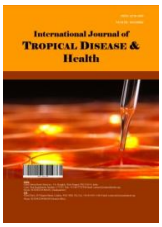

International Journal of TROPICAL DISEASE & Health

42(1): 25-39, 2021; Article no.IJTDH.65448
ISSN: 2278–1005, NLM ID: 101632866

Environmental Conditions and Predictors of Lassa Fever Transmission in a Low Socioeconomic Community in Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. Author GREEA designed the study and wrote the first draft of the manuscript. Author UAE performed the statistical analysis and wrote the protocol. Author FA managed the analyses of the study. Author ODB managed the literature searches. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJTDH/2021/v42i130429
Editor(s):
(1) Dr. Cihad Dundar, Ondokuz Mayıs University, Turkey.
Reviewers:
(1) Getachew Ferede Endalew, University of Gondar, Ethiopia.
(2) Fatemeh Farshadpour, Bushehr University of Medical Sciences, Iran.
Complete Peer review History: http://www.sdiarticle4.com/review-history/65448

Original Research Article

Received 10 December 2020
Accepted 13 February 2021
Published 02 March 2021

ABSTRACT

Lassa fever is of public health concern in West Africa due to its endemic nature. Housing conditions have been revealed to be important sites for primary transmission. This study assessed environmental and housing conditions of a low-income community for factors that could contribute to the transmission of Lassa fever. The study employed a cross-sectional design with a field component. Observational checklist and an interviewer-administered questionnaire were used to assess environmental conditions and respondents' hygiene knowledge and practices respectively. Rodent traps were also placed in selected households. Data collected were analysed using SPSS Version20. 40% of the respondents had poor housing conditions, 80% had good hygiene practice while 20% had poor knowledge. Respondents with good housing condition were 1.9 times more likely to have good hygiene practice compared to houses with poor housing condition (OR= 1.941, p= 0.009). Rodents trapped from the households were *Rattus rattus* (43.2%), *Rattus fuscipes*

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(38.6%) and *Rattus norvegicus* (18.2%). Houses with most rats trapped had the poorest housing conditions and hygiene practices. The results suggest that households in the community are susceptible to the transmission of Lassa fever. Therefore, effective awareness campaigns on the transmission of Lassa fever and good hygiene and sanitation practice should be encouraged in and around the home.

Keywords: Lassa fever; environmental conditions; housing conditions; transmission; spatial mapping.

1. INTRODUCTION

Lassa fever is a disease of public health concern and an acute viral illness that is endemic in West Africa. The virus is a member of the virus family Arenaviridae, it is a single-stranded RNA virus and is zoonotic or animal borne. The Lassa fever areas predicted are approximately 80% in Sierra Leone and Liberia, 50% in Guinea, 40% in Nigeria, 30% in Togo, Benin and Cote d'Ivoire and 10% in Ghana [1]. The Lassa virus infections per year in West Africa is estimated at 100 000 to 300 000, with approximately 5 000 deaths [2]. Housing characteristics and domestic organization affect rodent density in and around households and villages, and are likely to be a risk factor for Lassa fever in humans where reservoir exists [3]. The main reservoir for Lassa virus is the multimammate mouse, *Mastomys natalensis*. Other rodent reservoirs (*Mastomys erythroleucus* and *Hylomys cuspamfi*) have been recently identified [4]. The rodents are known to live in bushes, but during the dry season they run to houses for protection and live with humans and deposit excreta on floors, tables, beds and food [4]. Transmission from rodents to humans occurs through direct exposure to rodent fluids such as urine, saliva and blood or indirect exposure via surfaces and foodstuffs contaminated by these fluids [5].

Bonner et al. [6] found that houses with stores of food afford a perfect environment for rodents and easy transmission of the virus especially in homes used for both residential and commercial purposes. Ecological factors such as height variability seasonal timing of rainfall are other possible explanation variables for the discordance in the Lassa fever and Mastomys distribution in Africa. Since most outbreaks of Lassa fever have been observed to occur in regions with annual rainfall above 1500mm, it has been suggested that the Lassa virus may survive better in humid conditions during the rainy season [1]. Multimammate rats are ubiquitous in grass lands and cleared forest across sub-Saharan African and commonly invade the domestic environment, where transmission to humans is thought to most frequently occur [3]. The risk of contracting Lassa virus is thus directly linked to factors that lead to increased rodent infestation in and around the home, which may put housewives, children, and others who spend a lot of time at home at risk [7].

