



A quantitative exploration of nomadic pastoralists' knowledge and practices towards Rift Valley fever in Niger State, North-central Nigeria: The associated socio-cultural drivers



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ABSTRACT

Rift Valley fever (RVF) is a vector-borne re-emerging viral zoonosis that mainly affects poor and marginalized populations in Africa and the Middle East. The study assessed pastoralists' knowledge/awareness and preventive measures towards RVF in Fulani nomadic pastoral communities of Niger State, North-central Nigeria. An interview questionnaire-based cross-sectional survey was conducted in randomly selected 403 Fulani nomadic pastoral households. Descriptive and analytical statistical analyses were performed. About 97% (389/403) of the pastoralists responded. Majority (74.0%) of them was males and 26.0% was females, while most (65.3%) did not possess formal education. About 85% and 77% of respondents mentioned high mortality in newborns and abortions in pregnant cows, respectively, as signs of RVF in cattle. Also, 50.6% of respondents mentioned high fever as RVF symptoms in humans, while 36.5% reported headache. Pastoralists in age group 70–99 years (OR: 2.69; 95% CI: 1.14, 6.33) and those with tertiary education (OR: 2.53; 95% CI: 1.06, 5.99) were more likely to possess satisfactory knowledge about RVF than others. Extensive husbandry system (OR: 6.16; 95% CI: 3.46, 10.97) as well as culture of borrowing and loaning of cattle (OR: 27.00; 95% CI: 12.67, 57.52) were more likely to influence RVF occurrence in herds compared to other factors. The survey revealed gaps in levels of knowledge and practices regarding RVF among pastoralists. Socio-cultural activities were key social drivers for RVF occurrence in pastoral herds. The gaps, influenced by socio-demographic and cultural factors, necessitate the need for multidisciplinary approach including anthropologists in RVF preventive education for the pastoralists. Also, cross-disciplinary studies that would increase understanding of social determinants of re-emerging zoonotic diseases are encouraged.

1. Introduction

Rift Valley fever (RVF) is an acute vector-borne emerging viral zoonotic disease that affects animals and humans [1]. The disease is caused by the Rift Valley fever virus (RVFV), a member of the Genus *Phlebovirus*, Order *Bunyavirales*, and Family *Phenuiviridae* [2–4]. RVFV in domestic animals is transmitted either through bites of infected mosquitoes (mainly of the genera *Aedes* and *Culex*), or by direct contacts with infected animal tissues and bodily fluids and fomites [1,5]. Humans usually get infected with RVFV through bites of infected mosquitoes, aerosols of blood or amniotic fluid, or direct contacts with infected animals [6–8]. The disease is a serious public health problem in Africa and the Middle East, and a potential global health threat [9]. It causes major socioeconomic losses to pastoralists [10,11].

The main biophysical determinants of RVF transmission are the

presence of infected vectors and susceptible cattle hosts as well as other environmental factors for transmission of the disease such as high rainfall, extensive flooding, mosquito population density and presence of lakes and ponds [12–17]. However, social determinants of health that include income, education, occupation, gender, tribe, culture and other factors may have the potential to influence outcome of diseases [18,19]. It is clear that social, political, behavioral, and environmental factors shape the emergence and re-emergence of infectious diseases [20,21].

Fulani nomadic pastoral communities in Africa live in some of the most underdeveloped environments in the world [22]. Although these communities are reliant on their livestock as a source of socio-economic well-being, conventional veterinary services are poor and basic information on the epidemiology of important livestock diseases is limited. Epidemiological research and disease surveillance in such pastoral

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areas are difficult because human populations are relatively small and highly mobile, as they move their livestock across large areas with few roads and means of modern communications [23,24]. RVF is one of the re-emerging infectious diseases that mainly affect poor, marginalized and readily ignored populations that lack access to health services [25].

Identification of norms and practices of pastoral nomads that could underpin outbreak occurrence, spread of the disease and health hazard of RVF on herds and humans is needed to move the field of current epidemiological discourse from a focus on proximate, independent risk factors to new paradigms of distal, interconnected determinants of disease risk [26]. Research into socio-cultural characteristics of pastoralists that could influence disease spread is, therefore, essential to add innovations to RVF control and prevention. Exploration of pastoral nomads' epidemiological knowledge about RVF and their socio-cultural activities is crucial for the development of effective surveillance and preventive preparedness against the disease.

