Wildlife only	4	1.30
	None	3	0.98
	Total	**307**	**100.00%**

Livestock ownership was a key economic resource for this community who mainly dwelt in semi-permanent houses (73.29%) and depended on firewood (80.5%) and kerosene (47.88%) for cooking and lighting, respectively (Table 3).

Table 2. Socio-economic characteristics of the respondents

Variable	Category	Number	Proportion (%)
Livestock ownership	Own livestock	258	84.04
	Do not own livestock	49	15.96
Where livestock are housed	Livestock enclosure	256	99.22
	In the house	2	0.78
Type of house	Semi-permanent	225	73.29
	Permanent	47	15.31
	Temporary	35	11.4
House wall material	Wood	106	34.53
	Iron sheets	82	26.71
	Mud	67	21.82
	Stone	31	10.1
	Brick	17	5.54
	Polythene paper	4	1.3
House floor material	Earth	204	66.45
	Cement	100	32.57
	Tiles	2	0.65
	Wood	1	0.33
House roofing material	Iron sheets	249	81.1
	Grass	29	9.45
	Polythene paper	29	9.45
Domestic water source	Piped water	134	43.65
	Open source	89	28.99
	Bore-hole	77	25.08
	Supplied by vehicles	7	2.28
Toilet facilities	Pit-latrine	235	76.55
	No toilet facilities	66	21.5
	Flush toilet	6	1.95
Source of cooking energy	Firewood	247	80.5
	Gas	27	8.8
	Kerosene	16	5.2
	Charcoal	12	3.9
	Electricity	5	1.6
Source of lighting	Kerosene lamp	147	47.88
	Electricity	84	27.36
	Solar	60	19.54
	Rechargeable lamp	12	3.91
	None	2	0.65
	Firewood	1	0.33
	Wax candle	1	0.33

Majority of the respondents positively identified a tick (99.67%) and those that were aware that ticks could spread diseases to livestock were (97.4%) but the number decreased when asked about ticks transmitting diseases to humans or whether there were diseases are shared between wildlife and livestock (Table 3). Most of the respondents (69%) experienced heavy tick bites during the dry season (Table 3). Majority of the respondents (46.91%) picked Tick fever as a human tick borne disease followed by East Coast Fever as a human tick borne disease (27.69%). This is a tick borne disease known to affect cattle and not man (Figure 3).

Table 3. Responses to questions that assessed awareness on ticks and transmission factors of human tick-borne diseases

	Variable	Response	Proportion	%
1	Positively identify a tick	Yes	306	(99.67)
		No	1	(0.33)
2	Do ticks transmit diseases to livestock	Yes	299	(97.40)
		I don't know	6	(1.95)
		No	2	(0.65)
3	Do ticks transmit diseases to wild animals	Yes	280	(91.2)
		I don't know	22	(7.17)
		No	5	(1.63)
4	Do ticks transmit diseases to humans	Yes	208	(67.70)
		I don't know	73	(23.80)
		No	26	(8.50)
5	Are there diseases shared between livestock and wildlife	Yes	199	(64.82)
		I don't know	80	(26.06)
		No	28	(12.12)
6	Season of the most tick bites	Dry season	212	(69.06)
		Wet season	51	(16.61)
		All year round	34	(11.07)
		I don't know	10	(3.26)