Some reports suggest that other species of rodents could also be possible reservoir hosts for Lassa virus, but about 46.79% incidence of Lassa Virus seroconversion in *Mastomys natalensis* among rodents trapped was reported in a Lassa fever endemic village of Ekpoma in Edo State, Nigeria [8]. According to Oborature et al. (2014) in a rural area in South-South Nigeria, 54.5% of households had poor hygiene in Eguare while 15.4% of households had poor hygiene in Ikekogbe, affirming that the poorer state of houses increase risk for rodent infestation and transmission of Lassa fever. Poor awareness and knowledge of Lassa fever, together with poor housing facilities, characterized the communities studied and there is a need for relevant stakeholders to ensure better community health education and improved housing conditions in Southwestern Nigeria, with an emphasis on slum areas [9]. Therefore, to control this severe ailment there is a need for exhaustive information on risk factors for Lassa fever particularly those related to the environmental factors that could predispose a community to the transmission of Lassa fever. This study assessed environmental risk factors associated with the transmission of the disease and also assessed rodent density in each household giving spatial analysis of its distribution.

2. MATERIALS AND METHODS

2.1 Description of Study Area

This study was carried out in Awule village. Awule village is located in Akure South Local Government Area of Ondo State (7'10'N 5'05'E) in southwestern Nigeria bordering Ekiti state to the north, Kogi state to the northeast, Edo state to the east, Delta state, Ogun state and Osun state to the southeast, southwest and northwest

respectively. The community is a nucleated one characterized by an overcrowding of both houses and humans with pockets of fertile grassland growing variety of crops such as maize, pepper, vegetables, cocoa and others. The topography of Awule village can be described as undulating and hilly in nature. The map of study area is shown in (Fig. 1).

2.2 Study Design and Population

The study employed a descriptive cross sectional design with a field component which entailed a survey and onsite observations. A household survey was conducted on selected households in the community using checklists/questionnaires. Traps were placed in each of the households sampled, morphological identification was done on rodents captured from each of the households. The target population was made up of adult men and women within the age group of 18-65 years living in Awule village, eligible respondents where those living in the community for a minimum period of about 1 year from which households were selected for the study.

2.3 Sample Size

The sample size was obtained using the cross sectional study design formula [9]. From the formula a total of 276 respondents were recruited and 35 households were systematically sampled for the study.

2.4 Community Entry

The leaders in charge of the affairs of the community were approached and briefed on the project and work to be done in the community among households and also seek for their permission to proceed. Each household were approached to inform them on the aims and objectives of the project work and also to solicit for their cooperation, time and support for the short period of the project.

2.5 Survey

A semi-structured, self-administered questionnaire administered was designed to obtain information on the environmental conditions associated with the Lassa fever disease. Questionnaire was adapted from Oboratare et al., 2014 [10]. This instrument had 5 sections namely: Socio demographic factors, housing conditions, sanitation and hygiene condition, waste management and knowledge of Lassa fever. A total of 276 pre-tested semi-structured questionnaire was administered to study participants. Efforts were made to ensure the study participants did not influence each other while filling out the questionnaire.

2.6 Onsite Observation

Onsite observation was done using a checklist to observe housing conditions, environmental sanitation & indoor hygiene sanitary facilities, toilet facilities, waste management facilities, vector control and general inspection of waste management. Checklist was adapted from Oboratare et al., 2014 [10]. Prompt onsite observations was conducted on each of the households selected using the observational checklist.

2.7 Rodent Trapping

Traps was set along a specific transect in and around the house with baits, 5 – 10 traps was set along a specific transect in and around the house with baits. The traps were checked every morning and night for four [4] weeks and rodents trapped were identified using morphological characteristics [11,12]. Global positioning system (GPS) was used to obtain coordinates of each of the households sampled to generate a spatial map using ArcGIS 10.1 showing rodent infested areas (Fig. 2).

2.8 Data Statistics and Analysis

Data from completed questionnaire was entered and analyzed using the statistical package of social sciences (SPSS version 20). The frequency distribution of responses was generated for each variable. Respondents' practice was assessed using a 20-point perception scale and then the mean perception score was calculated. Hygiene and sanitary practice scores of 0-5, 6-10, 11-15, 16-20 was categorized as poor, fair and good and excellent respectively.

Furthermore, mean, standard deviation, 1st quartile, median and third quartile were computed for knowledge, housing condition and hygiene practice scores were derived. Logistics regression was used to determine the associations between hygiene practices and each of socio-demographic factors, respondents' knowledge and house conditions. The probability value of 0.05 was used as a bench mark for significant difference between the parameters, this association derived adjusted odds ratio, p-value, and lower and upper confidence intervals.