The objective of this study to: to assess pastoralists' knowledge about RVF, and preventive measures against the disease in Fulani nomadic pastoral communities of North-central Nigeria. We hypothesized that: 1) the socio-demographic characteristics of pastoralists cannot be associated with their overall knowledge and preventive measures practice towards RVF in nomadic herds; and 2) the socio-cultural activities of pastoralists cannot influence occurrence of RVF in nomadic herds. The findings from this study are expected to be valuable in minimizing zoonotic challenges of RVF and other emerging and re-emerging zoonotic diseases in developing countries.

2. Materials and methods

2.1. Study area

The study was conducted in Niger State, located at the Southern Guinea savannah zone of Nigeria, between latitudes 8° 20' N and 11° 30' N, and longitudes 3° 30' E and 7° 20' E. It is one of the 36 states of Nigeria and provides transit routes for pastoral nomads on seasonal migrations from the northern parts to the southern areas of the country. The state has three Agro-geographical zones, with variable climatic conditions. These are: Agro-geographical zone A (Southern zone), with many rivers, streams and ponds, fadamas for rice farming, Jebba hydro-electric dam and large grazing lands; Agro-geographical zone B (Eastern zone), with many mountains, trees, and few rivers and streams, Shiroro hydro-electric dam, arable and grazing lands; and Agro-geographical zone C (Northern zone), with few rivers and streams, Kainji hydro-electric dam, Kainji National Game Reserve, arable and large grazing areas, and many stock routes.

The state experiences two distinct seasons: rainy season that spans between April and October and dry season between November and March, with a mean annual rainfall of about 150 cm and for a period of about 180 days. It has average relative humidity of about 58.6% and temperature of 22 °C to 39 °C. All these provide suitable breeding environments for vectors of vector-borne diseases. It has an estimated cattle population of 2.5 million cattle, which are mostly in the custodies of pastoralists [27].

2.2. Structure of target population and livelihood

The target populations were the Fulani nomadic pastoral herd owners, aged 30 years and above, with herds of local breeds of cattle (Bunaji, Rahaji and Bokoloji), domiciled in remote areas of the state during the study period. Average number of households that formed a Fulani nomadic pastoral community was 28, each managed by herd head or owner (a man, his wives and children, or an elderly widow and her children). Average number of animals in a nomadic herd was 102 cattle of variable ages. For the purpose of this research, a Fulani nomadic pastoral household was defined as herd in Fulani ethno-cultural group that keeps mainly cattle, has large herd size, and is on seasonal

movements and on large-range grazing and watering, and with no permanent homestead. Fulani pastoral communities are predominantly nomads that practice livestock keeping as the main source of livelihood and nomadic way of life is the predominant social order.

2.3. Study design, sample size and sampling procedure

An interview questionnaire-based cross-sectional survey was conducted in randomly selected pastoral households between October 2015 and April 2016. The sample size was calculated using the OpenEpi 2.3.1 software [28], with power set at 50% and 5% margin of error at 95% confidence level. A sample size of 384 households was obtained. A 5% contingency was added to take care of non-response, and 402 households were enrolled into the study.

A multi-stage sampling method was conducted to select the pastoralist households. In the first stage, the three Agro-geographical zones in the state were purposively considered. Each Agro-geographical zone had Fulani nomadic settlements. In the second stage, 30 pastoral communities were selected across the study area, with 10 from each Agro-zone. In the final stage, 134 pastoral households were randomly selected in each zone. Systematic random sampling method was used to select the households. Sampling interval of three was used, obtained by dividing the total number of expected households in the three zones ($n = 402$) by the desired number of households to be sampled in each ($n = 134$).

2.4. Questionnaire design, pretesting and data collection

A structured questionnaire was designed based on a literature review. It contained mostly close-ended questions, to ease data processing, minimize variation and improve precision of responses [29]. The questionnaire consisted of four sections: (i) pastoralist's socio-demographic characteristics (age, gender, marital status, occupation and formal education); (ii) knowledge/awareness about RVF, its vectors, clinical signs, symptoms, transmission modes in domestic animals and humans; (iii) perceptions about its zoonotic risk; (iv) identification of socio-cultural factors that predisposed to RVFV infection in pastoral herds; and (v) preventive measures practiced. The questionnaire was designed in English and verbally translated into local *Hausa* languages during the process of questioning, as most of pastoralists did not possess formal education. Six enumerators fluent in the English and *Hausa* languages were trained and carried out interviewer-administered questionnaires. They asked the questions in *Hausa* and recorded the responses in English. We monitored the administration of the questionnaires daily, and checked the filled forms for the purpose of quality control.