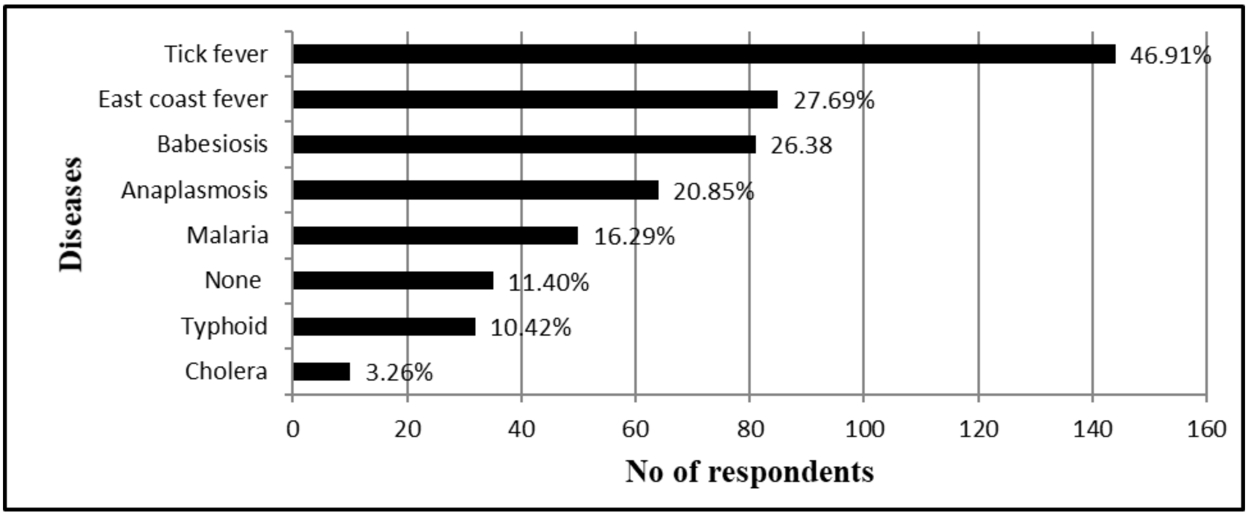

Figure 3. Response to the question that sought to determine which diseases the respondents thought were human tick-borne diseases

When asked to identify common signs and symptoms associated with tick bites in humans, 71.7% of the respondents mentioned skin rash followed by general weakness (43%) as the main symptoms (Figure 4). A proportion of 60.91% of the respondents thought tick borne diseases occurred in the area while 63.52% of the respondents thought that they were at risk of infection with tick-borne diseases (Table 4). The respondents strongly agree that use of proper prevention strategies was important (72.96%). However only 49.19% believed that use of tick repellents was an effective prevention strategy (Table 4). Overall, there was a strong agreement for need of community education about tick borne diseases (72.31%) as shown in table 4.