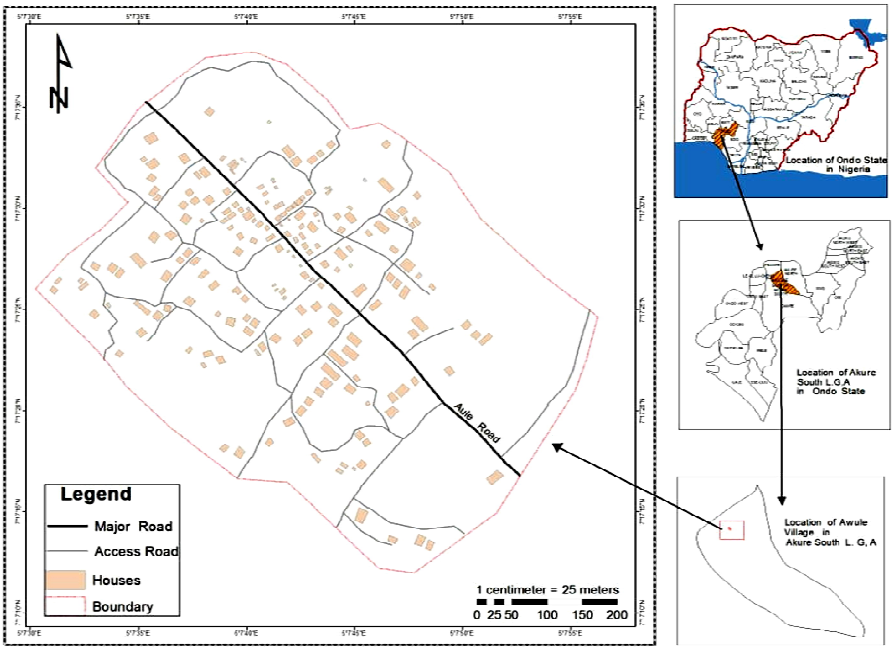

Fig. 1. Map of the study area (Awule community)

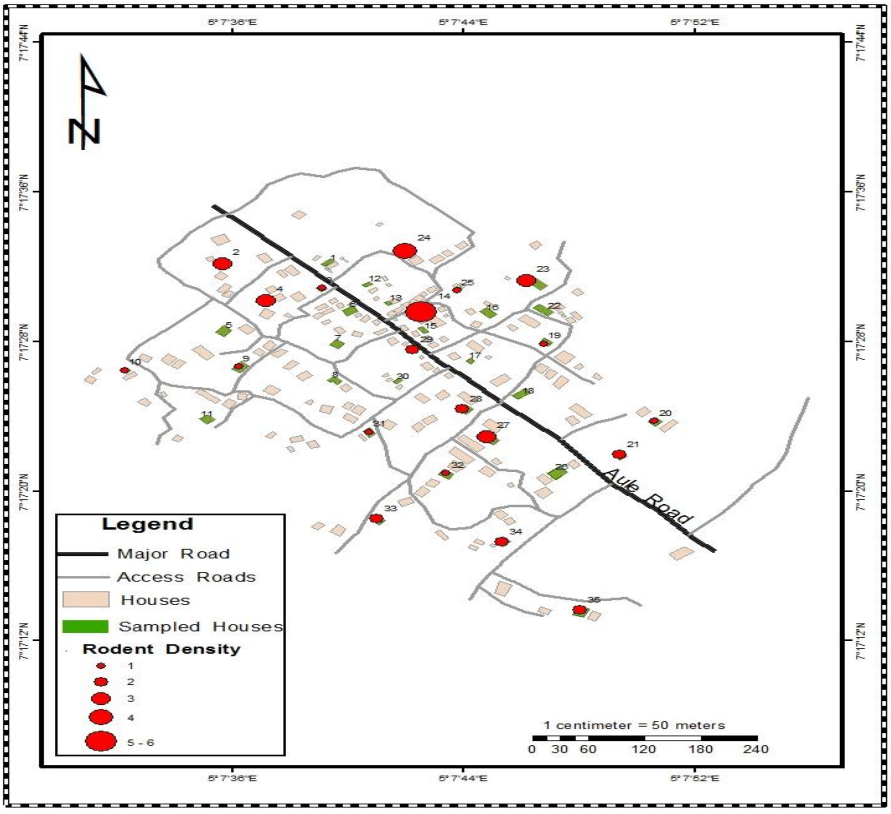

Fig. 2. Map showing rodent density in households in the study area

3. RESULTS

3.1 Environmental Inspection

Onsite observation showed that a high proportion of houses had cracks and holes on their walls and floors respectively. Vegetation/foliage was minimally present in most houses. Protection round the toilet was absent in many of the sampled houses, no littered faecal matter on the floor of the toilet in most houses and majority of the houses had poor disposal of used toilet paper. Sanitary facilities were poor, toilet area were not clean and tidy, soap was absent in quite a number of the houses sampled, sanitary hand towels were not in place, toilet paper were sparsely available. There was no litter of waste in the surroundings of majority of the households and sharp objects were minimally present in surroundings of most houses. (Table 1 shows the onsite observations made on some of the sampled households).