The questionnaire was subjected to a pre-test on fifteen households in one pastoral nomad's community before administration to respondents in its final form. The pre-test was aimed at identifying any problems and eliminate them for adequate delivery of the required data.

Respondents were provided with verbal information on the objectives of the study. Their informed consent was obtained verbally before commencement of each section of questionnaire administration and none declined to participate in the study. They were assured of voluntary participation, confidentiality of responses and the opportunity to withdraw at any time without prejudice in line with the Helsinki Declaration (World Medical Association Declaration of Helsinki [30]). Advocacy visits were made to each community a week prior to the proposed interview and necessary permission obtained from Ardos (Community Leaders). The study protocols were approved by the Niger State Ministry of Livestock and Fisheries Development Internal Research Ethics Committee (Ref. Number MLFD/NGS/757).

2.5. Data management and analysis

Participants' responses were summarized into Microsoft Excel 7 (Microsoft Corporation, Redmond, WA, USA) spreadsheets. Descriptive analysis was performed and results expressed in frequencies and proportions. Analytical analysis was carried out to determine associations.

The participants' levels of knowledge/awareness about the disease was determined according to the following learning outcome criteria; the word “very low” represented a proportion of respondents with “know” knowledge level that ranges from 1% to 24%; the word “low” represented a proportion of respondents with “know” knowledge level that ranges between 25% and 49%; the word “high” represented a proportion of respondents with “know” knowledge level that ranges between 50% and 74%; and the word “very high” represented a proportion of respondents with “know” knowledge level that ranges from 75% to 100%. A similar analysis was performed in evaluating the levels of practiced preventive measures.

To assess influence of pastoralists' socio-demographic characteristics on their levels of knowledge and preventive measures practiced on RVF as well as influence of their socio-cultural activities on the disease occurrence in herds, independent (explanatory) variables were created from these characteristics, while respondents' overall response levels constituted the dependent (outcome) variables. However, to create outcome variables, a unique scoring system was used for the responses. Each respondent was assigned a response score within a range of 1–20 points and converted to 100%. These scores reflected stringency of their responses to questions. The score range was further categorized into ‘poor’ or ‘satisfactory’ to keep them as binary variables. Response scores that fell within 1–10 points were considered ‘poor’ ($\leq 49\%$), and those that fell within 11–20 points were considered ‘satisfactory’ ($\geq 50\%$).

Associations between the explanatory and outcome variables were first subjected to univariable analysis using Chi-square tests [31]. Factors found to be statistically significant at this analysis were finally subjected to likelihood stepwise backward multivariable logistic regression models to control for confounding and test for effect modification. The Hosmer and Lemeshow test was used to assess for goodness of fit of the final model and was found to be good. $P < 0.05$ was considered statistically significant in all analyses. All data were analyzed using the OpenEpi version 2.3.1 software [28].

3. Result

3.1. Socio-demographic characteristics of participants

A total of 389 (97%) out of the 402 Fulani nomadic pastoralists recruited participated in the study, with a mean age of 54.9 ± 10.8 SD years, and most (33.9%) were in age group 50–59 years (Fig. 1). Gender

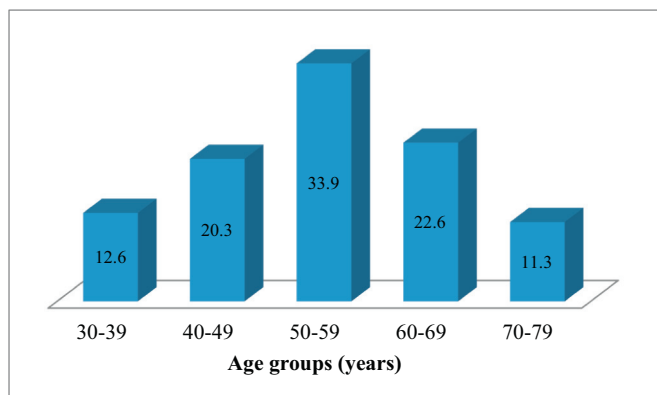


Fig. 1. Age distribution of the participated pastoralists in Niger State, North-central Nigeria.