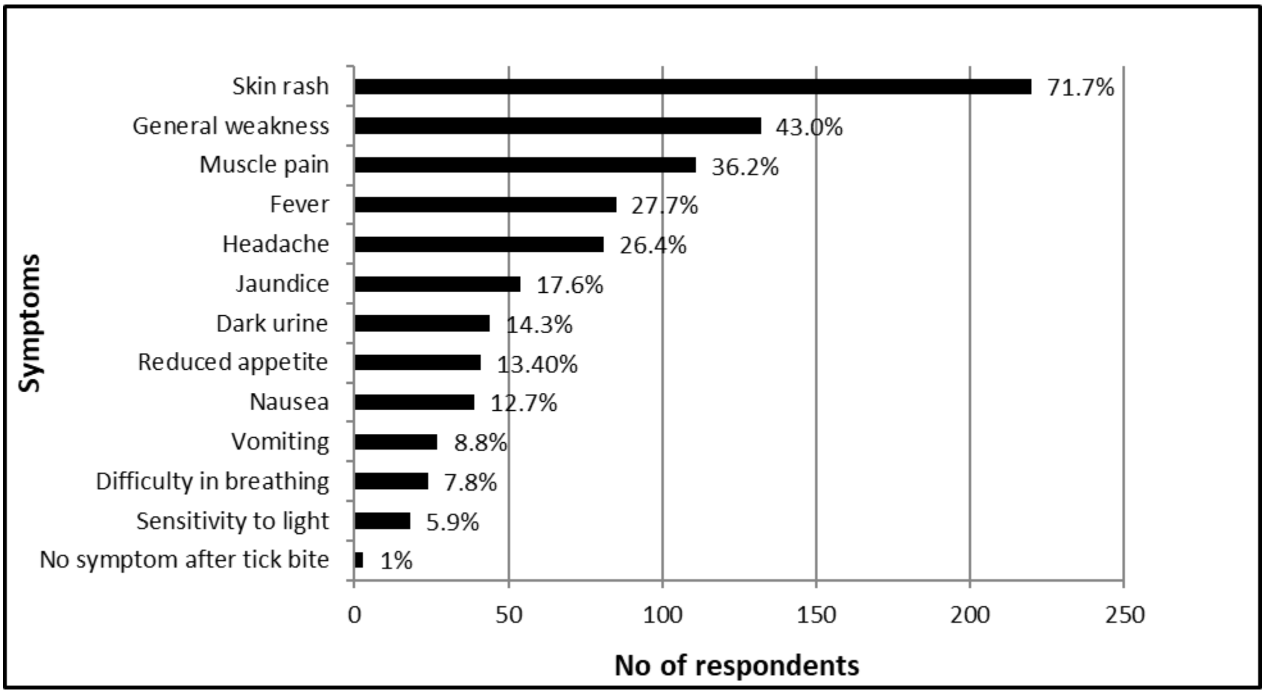

Figure 4. Signs and symptoms that respondents associated with tick bites in humans

Table 4. Responses to questions assessing awareness on the risk of infection by human tick-borne diseases

Assessment variables	I Strongly disagree		I disagree		I neither agree nor disagree		I agree		I strongly agree	
	n	%	*n*	%	*n*	%	*n*	%	*n*	%
Diseases spread by ticks occur in my area	11	3.58	37	12.05	72	23.45	117	**38.11**	70	22.80
A tick can spread more than one disease	10	3.26	31	10.1	83	27.04	103	**33.55**	80	26.06
I am at risk of getting a disease spread by ticks	19	6.19	42	13.68	51	16.61	129	**42.02**	66	21.5

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By use of proper prevention strategies I can prevent diseases spread by ticks	13	4.23	37	12.05	33	10.75	105	34.20	119	**38.76**
I believe tick repellents are effective	56	18.24	45	14.66	55	17.92	113	**36.81**	38	12.38
There should be more education about diseases spread by ticks	10	3.26	6	1.95	1	0.33	68	22.15	222	**72.31**

Key: The responses with the highest proportion in each category are in bold.

Responses to questions that assessed community practices on prevention of tick bites and tick-borne diseases are summarized in figure 5. Overall, the respondents had poor practices against prevention of tick bites (46.58%). It was noted that 45.86% of the respondents did not take any preventive measures against tick exposure. The most popular protection measure with the respondents was visual tick checks on their clothes after exposure to ticks (34.53%) followed by visual tick checks on the body after exposure (34.2%) while the least used method of protection was application of tick repellents (7.17%). Many respondents (77.2%) sought medical intervention when they developed any fever (figure 5).