3.2 Socio Demographic Characteristics of Respondents

Observations showed that 57% of the respondents were female, most of the respondents fell within the age group of 41-50 years (27.4%) which was closely followed by those in the age group 31-40 years (26.9%). The respondents had a mean age of 42.41±14.6 years. More than half of the respondents were married (78.6%). Most of the respondents were secondary school leavers (35.7%) and primary school leavers (28.3%). Less than 20% are graduates of tertiary institutions. Majority (84.2%) of the respondents are of the Christianity faith, while 70% of the respondents had lived in the study community for 10 years. Almost half of the respondents were farmers (45.8%), 23.5% are traders and 13.5% are artisans. Majority of the respondents earned less than ₦20,000 ($51) monthly, which is followed by 8.8% of the respondents earning between the range of ₦20,000 ($51) and ₦39,999 ($103). Less than 2% earn more than ₦100,000 ($258) monthly (See Table 2).

3.3 Housing Conditions of the Respondents

It was observed that 60.4% of the respondents had vegetation/foliage overgrown around their houses. About 53.4% had dump sites close to the house, 34.0% had garbage bin in their house, and 46.4% had heap of solid wastes neglected in their surroundings. From the total of the respondents, 62.9% had protections around their toilets while 48.7% of the respondents' toilet had no toilet cover. About 87.2% of the respondents reported that there was no sign of faecal matter on the floor of their toilet, 58.8% of the respondents disposed their toilet papers improperly.

On the other hand, 98.5% of the respondents reported that their food items were covered, 93.2% reported that items in the house were neatly arranged which was a positive practice. It was also noted that 50.8% of the respondents had bushes overgrown in their surroundings, 61.9% of the respondents reported that there were cracks on the wall of their houses while 60.4% responded that their walls had holes. From the total sampled houses, 33.6% of the respondents' floor had no holes while 65.7% of their floor had cracks (As shown in Table 3).

3.4 Hygiene and Sanitation Conditions of the Respondents

It was observed that 25.5% of the respondents had a functional toilet, 48.4% of those with functional toilets used the water closet system while 39.1% used the pit latrine system. 98.5% of the respondents had their toilet area clean and tidy. 82.1% of the respondents had adequate soap in the toilet for use after toilet usage.55.2% of the respondents cleaned their toilet with brush everyday while 29.9% did it once a week and 14.9% twice a week. 65.7% of the respondents had hand towels in place after toilet use. 79.1% had toilet paper in their toilets. 6.0% of the respondents had experienced toilet breakdown in last 3 months before the study.

Furthermore, 73.1% of the respondents reported that they shared their toilet with 4 or more households, 94.1% of the respondents had sufficient cleaning water in their toilet, and 89.6% of the respondents had an indoor toilet. It was observed that 90 days before the study, 93.2% of the respondents reported to have seen rats or mice in their houses. Also, 78.7% of the respondents had bathrooms or shower, 34.2% of the respondents have litters or rubbish in their surroundings, and 5.3% of the respondents had drainage systems in their house (See Table 4).

3.5 Waste Management Practices by the Respondents

Observations showed that 86.7% of the respondents often cleaned their surrounding

Table 1. General on-site observations at the study location

	Indicators	H 11	H 12	H 13	H 14	H 15	H 16	H 17	H 18	H 19	H 20
Housing conditions	Cracks on the wall	+	+	+	++	+	+	++	+	+	_
	Holes on the walls	+	+	+	++	+	+	++	+	+	++
	Cracks on the floor	+	++	+	+++	++	++	++	++	++	_
	Holes on the floor	+	++	+	+++	++	++	++	++	++	_
Environmental sanitation and indoor hygiene	Vegetation/ foliage overgrown	+	_	+	+	++	+	+	+	+	++
	Heaps of woods etc. around house	+	_	++	+	+	++	++	++	++	++
	Protection round the toilet	_	_	_	_	_	_	_	++	_	_
	Littered faecal matter on the floor	_	_	_	_	_	_	_	++	_	_
	Proper disposal of used toilet paper	_	_	_	_	_	_	_	++	_	_
Sanitary facilities	Toilet area clean and tidy	_	_	_	_	_	_	_	++	_	_
	Soap	_	_	_	_	_	_	_	+	_	_
	Sanitary hand towels in place	_	_	_	_	_	_	_	_	_	_
	Toilet paper available	_	_	_	_	_	_	_	_	_	_
	Water in toilet	_	_	_	_	_	_	_	++	_	_
General inspection of waste management	Litters of waste in surrounding	_	_	+	_	_	_	_	_	_	++
	Sharp objects in surrounding	+	+	+	+	++	_	_	+	+	++

Key: - Absent, + Minimally Present, ++ Moderately Present, +++ Highly Present, H House

Table 2. Socio-demographic characteristics of respondents

Characteristics		Frequency (N=271)	Percentage
Sex	Male	117	43.2
	Female	154	56.8
Marital Status	Single	32	11.8
	Married	213	78.6
	Divorced	8	3.0
	Widowed	18	6.6
Ethnicity	Yoruba	166	62.8
	Igbo	62	23.4
	Others	36	13.8
Religion	Christianity	224	84.2
	Islam	42	15.8
Number of years in the community	<=10	102	68.0
	11-20	28	18.7
	21-30	12	8.0
	40 and above	8	5.3
Occupation	Civil servant	21	8.1
	Farmer	119	45.8
	Artisan	35	13.5
	Trader	61	23.5
	Professional	2	0.7
	Student	21	8.1
	Unemployed	1	0.3
Monthly income	Less than 20,000	227	87.3
	20,000-39,999	23	8.8
	40,000-79,999	5	1.9
	80,000-99,000	2	0.8
	>100,000	3	1.2