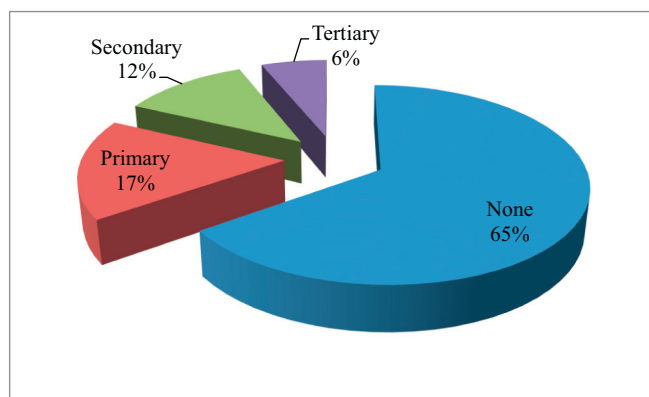


Fig. 2. Formal educational levels of the participated pastoralists in Niger State, North-central Nigeria.

of the respondents was composed of 26% ($n = 101$) females and 74% ($n = 288$) males. About 72% ($n = 279$) were married, while 6.7% ($n = 26$) and 17.0% ($n = 66$) were single and widows, respectively. High proportion (65.3%, $n = 254$) of respondents had no formal education and very few (6.2%, $n = 24$) had tertiary education (Fig. 2). The majority (34.2%, $n = 133$) of the participants were from the Agro-geographical zone A (Southern zone) while Agro-geographical zones C (Northern zone) had the least respondents (32.4%, $n = 126$) (Fig. 3).

3.2. Pastoralists' knowledge and awareness level about RVF

All the respondents have heard about RVF, which they locally called *Gabi-gabi*. Relatives (58.1%) and friends (33.6%) were the common sources of information about RVF to the respondents. Other sources were animal health authorities (5.7%) and radio (2.6). When asked about how RVF manifestations in cattle clinically, 84.6% of respondents mentioned high mortality in newborn calves and 76.6% reported sudden onset of abortions in pregnant cows. Also, 75.1% of them mentioned listlessness in newborn calves while 48.6% reported anorexia as signs. However, very low proportions of the respondents knew about other signs in cattle. Regarding mode of transmission of RVF to animals, 43.4% of participants reported bites of mosquito to be risk factor for RVF infection, while 46.5% of them mentioned bites of other biting flies. Concerning knowledge of RVF symptoms in humans, 50.6% of respondents mentioned high fever and 36.5% of them reported headache. Furthermore, 13.9% of respondents mentioned RVF to be transmissible to humans through bites of infected mosquitoes and other biting flies, while 23.7% reported touching of aborted foetus. Table 1 presents proportions of pastoralists who had knowledge about clinical

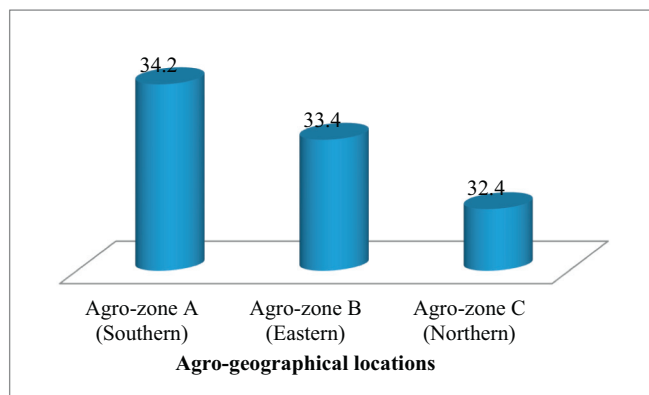


Fig. 3. Distribution of the participated pastoralists in different Agro-geographical zones of Niger State, North-central Nigeria.

Table 1
Pastoralists' knowledge and awareness about RVF in Niger State, North-central Nigeria.