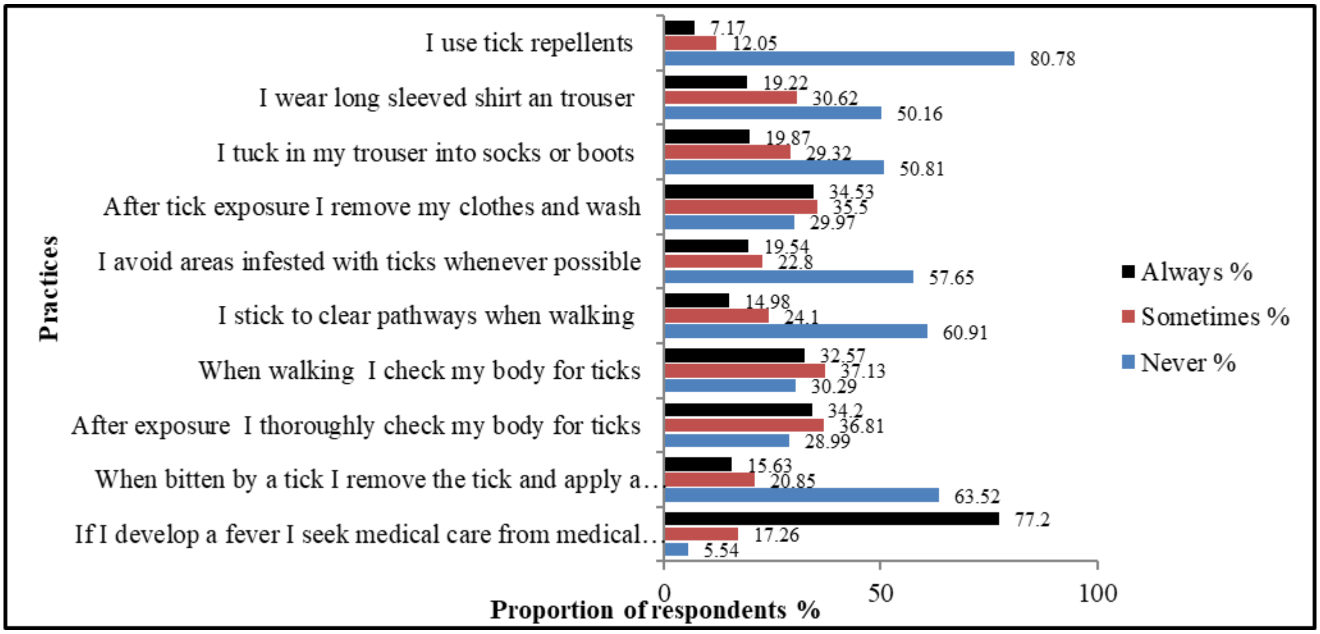

Figure 5. Community practices on prevention of tick bites and tick-borne diseases

For the bivariate analyses, two composite variables were generated for Practice and awareness levels respectively based on the various awareness and practice activities investigated. Analysis of the association between socio-demographic factors on awareness on ticks and tick-borne diseases showed that location of residence of the respondents, gender, level of education and the occupation was statistically significant or influenced awareness on ticks and human tick-borne diseases. Location was statistically significant at (χ^2 12.699, P = 0.013). Gender at (χ^2 8.295, P = 0.016), level of education at (χ^2 29.139, P = 0.002) and occupation at (χ^2 22.592, P =0.031). Age and livestock ownership did not have any association with awareness.

Table 5. Association between the socio-demographic and economic characteristics and the composite level of awareness

Variable	Level of Awareness								Chi-Square	P-value
	Poor		Fair		Good		Total			
	n	%	n	%	n	%	n	%		
Gender										
Male	2	0.65	82	26.71	130	42.35	214	69.71		
Female	1	0.33	52	16.94	40	13.03	93	30.29	**8.477**	**0.016***
Total	**3**	**0.98**	**134**	**43.65**	**170**	**55.37**	**307**	**100.00**		
Location										
North	2	0.65	32	10.42	21	6.84	55	17.92	**12.699**	**0.013***

OPC	1	0.33	58	18.89	93	30.29	152	49.51		
South	0	0.00	44	14.33	56	18.24	100	32.57		
Total	**3**	**0.98**	**134**	**43.65**	**170**	**55.37**	**307**	**100.00**		
Age										
18-30	1	0.34	55	18.52	75	25.25	131	44.11		
31-40	1	0.34	38	12.79	42	14.14	81	27.27		
41-50	1	0.34	21	7.07	21	7.07	43	14.48	5.3	0.815
51-60	0	0.00	8	2.69	16	5.39	24	8.08		
Above 60	0	0.00	10	3.37	8	2.69	18	6.06		
Total	**3**	**1.01**	**132**	**44.44**	**162**	**54.55**	**297**	**100.00**		
Level of Education										
No formal schooling	2	0.66	53	17.43	27	8.88	82	26.97		
Complete primary school	1	0.33	18	5.92	29	9.54	48	15.79		
Complete secondary school	0	0.00	24	7.89	56	18.42	80	26.32		
Incomplete primary school	0	0.00	9	2.96	13	4.28	22	7.24		
Incomplete secondary school	0	0.00	25	8.22	37	12.17	62	20.39	**31.337**	**0.0001***
Post-secondary certificate or diploma	0	0.00	3	0.99	5	1.64	8	2.63		
Degree and above	0	0.00	0	0.00	2	0.66	2	0.66		
Total	**3**	**0.99**	**132**	**43.42**	**169**	**55.59**	**304**	**100.00**		
Occupation										
Employed herders	1	0.33	31	10.10	46	14.98	78	25.41		
Mixed farmers	0	0.00	34	11.07	38	12.38	72	23.45		
Game wardens	0	0.00	22	7.17	33	10.75	55	17.92		
Pastoralists	2	0.65	31	10.10	16	5.21	49	15.96	**22.592**	**0.031***
Office workers	0	0.00	8	2.61	14	4.56	22	7.17		
Business men	0	0.00	7	2.28	15	4.89	22	7.17		
Casual laborers	0	0.00	1	0.33	8	2.61	9	2.93		
Total	**3**	**0.98**	**134**	**43.65**	**170**	**55.37**	**307**	**100.00**		
Interaction with animals										
Cattle and wildlife	3	0.98	71	23.13	101	32.90	175	57.00		
Cattle only	0	0.00	60	19.54	65	21.17	125	40.72		
Wildlife only	0	0.00	2	0.65	2	0.65	4	1.30	3.815	0.702
None	0	0.00	1	0.33	2	0.65	3	0.98		
Total	**3**	**0.98**	**134**	**43.65**	**170**	**55.37**	**307**	**100.00**		
Livestock ownership										
Own livestock	3	0.98	112	36.48	143	46.58	258	84.04		
Do not own livestock	0	0.00	22	7.17	27	8.79	49	15.96	8.477	0.744
Total	**3**	**0.98**	**134**	**43.65**	**170**	**55.37**	**307**	**100.00**		