Others. Kogi, Igala, Idoma, Gara, Edo, Benue

Table 3. Housing conditions of the respondents

Housing conditions	Yes (%)	No (%)
Are there vegetation/foliage overgrown around your house	162 (60.4)	106 (39.6)
Is the refuse dump less than 30m from your house	143 (53.4)	125 (46.6)
Any garbage bin in your house	90 (34.0)	175 (66.0)
Any heap of solid waste neglected around and inside the house	124 (46.4)	143(53.6)
Any protection round the toilet	98 (37.1)	166 (62.9)
Any toilet cover over the toilet pot	135 (51.3)	128 (48.7)
Are littered faecal matter on the floor of your toilet	34 (12.8)	231(87.2)
Any proper disposal of used toilet paper	157 (58.8)	110 (41.2)
Are your food items covered	261(98.5)	4 (1.5)
Are items neatly arranged in your house	248 (93.2)	18 (6.8)
Are there bushes overgrown around your house	134 (50.8)	130 (49.2)
Are there cracks on the wall of your house	166(61.9)	102 (38.1)
Are there holes on the wall of your house	162(60.4)	106 (39.6)
Are there holes on the floor of your house	90(33.6)	178 (66.4)
Are the cracks on the floor of your house	92 (34.3)	176 (65.7)

Table 4. Hygiene and sanitation conditions of the respondents

Hygiene and Sanitation Conditions		Frequency(N= 271)	Percentage
Functional toilet	No	199	74.5
	Yes	68	25.5
Type of toilet facility	Pit latrine	25	39.1
	VIP	8	12.5
	Water closet	31	48.4
Toilet area clean and tidy	No	1	1.5
	Yes	65	98.5
Adequate soap in toilet	No	12	17.9
	Yes	55	82.1
Cleaning of toilet with brush	Everyday	37	55.2
	Once a week	20	29.9
	Twice a week	10	14.9
Hand towels in place after toilet use	No	23	34.3
	Yes	44	65.7
Toilet paper in toilet	No	14	20.9
	Yes	53	79.1
Toilet breakdown in last 3 months	No	63	94.0
	Yes	4	6.0
Number of households that share a toilet	One	2	3.0
	Two	4	6.0
	Three	12	17.9
	Above 4	49	73.1
Sufficient cleaning water in the toilet	No	4	5.9
	Yes	64	94.1
Indoor toilet	No	7	10.4
	Yes	60	89.6
Signs of rats or mice in the house in the past 90 days	No	18	6.8
	Yes	247	93.2
Bathroom or shower	No	56	21.3
	Yes	207	78.7
Litters or rubbish in the surrounding	No	173	65.8
	Yes	90	34.2
Drainage system	No	250	94.7
	Yes	14	5.3

while 3.1% do it occasionally and 10.2% did it sometimes. On the other hand, 68.5% of the respondents dumped their refuse around the house, 23.3% made use of waste bins, 7.8% dumped their refuse in the bush while 0.4% used the incinerator. Also, 85.9% of the respondents said their communities engaged in environmental sanitation, 85.5% said they engaged in the environmental sanitation programme often while 1.3% said it is done occasionally and 13.2% said sometimes (As shown in Table 5).

3.6 Knowledge of Lassa fever by the Respondents

It was noted that 89.8% of the respondents have heard of Lassa fever, 97% of those who are informed about Lassa fever said it can be prevented. Radio (50.2%) is the most popular means through which the respondents heard of Lassa fever. Moreover, 67.8% of the respondents reported that they see rat faeces in their houses, 5.3% of the respondents eat rats, and 73.4% of respondents reported that they see rats every day in their house (See Table 6).

3.7 Hygiene and Sanitation Practice

It was observed that Housing condition, Knowledge of Lassa fever and Hygiene Practice Score for the 1st quartile was 6, 6 and 18, the corresponding 2nd quartile had 8, 7 and 21 respectively while 3rd quartile was 9, 13 and 24 respectively. The minimum values observed from the scoring were 2, 1 and 2 and maximum values were 14, 25 and 32.It was discovered that most of the participants had hygiene practice score above 2nd quartile while respondents that

scored below 2nd quartile were more than those that had score above the 2nd quartile for housing condition. Meanwhile, those that scored higher and lower than 2nd quartile in Lassa fever knowledge were almost the same. Respondents that scored below 2nd quartile were considered as having poor knowledge of Lassa fever, housing condition and hygiene practice (As shown in Fig. 3).