Variable	Frequency (n)	Proportion (%)	95% CI
Sign of RVF in cattle (n = 389)			
High fever	77	19.8	16.1, 24.0
Anorexia	189	48.6	43.6, 53.6
High mortality in newborn calves	329	84.6	80.7, 87.9
Sudden onset of abortions	298	76.6	72.2, 80.6
Mucopurulent nasal discharge	96	24.7	20.6, 29.2
Listlessness in newborn calves	292	75.1	70.6, 79.2
Profuse fetid diarrhea	85	21.9	18.0, 26.2
Mode of transmission of RVF in cattle (n = 389)			
Bites of infected mosquitoes	169	43.4	38.6, 48.4
Bites of other biting flies	181	46.5	41.6, 51.5
Contact with aborted fetus	91	23.4	19.4, 27.8
Aerosol of infected bodily fluid	36	9.3	6.7, 12.5
Aerosol of infected blood	84	21.6	17.7, 25.9
Sign of RVF in humans (n = 389)			
High fever	197	50.6	45.7, 55.6
Headache	142	36.5	31.8, 41.4
Muscle pain	112	28.8	24.5, 33.4
Blurred vision	68	17.5	14.0, 21.5
Bleeding	55	14.1	10.9, 17.9
Backache	96	24.7	20.6, 29.2
Mode of transmission of RVF in humans (n = 389)			
Bites of infected mosquitoes and other biting flies	54	13.9	10.7, 17.6
Drinking raw milk	77	19.8	16.1, 24.0
Eating undercooked meat	85	21.9	18.0, 26.2
Touching aborted foetus	92	23.7	19.6, 28.1
Touching body fluids	39	10.0	7.3, 13.3
Sleeping in same place with animals	47	12.1	9.1, 15.6

n – Number of participants that gave YES responses; CI - Confidence interval.
manifestations and mode of transmission of RVF in cattle and humans.

3.3. Preventive measures practice by pastoralists against RVF

On preventive measures practiced against likelihood of RVF occurrence in pastoral communities, low proportion (39.1%) of the respondents used repellants on animals against arthropods as preventive measure, while very low proportion (22.1%) of them avoided culture of loaning or borrowing animals as preventive measures. Avoiding mosquito sites (ponds and swampy areas) during grazing were practiced by 33.7% of the respondents and 44.7% of them avoided contacts of healthy animals with aborted fetuses. In addition, only 22% of the participants practiced separation of healthy animals from infected ones in herds as preventive measure (Table 2).

Table 2
Practices of preventive measures against RVF by pastoralists in Niger State, North-central Nigeria.

Practice	Frequency (n)	Proportion (%)	95% CI
Use of repellants on animals against arthropods	152	39.1	34.3, 44.0
Avoiding mosquito sites (ponds and swampy areas) during grazing	131	33.7	29.1, 38.5
Avoiding contacts of healthy animals with aborted fetuses	174	44.7	39.8, 49.7
Separation of healthy animals from infected ones in herd	95	24.4	20.1, 28.3
Avoiding culture of loaning or borrowing animals	86	22.1	18.2, 26.4

n – Number of participants that gave YES responses; CI - Confidence interval.

Table 3
The association between socio-demographic characteristics of the pastoralists and their knowledge on RVF in Niger State, North-central Nigeria.

Characteristic	Poor knowledge n (%)	Satisfactory knowledge (%)	Odds ratio (OR)	95% CI	P-value
Age					
30–39	31 (63.3)	18 (36.7)	1.00		
40–49	44 (55.7)	35 (44.3)	1.37	0.66, 2.85	0.406
50–59	60 (45.5)	72 (54.5)	2.07	1.05, 4.06	0.030
60–69	38 (43.2)	50 (56.8)	2.27	1.11, 4.65	0.020
70–79	16 (39.0)	25 (61.0)	2.69	1.14, 6.33	0.020
Gender					
Females	62 (61.4)	39 (38.6)	1.00		
Males	117 (40.6)	171 (59.4)	2.32	1.46, 3.70	0.001
Formal education					
None	153 (60.2)	101 (39.8)	1.00		
Primary	36 (55.4)	29 (44.6)	1.22	0.70, 2.12	0.481
Secondary	22 (47.8)	24 (52.2)	1.65	0.88, 3.11	0.122
Tertiary	9 (37.5)	15 (62.5)	2.53	1.06, 5.99	0.030

n – Number of respondents; % - Row percentage; CI – Confidence interval; Statistically significant at p < 0.05.