Key: * statistically significant

Generally, awareness did not influence practices of the respondents significantly (table 6). Out of all variables cross tabulated with practice in general (the total score for practice for the respondents), only occupation influenced the respondents general practices towards prevention of tick bites and tick-borne diseases occupation (χ^2 22.964, P =0.028) as shown in table 7.

Table 6. Association between awareness and practice

Awareness	**Practice**				**Chi square Test statistics**
	Poor	**Fair**	**Good**	**Totals**	

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Poor	1	1	1	3	χ^2 Value:10.028 P-Value: 0.025
Fair	58	70	6	134	
Good	84	67	19	170	
Totals	143	138	26	307	

Table 7. Association between socio-demographic and economic characteristics and composite levels of practice

Variable	**Level of Practice**								**Chi-Square**	**P-value**
	Poor		Fair		Good		Total			
	n	%	n	%	n	%	n	%		
Gender										
Male	104	33.88	92	29.97	18	5.86	214	69.71	1.254	0.542
Female	39	12.70	46	14.98	8	2.61	93	30.29		
Total	**143**	**46.58**	**138**	**44.95**	**26**	**8.47**	**307**	**100.00**		
Location										
North	34	11.07	17	5.54	4	1.30	55	17.92	9.165	0.057
OPC	70	22.80	72	23.45	10	3.26	152	49.51		
South	39	12.70	49	15.96	12	3.91	100	32.57		
Total	**143**	**46.58**	**138**	**44.95**	**26**	**8.47**	**307**	**100.00**		
Age										
18-30	59	19.87	62	20.88	10	3.37	131	44.11	2.23	0.991
31-40	40	13.47	34	11.45	7	2.36	81	27.27		
41-50	20	6.73	19	6.40	4	1.35	43	14.48		
51-60	11	3.70	10	3.37	3	1.01	24	8.08		
Above 60	7	2.36	9	3.03	2	0.67	18	6.06		
Total	137	46.13	134	45.12	26	8.75	297	100.00		
Level of Education										
No formal schooling	43	14.14	35	11.51	4	1.32	82	26.97	8.775	0.756
Complete primary school	21	6.91	23	7.57	4	1.32	48	15.79		
Complete secondary school	36	11.84	39	12.83	5	1.64	80	26.32		
Incomplete primary school	11	3.62	8	2.63	3	0.99	22	7.24		
Incomplete secondary school	26	8.55	28	9.21	8	2.63	62	20.39		
Post-secondary certificate or diploma	4	1.32	3	0.99	1	0.33	8	2.63		
Degree and above	2	0.66	0	0.00	0	0.00	2	0.66		
Total	**143**	**47.04**	**136**	**44.74**	**25**	**8.22**	**304**	**100.00**		
Occupation										
Employed herders	35	11.40	41	13.36	2	0.65	78	25.41	**23.34**	**0.028***
Mixed farmers	25	8.14	36	11.73	11	3.58	72	23.45		
Game wardens	29	9.45	20	6.51	6	1.95	55	17.92		
Pastoralists	31	10.10	17	5.54	1	0.33	49	15.96		
Office workers	8	2.61	12	3.91	2	0.65	22	7.17		
Business men	12	3.91	8	2.61	2	0.65	22	7.17		
Casual laborers	3	0.98	4	1.30	2	0.65	9	2.93		
Total	**143**	**46.58**	**138**	**44.95**	**26**	**8.47**	**307**	**100.00**		
Interaction with animals										
Cattle and wildlife	84	27.36	75	24.43	16	5.21	175	57.00	4.903	0.556
Cattle only	54	17.59	61	19.87	10	3.26	125	40.72		
Wildlife only	2	0.65	2	0.65	0	0.00	4	1.30		