Table 5. Waste management practices by the respondents

Waste management practices	Frequency (N=271)	Percentage
Cleaning of surrounding		
Often	229	86.7
Sometimes	27	10.2
Occasionally	8	3.1
Refuse dump site		
Around the house	176	68.5
Waste bin	60	23.3
Bush	20	7.8
Incinerator	1	0.4
Community environmental sanitation		
No	37	14.1
Yes	226	85.9
Regularity of environmental sanitation		
Often	188	85.5
Sometimes	29	13.2
Occasionally	3	1.3

Table 6. Knowledge of Lassa fever by the respondents

Variables		Frequency (N=271)	Percentage
Have you heard of Lassa fever	No	27	10.2
	Yes	239	89.8
Lassa fever is preventable	No	7	3.0
	Yes	224	97.0
How did you know of Lassa fever	Family	10	4.3
	Friends	4	1.7
	Market women	3	1.3
	Television	26	11.3
	Radio	116	50.2
	Print media	8	3.5
	Religious institution	2	0.9
	Health workers	62	26.8
Do you see rat faeces in your house	No	85	32.2
	Yes	179	67.8
Do you eat rats	No	249	94.7
	Yes	14	5.3
How often do you eat rats	Often	3	25.0
	Sometimes	6	50.0
	Occasionally	1	8.3
	Rarely	2	16.7
How often do you see rats in your house	Everyday	188	73.4
	Twice daily	25	9.8
	Every week	7	2.7
	Rarely	36	14.1

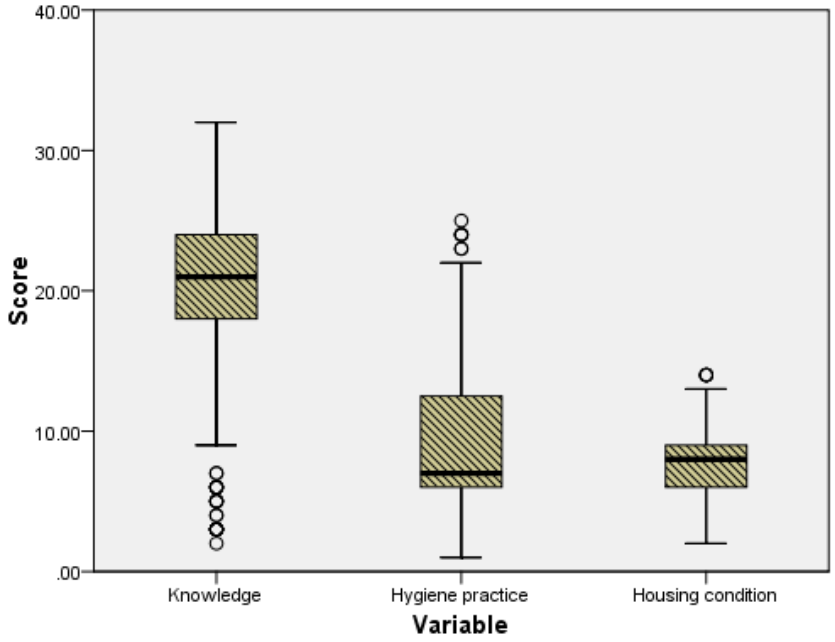

Fig. 3. Box plot of housing condition, knowledge and hygiene practice score

3.8 Relationship between Respondents' Socio-demographics and Knowledge of Lassa Fever

The findings in Table 7 below showed that Yoruba participants were 3.5 times more likely to have good knowledge of Lassa fever compared to other tribes (OR= 3.475, p= 0.044). Participants that spent 11-20 years in the community were 3.8 times more likely to have good knowledge about Lassa fever compared to those that spent 10 or less years (OR= 3.764, p= 0.044). There were associations between ethnicity and knowledge of Lassa fever and also an association between years spent in the community and knowledge of Lassa fever (Table 7).

3.9 Relationship between Respondents' Socio-demographics, Knowledge of Lassa fever, Housing Conditions and Hygiene and Sanitation Practice

This study showed that unmarried participants were 2.1 times more likely to have good hygiene practice compared to those that were married (OR= 2.171, p= 0.022). Artisans were 0.29 times more likely to have good hygiene practice compared to those that were not working (OR= 0.285, p= 0.030). Participants that earned ₦20, 000 or more were 3.2 times more likely to have good hygiene practice compared to those that earned less than ₦20, 000 (OR= 3.229, p= 0.013). Respondents with good housing condition were 1.9 times more likely to have good hygiene practice compared to those that had poor housing condition (OR= 1.941, p= 0.009). Primary educated participants were 3.8 (1/0.26) times less likely to have good hygiene practice compared to those that had tertiary education (OR= 0.26, p= 0.003) (Table 8).