3.4. Pastoralists' socio-demographic characteristics associated with their overall knowledge about RVF

All the socio-demographic characteristics of pastoralists, except marital status and agro-geographical location, significantly (P < 0.05) influenced their overall knowledge about RVF at univariable analysis. However, multivariable logistic regressions indicated that, pastoralists in age group 70–99 years were three times more likely to possessed satisfactory knowledge about RVF than those in age group 30–39 years (OR: 2.69; 95% CI: 1.14, 6.33). Also, male pastoralists were two times more likely to possessed satisfactory knowledge about RVF than the females (OR: 2.32; 95% CI: 1.46, 3.70) (Table 3). And pastoralists with tertiary education were more likely to possessed satisfactory knowledge about the disease than those without formal education (OR: 2.53; 95% CI: 1.06, 5.99) (Table 4).

3.5. Pastoralists' socio-demographic characteristics associated with their overall preventive measures practice against RVF

Except marital status and agro-geographical location, other socio-demographic characteristics of the pastoralists significantly (P < 0.05) influenced their overall practiced preventive measures against RVF occurrence at univariable analysis. On multivariable logistic regressions, pastoralists in age group 70–79 years were six times more likely to practice satisfactory preventive measures against RVF than those in age group 30–39 years (OR: 5.96; 95% CI: 2.39, 14.87). Also, male pastoralists were five times more likely to practiced satisfactory preventive measures against the disease than females (OR: 5.01; 95% CI: 2.42, 10.37). Furthermore, pastoralists with secondary and tertiary education were two times and four times more likely to practice satisfactory preventive measures against RVF than those without formal education [(OR: 2.31; 95% CI: 1.16, 4.59) and (OR: 3.46; 95% CI: 1.25, 9.54), respectively] (Table 4).

3.6. Pastoralists' socio-cultural activities that influenced RVF occurrence in herds

All the socio-cultural activities of Fulani nomadic pastoralists significantly influenced occurrence of RVF in cattle herds at univariable analysis. At multivariable logistic regressions, extensive husbandry system was more likely to influenced RVF occurrence in herds (OR: 6.16; 95% CI: 3.46, 10.97), while culture of borrowing and loaning of cattle was twenty seven times more likely to influence RVF occurrence

Table 4

The association between socio-demographic characteristics of the pastoralists and practice preventive measures against RVF in Niger State, North-central Nigeria.

Characteristic	Poor practice n (%)	Satisfactory practice n (%)	Odds ratio (OR)	95% CI	P-value
Age					
30–39	36 (73.5)	13 (26.5)	1.00		
40–49	33 (41.8)	46 (58.2)	3.86	1.78, 8.39	0.001
50–59	47 (35.6)	85 (64.4)	5.01	2.42, 10.37	0.001
60–69	30 (34.1)	58 (65.9)	5.35	2.47, 11.59	0.001
70–79	13 (31.7)	28 (68.3)	5.96	2.39, 14.87	0.001
Gender					
Females	75 (74.3)	26 (25.7)	1.00		
Males	159 (55.2)	129 (44.8)	5.01	2.42, 10.37	0.001
Formal education					
None	121 (47.6)	133 (52.3)	1.00		
Primary	26 (40.0)	39 (60.0)	1.37	0.78, 2.38	0.275
Secondary	13 (28.3)	33 (71.7)	2.31	1.16, 4.59	0.010
Tertiary	5 (20.8)	19 (79.2)	3.46	1.25, 9.54	0.010

n – Number of respondents; % - Row percentage; CI – Confidence interval; Statistically significant at p < 0.05.

in herds (OR: 27.00; 95% CI: 12.67, 57.52). And giving out cattle as gift or payment of dowry was more likely to influence RVF occurrence in herds (OR: 4.60; 95% CI: 2.12, 9.98). Also, sharing a water source that caused concentration of cattle in one point was fifty three times more likely to influence occurrence of the disease in herds (OR: 24.94; 95% CI: 13.54, 45.93). Furthermore, mixed grazing and watering of cattle with small ruminants as well as introduction of new cattle into herds from livestock markets were more likely to influence occurrence of RVF in nomadic herds [(OR: 3.20; 95% CI: 2.07, 4.93) and (OR: 5.35; 95% CI: 3.14, 9.12), respectively] (Table 5).