None	3	0.98	0	0.00	0	0.00	3	0.98		
Total	**143**	**46.58**	**138**	**44.95**	**26**	**8.47**	**307**	**100.00**		
Livestock ownership										
Own livestock	119	38.76	118	38.44	21	6.84	258	84.04	0.65	0.778
Do not own livestock	24	7.82	20	6.51	5	1.63	49	15.96		
Total	**143**	**46.58**	**138**	**44.95**	**26**	**8.47**	**307**	**100.00**		

Key: * statistically significant

However when the independent variables were cross tabulated with specific practices geared towards prevention of tick bites and human tick-borne diseases, the results showed that the use of tick repellents was influenced by location (χ^2 27.445, P =0.001), gender (χ^2 15.741, P =0.001), interaction with animals (χ^2 11.495, P =0.05) and occupation (χ^2 27.131, P =0.007) as shown in table 8. The use of protective clothing was influenced by location (χ^2 23.655, P =0.001), gender (χ^2 12.259, P =0.002) and occupation (χ^2 33.036, P =0.001) as shown in table 9.

Table 8. Association between the use of tick repellents and the socio-demographic and economic variables

Practice (Use of tick repellents)

	Chi- Square test of statistics	
Independent variables	**χ^2 Value**	**P-Value**
Location	27.445	**0.001***
Gender	15.741	**0.001***
Age	4.919	0.766
Interaction with animals	11.495	**0.05***
Livestock ownership	4.531	0.104
Level of education	10.985	0.516
Occupation	27.131	**0.007***

Key: * statistically significant

Table 9. Association between the use of protective clothing and the socio-demographic and economic variables

Practice (Use of protective clothing)

	Chi- Square test of statistics	
Independent variables	**χ^2 Value**	**P-Value**
Location	23.655	**0.001***
Gender	12.259	**0.002***
Age	6.110	0.645
Interaction with animals	11.569	0.072
Livestock ownership	0.429	0.824
Level of education	13.286	0.349
Occupation	33.036	**0.001***

Key: * statistically significant

Visual checks for ticks was associated with the level of education of the respondents (χ^2 21.869, P =0.039) as shown in table 10. The practice of avoiding habitats with ticks was associated with location (χ^2 36.240, P =0.0001), gender (χ^2 14.612, P =0.001), interaction with animals (χ^2 21.313, P =0.002) and occupation (χ^2 59.433, P =0.0001) as shown in table 11. The practice of seeking medical attention was influenced by location, gender, age, interaction with animals, livestock ownership, level of education and occupation (Table 12).