3.10 Rodent Density in Households

The distribution of rodents species found in households in the study area are shown in the Table 9 below. In total 44 rodents were captured, three species of rodents were trapped from the selected households with *Rattus rattus* (43.2%) being the dominant species in the homes of the study area followed by *Rattus fuscipes* (38.6%) and *Rattus norvegicus* (18.2%). The highest number of rodent samples captured in a house were between 5-6 samples and the least number of rodents captured was 1-2 samples. The highest number of rats were captured in the north eastern part of the study area while the eastern part of the study area had the lowest number of rat infestation (Fig. 2).

Table 7. Relationship between respondents' Socio-demographics and knowledge of Lassa fever

Variables	Adjusted Odd ratio	95% CI		p-value
		Lower	Upper	
Sex				
Male	1.143	0.479	2.729	0.764
Female				
Age				
<=20 years	8.081	0.235	278.492	0.247
21-40 years	0.726	0.286	1.840	0.499
=>41 years				
Ethnicity				
Yoruba	3.475	1.033	11.685	0.044*
Igbo	3.611	0.910	14.332	0.068
Others				
Marital status				
Unmarried	0.701	0.242	2.033	0.513
Married				
Years spent in the community				
<=10 years				
11-20 years	3.764	1.033	13.711	0.044*
=>21 years	1.592	0.419	6.043	0.495
Occupation				
Civil servant	1.737	0.096	31.305	0.708
Artisan	3.963	0.276	56.980	0.311
Trader	2.772	0.191	40.276	0.455
Not working				
Income (₦)				
20, 000 or more	2.060	0.632	6.715	0.231
Less than 20, 000				
Education				
No formal education	0.894	0.149	5.376	0.902
Primary	0.976	0.173	5.509	0.978
Secondary	0.351	0.063	1.955	0.232
Tertiary				

**- significant*

Table 8. Relationship between respondents' Socio-demographics, Knowledge of Lassa fever, Housing Conditions and Hygiene and sanitation Practice

Variables	Adjusted Odd ratio	95% CI		p-value
		Lower	Upper	
Sex				
Male	0.859	0.522	1.416	0.552
Female				
Age				
<=20 years	1.714	0.443	6.639	0.435
21-40 years	0.823	0.496	1.365	0.450
=>41 years				
Education				
No formal education	0.436	0.170	1.121	0.085
Primary	0.260	0.105	0.640	0.003*
Secondary	0.486	0.201	1.178	0.110
Tertiary				

Variables	Adjusted Odd ratio	95% CI		p-value
		Lower	Upper	
Ethnicity				
Yoruba	1.789	0.862	3.713	0.118
Igbo	1.288	0.562	2.954	0.549
Others				
Marital status				
Unmarried	2.171	1.118	4.215	0.022*
Married				
Years spent in the community				
<=10 years				
11-20 years	0.624	0.265	1.471	0.281
=>21 years	1.793	0.645	4.984	0.263
Occupation				
Civil servant	0.346	0.088	1.359	0.128
Artisan	0.285	0.092	0.883	0.030*
Trader	0.456	0.136	1.525	0.202
Not working				
Income (#)				
20, 000 or more	3.229	1.282	8.130	0.013*
Less than 20, 000				
Housing condition				
Good	1.941	1.179	3.198	0.009*
Poor				
Lassa fever knowledge				
Good	0.912	0.551	1.511	0.722
Poor				

**- significant*

Table 9. Distribution of rodent species and number of lassa virus cases in the study area

Rodent Species	Frequency
Rattus rattus	19 (43.2%)
Rattus fuscipes	17 (38.6%)
Rattus norvegicus	8 (18.2%)
	44 (100%)

3.11 Maps Showing Rat Infested Areas

Global Positioning System (GPS) coordinates of trapped rodents were transferred to Arc GIS 10.1 software for spatial analysis. The map below shows the ranges of rodents caught per trap sites. The size of the dots reflects the number of rodents caught per trap sites and how the rodents are distributed in the study area (Fig. 2).

4. DISCUSSION AND CONCLUSION

This study revealed that poor housing conditions and sanitation/hygiene practices in and around the home can aggravate the transmission of Lassa fever. It also confirmed that housing conditions are potential sites for Lassa fever transmission. There was an association between housing condition and hygiene & sanitation practices inferring that respondents with good housing condition were 1.9 times more likely to have good hygiene practice compared to those that had poor housing condition. This confirmed Oboratare et al., 2014 report that poor hygiene and use of buildings for both residential and commercial purposes are likely risk factors for transmission of Lassa virus in households therefore cleaning up houses and surroundings should be seen as a way of controlling the disease. It was observed that most hygienic practices and housing conditions were poor and these factors could predispose the community a possible outbreak of the disease. The risk of Lassa fever depends on individual housing quality and the hygiene of the immediate surrounding environment [6].