4. Discussion

RVF is one of the least studied (surveyed) cattle zoonotic diseases in Nigeria, and to our knowledge, this study is the first to investigate the disease among the Fulani nomadic pastoralists using questionnaire approach. Although a high proportion (65.3%) of the pastoralists in this study did not possess formal education, they had significant knowledge and awareness about RVF. However, possession of formal education is very important as it creates opportunities for exchange of ideas and having up-to-date information about a disease pattern through seminars, workshops, and conferences. Formal education levels can, therefore, contribute to increased perception of risks about RVF. Low respondents' knowledge about RVFV mode of transmission among humans may be attributed to low formal educational level, which can predispose to potential risks of infections due to low perceptions.

In this study, pastoralists got to know about the RVF through radio, relatives, friends and veterinary authorities. To provide more epidemiological information about RVF directly to the pastoralists, radio programmes is crucial since they depend much on radios to get information about livestock diseases, as they can carry radios with them even to the remote grazing areas. The use of radio as an efficient media for dissemination of information to educate livestock keepers on RVF has been recommended [32,33]. Also, there is need to intensify sensitization of herders through community meetings and veterinary extension workers since some of the participants obtained information

Table 5

The socio-cultural activities of pastoralists that influence RVF occurrence in Niger State, North-central Nigeria.

Activities	Poor influence (%)	Satisfactory influence (%)	Odds ratio (OR)	95% CI	P-value
Husbandry system practice					
Semi-extensive	36 (58.1)	26 (41.9)	1.00		
Extensive	60 (18.3)	267 (81.7)	6.16	3.46, 10.97	< 0.001
Daily grazing distance					
Short distance	29 (46.8)	33 (53.2)	1.00		
Long distance	76 (23.2)	251(76.8)	2.90	1.66, 5.09	0.001
Keeping of healthy animals with sick ones within herds					
No	32 (35.6)	58 (64.4)	1.00		
Yes	40 (13.4)	259 (86.6)	3.57	2.07, 6.16	0.001
Sharing watering sources leading to concentration of stocks in one point					
No	61 (70.9)	25 (29.1)	1.00		
Yes	27 (8.9)	276 (91.1)	24.94	13.54, 45.93	< 0.001
Mixed grazing and watering of cattle with small ruminants					
No	75 (52.8)	67 (47.2)	1.00		
Yes	64 (25.9)	183 (74.1)	3.20	2.07, 4.93	0.001
Culture of borrowing and loaning of cattle					
No	28 (63.6)	16 (36.4)	1.00		
Yes	21 (6.1)	324 (93.9)	27.00	12.67, 57.52	< 0.001
Introduction of new cattle into the herd from market					
No	41 (44.1)	52 (55.9)	1.00		
Yes	38 (12.8)	258 (87.2)	5.35	3.14, 9.12	< 0.001
Giving out cattle as gift or payment of dowry					
No	16 (55.2)	13 (44.8)	1.00		
Yes	76 (21.1)	284 (78.9)	4.60	2.12, 9.98	0.001

Statistically significant at p < 0.05.

about RVF through informal channels, such as relatives and friends.

Except for high mortality in newborn calves and sudden onset of abortions in pregnant cows that were mentioned to be RVF clinical manifestations in cattle by many participants, we found low knowledge about other clinical signs. This later finding was consistent with a report that indicated very low knowledge about some clinical signs of RVF in animals among livestock keepers in Tanzania [34]. The low proportion of those with knowledge about the disease observed in this study could be due to lack of education programmes targeting livestock owners on emerging and re-emerging infectious diseases in Nigeria. Pastoralists in this study identified high fever as a key symptom of the disease in humans, followed by headache. The lack of reporting cases of RVF by pastoralists makes it difficult for public health authorities to appreciate the gravity of the problem when outbreaks occur, especially the sporadic cases. There is need to sensitize pastoral communities on the importance of reporting abortion storms and cases of deaths in newborn animals. Collaboration among various stakeholders is an important element in designing strategy for the surveillance, prevention and control of RVF in animals and humans [17].