Table 10. Association between visual checks for ticks and the socio-demographic and economic variables

Practice (visual checks for ticks)		
	Chi- Square test of statistics	
Independent variables	**χ^2 Value**	**P-Value**
Location	5.082	0.279
Gender	0.322	0.851
Age	5.672	0.684
Interaction with animals	8.818	0.184
Livestock ownership	4.095	0.129
Level of education	21.869	**0.039***
Occupation	13.848	0.311

Key: * statistically significant

Table 11. Association between tick habitat avoidance and the socio-demographic and economic variables

Practice (tick habitat avoidance)		
	Chi- Square test of statistics	
Independent variables	**χ^2 Value**	**P-Value**
Location	36.240	**0.0001***
Gender	14.612	**0.001***
Age	11.365	0.182
Interaction with animals	21.313	**0.002***
Livestock ownership	3.217	0.2
Level of education	19.141	0.085
Occupation	59.433	**0.0001***

Key: * statistically significant

Table 12. Association between seeking medical attention and the socio-demographic and economic variables

Practice (Seeking medical attention)		
	Chi- Square test of statistics	
Independent variables	**χ^2 Value**	**P-Value**
Location	44.380	**0.0001***
Gender	14.237	**0.001***
Age	16.042	**0.042***
Interaction with animals	22.031	**0.001***
Livestock ownership	13.503	**0.001***
Level of education	34.868	**0.0001***
Occupation	52.378	**0.0001***

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Key: * statistically significant

4. Discussion

Based on the socio-economic and demographic features, the respondents in this study were a rural low income community that was highly dependent on livestock keeping and crop farming. These factors are associated with the risk of exposure to ticks and transmission of tick-borne diseases [21]. Particularly, close contact with livestock, which are often reservoirs of pathogens and ticks [7] is strongly associated with increased human sero-positivity to tick borne pathogens such as *Coxiella brunetii*, the causal agent for Q – fever [21].

Architectural design of most of the houses coupled with their proximity to livestock enclosures further enhanced the risk of exposure to ticks on the entire household. The high proportions of affirmative responses to questions on ticks and transmission factors of tick borne diseases suggest high awareness level. Although a large proportion of the respondents had formal schooling, and many could distinguish ticks from other arthropods, it was not surprising that majority of respondents associated ticks with animal diseases and less as vectors of human diseases. This could be attributed to the fact that livestock is the backbone of rural economy in Kenya and that loss of their productivity, morbidity and mortality due to tick-borne diseases have been widely publicized. In the survey, many recognized East Coast Fever as a human tick borne disease yet it is a disease affecting cattle. Generally in Africa, human tick borne diseases are neglected and least documented. Lyme disease, a tick-borne bacterial disease caused by *Borrelia burgdorferi* is richly described in terms of its public health impact, epidemiology and diagnosis in endemic continents. Conversely, in spite of the multiple species of *Borellia* causing relapsing fever in Africa little is known about them [9] especially information on epidemiology and public health burden. According to Trape et al. [22], about 44 million people living in rural Africa are at risk of tick-borne relapsing fever and the high demand for public health awareness campaigns (72.31%) as shown by this study is warranted.

Tick-borne diseases in humans are often associated with diverse symptoms, though fever is quite common. In this survey, the respondents rated highly skin rash, which is an immediate immune response on the site of a tick bite. Tick-borne symptoms are often masked by other fever-causing illnesses therefore leading to misdiagnosis and wrong medication, especially in malaria endemic regions [11]. Eco-climatic factors are associated with tick abundance and distribution [6]. In this study, respondents indicated that intensity of tick bites coincides with dry season (Table 3), which is consistent, specifically in terms of abundance, to observation from pastoralist communities in Northern Tanzania [23]. Increased tick bite intensity is likely to enhance risks of tick bites among pastoralists, given that dry season is associated with sparse pasture and they have to trek further and stay more in tick infested habitats.

While majority of the respondents were aware that the area they occupied was infested with ticks and that they were at risk of infection with tick-borne diseases, they were less keen to take preventive measures against tick bites. It has been demonstrated that personal protective behaviors (PPBs) against tick bites such as wearing protective clothing, applying tick repellent on skin and clothing, checking for and removing ticks and avoiding tick habitats [24] are less used, even among knowledgeable people or people occupying areas with endemic diseases due to the inconvenience and discomfort especially during summer or in the hot tropics [25].

Although many respondents affirmed that use of repellents is effective in preventing tick bite, but it was interesting that this was the least used protection method by the community probably due to cost implications and their limited availability to rural communities in Africa. According to Schreck et al. [26], repellents containing DEET applied on the skin and those containing permethrin applied to clothing or tents are effective in preventing tick bites.