Results obtained showed that the frequency of signs of rats or mice in the building in the past 90

days was high and it was observed that most households had cracks and holes on the floors and walls of their houses and most responded that they see rats every day in their various homes. These findings propagate the fact that there is a possibility of the transmission of the disease if certain control measures are not in place. This findings strengthened the study carried out by [6] that the poorer state of houses the increase risk for rodent infestation and for transmission of Lassa virus in the house's immediate surroundings and that poor external hygiene could also be a risk factor for rodent infestation of the house or be an independent risk factor for occurrence of Lassa fever by providing opportunities for transmission outside the house.

From the observations made in this study it was inferred that most households sampled had cracks and holes and these factors aggravate the proliferation of rats in each household. The uncertainty about the precise natural host of Lassa virus is considered a major obstacle in the control of the disease [13]. Rodents captured in this study were; *Rattus rattus*, *Rattus fuscipes* and *Rattus norvegicus* and these are potential reservoirs for the virus. *Mastomys natalensis* was not found among the species captured in the study area but other species seen or captured showed not be overlooked. Apart from *Mastomys natalensis,* other rodents such as R*attus rattus,* and *Mus musculus* may also serve as reservoirs for Lassa virus and more comprehensive study on rodents as reservoir host need to be undertaken across the entire states of Nigeria [14]. Furthermore from to the spatial analyses carried out, the map shows that most houses in the north eastern part of the community had a higher proportion of rodents in their homes. Ecologically studies suggest that rodent abundance in houses doubles during the dry season indoors, possibly as a result of restricted food supply outdoors and increase food supply indoors [15]. Furthermore, the absence of ultraviolet light indoors may also prolong virus survival on surfaces contaminated by rodents [16].

Lassa fever affects all age groups; both gender and cut across all social class especially communities with poor housing and poor environmental sanitation [17]. Results show that over three-quarter of residents in the community are aware of Lassa fever but their attitude towards preventing the disease is relatively low and of such is of great concern. According to Adebimpe, 2015 it was inferred that the means and modes recorded for good knowledge of Lassa virus infection as well as adequate prevention measures may reduce the infection rate. Therefore knowledge levels of the disease should increase so as to control possible outbreaks in the community.

According Nwonwu et al*.,* 2018 [16] it was observed that a greater proportion of people live in the rural communities where poverty prevails, and standards of living are low, and the emergence of highly virulent and contagious diseases such Lassa fever is common, therefore communities should have comprehensive information about the virus and the disease it causes. Results from the study also showed that most of the respondents heard about the disease through the radio. This finding supports the need for continuous campaigns in the community and news items in the public media to sustain the dissemination of information on Lassa fever. Knowledge of the Lassa fever transmission process is key to breaking the chain of infection [18]. The poor awareness and knowledge of Lassa fever together with poor housing facilities, characterized the communities studied and there is a need for relevant stakeholders to ensure better community health education and improved housing conditions in Southwestern Nigeria, with an emphasis on slum areas [9].

For community such as this study area, prevent measures such as rodent control, awareness campaigns, hygiene practices, surveillance must be encouraged and implemented to avoid a sudden outbreak. An effective leadership commitment and investment in Lassa fever is urgently needed in building integrated and effective community "One Health" surveillance and rapid response approach practice coupled with pest management and phytosanitation measures against Lassa fever epidemic as this will offer new opportunities in understanding human-animal interactions in strengthening Lassa fever outbreak early detection and surveillance, warning alerts and rapid response implementation in vulnerable settings [19].

Lassa fever is severe acute infection caused by Lassa virus and before now environmental factors such as housing, hygiene/sanitation and waste management were hypothesized as contributing factors to the transmission of Lassa fever but this study revealed that these factors can predispose a community to an outbreak of Lassa fever. There should be effective

awareness campaigns on the transmission of Lassa fever, residents in the community should be conscious of rodent activities in their homes and there should be good hygiene and sanitation practice in and around the home, waste disposal should be done preferably far away from the house.

5. LIMITATIONS OF THE STUDY

1. Accessibility to the study area during the study was a problem due to poor road infrastructure and bad terrain.
2. No financial aid was received for this study, every fund used for this study was paid out of pocket by the authors and due to this reason more locations could not be studied.

CONSENT AND ETHICAL APPROVAL

Ethical approval was gotten from the University of Ibadan/UCH Research Ethic Committee before the commencement of the field work. Consent was gotten from community stakeholders and heads of households. Assent was also gotten from each of the study participant; there was no form of coercion and confidentiality should be maintained.

IRB/ERB Name; University of Ibadan/UCH Research Ethic Committee, College of Medicine, University of Ibadan, Ibadan, Nigeria. (NHREC/05/01/2008a)
Clearance Number: UI/EC/18/0697
Clearance Date: 13/12/2019

ACKNOWLEDGEMENTS

Our honest gratitude goes to the Almighty God for his never ending favour, protection, provision and wisdom throughout this study. We sincerely appreciate Awule community for their acceptance, support and involvement in this research.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle4.com/review-history/65448