Understanding the mode of transmissions for RVFV is crucial to the implementation of preventive measures. The results of this study show that low proportion of participant knew that RVFV can be transmitted to humans through mosquito bites, drinking raw milk, eating undercooked meat, touching aborted fetus, touching body fluids and sleeping in same place with animals. The low knowledge level of respondents on the role of mosquitoes in the transmission of the virus is of particular concern. Consumption of raw milk identified as pathway for

spread of RVFV in this study is consistent with a report that only few (35.3%) of herdsmen in Ghana boil raw milk before consumption [35]. These unsafe practices increase the vulnerability of pastoralists to zoonotic diseases, including RVF. This study also found preventive measures against RVF, such as avoiding culture of giving out animal as gift or payment for dowry and avoiding culture of loaning or borrowing animals, to be low among the respondents. These are serious challenges that require adequate and urgent public enlightenment for cultural transformation with the view to reducing the risk of RVF occurrence and its spread, since animals involved are never certified healthy before being given out of the study area and could serve as channels for RVFV transmission.

This study found age and gender to have significant influence on possession of knowledge about RVF in herds. Fulani pastoralists in age groups 50–59, 50–69 and 70–79 years are believed to possess adequate information and awareness about RVF. This could be due to their long time close contact relationships with animals and management experiences about animal health issues, unlike those in lower age groups who have relatively short relationship, and this is vital in disease control. In a related study on the role of cattle in the transmission cycle of human African trypanosomiasis, gender and age were found to have significant influence on pastoralists' knowledge about the disease [36].

This study found some social drivers for RVF occurrence in nomadic pastoral herds in Nigeria, which are not associated with biological or environmental factors, but with important salient socio-cultural activities such as the extensive husbandry management system. Traditionally, mobility of herds in search of pasture and water is the basic requirement for nomadic pastoralists. This often predisposes animals and nomads to infectious diseases. During nomadic movement, healthy livestock make contacts with infected ones, wildlife and vectors, which are most often reservoirs of zoonotic diseases such as RVF [37]. Frequent movement of cattle to different ecosystems could expose them to wildlife and infectious sylvatic mosquitoes [38,39]. Also, the outbreaks of RVF in the Middle East (Saudi Arabia and Yemen) in 2000 was associated with livestock movements [40–42]. Furthermore, we found herd composition of grazing cattle together with small ruminants (sheep and goats) to have influence on RVF occurrence in nomadic herds. Sheep are more susceptible to RVF with serious clinical outcomes than other ruminants [12]. Therefore, mix grazing of cattle with sheep increases chances of cross infection with RVFV through infected aerosols. The practices of giving cattle as dowries and gifts exacerbate the occurrence and distribution of infectious diseases in Africa [43]. Human socio-cultural and economic behavior is, perhaps, the most complex factor in the emergence of infectious diseases [18,36], especially animal diseases. Some infectious diseases emergences have been reported to be influenced by socio-cultural activities, disruption of global ecosystems, and poverty [44]. The importance of social factors as drivers of disease occurrence and spread has been well-established [45].

Understanding the shifting of RVF epidemiology from ecological to social and cultural perspectives will enhance development of interventions that will mitigate and prevent RVF dissemination to human and its casualties. These will include, among others, behavioral change of identified predisposing traditions, strategy for occurrence prevention and promotion of appropriate vector control, as previously proposed [46,47]. Education of pastoralists on the health impacts of RVF is needed and interventions that will enable the communities live in separate houses from animals are also required. There is a need for creating a point of intersection between the veterinary and public health authorities so as to fit into the 'One Health Approach', which is a better way of combating infectious diseases.

Our findings should be interpreted in light of limitations of using only questionnaire based survey. However, the questionnaire was pre-tested prior to actual data collection to improve the accuracy and quality of data.

5. Conclusions

The survey revealed gaps in levels of knowledge and practices regarding RVF among the Fulani nomadic pastoralists. Socio-cultural activities were key social drivers for RVF occurrence in pastoral herds. RVF surveillance and preventive programmes that take these factors into consideration will be beneficial to the livestock industry in Africa. The gaps, influenced by socio-demographic and cultural factors, demand for collaborative strategies that will involve other relevant disciplines such as Virologists, Entomologists, Environment Scientists, Anthropologists etc., in RVF preventive education for the pastoralists. Cross-disciplinary studies that would increase understanding of social determinants of emerging zoonotic diseases are recommended, as they will facilitate preventive preparedness towards the diseases.

Competing interests

The authors declare that they have no competing interests.

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