This study determined that awareness of ticks and human tick borne diseases was associated with location, gender, occupation and level of education. The association between occupation and awareness suggests that awareness is socially structured in this community and specifically by occupation given its direct influence on awareness. Combined with the fact that overall, level of education is positively associated with awareness, the cultural gender-bias for formal education among pastoralist communities disadvantages the females also on issues of health [3]. Conversely, since livestock herding is dominantly a male responsibility, the occupation similarly disadvantages this group by putting them at risk of tick-borne diseases. A public health awareness campaign thus should actively seek to engage these groups that are engaged in transhumance and women.

Although the study population had a good level of awareness on ticks and tick borne diseases, they were generally indifferent to taking measures that prevent tick bites. There was no association between gender, level of education and livestock ownership on practice. Except occupation that was statistically significant. Analysis showed that people who interacted with animals had positive practices compared to those who did not. This discrepancy that favored positive preventive behavior on individuals who interacted with animals was probably influenced by the type of interaction. For instance, a herder is likely to have direct contact with cattle through touch and milking thereby expose himself to tick bites as opposed to individuals who did not interact with any animals. Occupation also had a statistically significant influence on the use of protective clothing. For instance, wardens, mixed farmers, office workers and herders are more likely than pastoralist and business people to use protective clothing to minimize tick bites and tick borne diseases. It is likely that inconvenience and discomfort is the main cause for the discrepancy in the use of protective clothing among pastoralists, but for business people this could be as a result of their occupation not having any direct interaction with animals. It is common for employees, such as wardens and herders, to adhere to formal work uniforms that likely come with protective advantages.

There was an interesting interaction between gender and occupation in terms of personal preventive behavior (PPBs). First, females are more likely to use tick repellent and check their bodies for ticks and avoid tick infested areas compared to males. Conversely, occupation took precedence over gender with regard to tick habitat avoidance. For instance those who work with animals (wildlife wardens and herders) are least likely to avoid tick habitats compared to individuals in other occupations. It is probable that wildlife wardens would not care to avoid tick habitats because ticks are likely to be ubiquitous in the entire wildlife habitat. Further, wildlife wardens usually wear uniforms that include long pants that could be tucked on boots, thus protect them against ticks. Generally, males from the community in this study were likely to use protective clothing than females, a practice that has been observed in other communities [27] and suggests a gender-based preference in personal protective behaviors.

Further, in terms of occupation, pastoralists are naturally a high tick exposure group and since they are mostly males, they least cared for any preventive practice against ticks compared to other occupations. Probably this could be due to the inconvenience of wearing protective clothing given that herders and pastoralists have to trek long distances with cattle under scorching heat, in rugged terrain and bushy habitats. This suggests that male herders are more at risk to tick-borne pathogens compared to females as have been shown by high sero-positivity to rickettsial exposure in a pastoral Tanzanian community [28].

Occupation influenced the practice of seeking medical attention. The highest risk group members of the community, the herders and pastoralists, were least likely to seek medical care attributed to tick-borne illnesses. The practice of seeking medical attention was also positively influenced by the level of education of the respondents.

5. Conclusion

Socio-economic incentives and demographic factors of this community are core drivers to exposure to tick habitats that predispose them to risk of tick-borne diseases. Our analysis revealed a complex interaction between social constructs, awareness and practice. Gender, formal education and interaction with animals were the main social factors that influenced awareness and practices. In addition, when individuals have higher education and also interact with animals they are likely to apply techniques that reduce exposure to tick bites and tick-borne diseases. In summary, higher education and animal based occupation shaped the community awareness about ticks and tick borne diseases and drives specific practices of prevention to tick bites and tick borne diseases. Our conclusion is thus consistent to that of Stefanoff et al. [15], which suggested that risk of acquiring tick-borne diseases decreases with increase in educational level and increase in income per household.

6. Ethics

Ethical approval to conduct the study was obtained from the Kenyatta University Ethics Review Committee application number PKU/557/E52.

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