Original Article

Household Rat Infestation and Methods of Its Control in a Lassa Fever Endemic Community in Southeast Nigeria

Maria-Lauretta Chito Orji[1], Damian Uchechukwu Nwaneri[2], Dorathy Chinwe Obu[1], Onyinye Uchenna Anyanwu[1]

[1]Department of Paediatrics, Alex-Ekwueme Federal University Teaching Hospital, Abakaliki, Ebonyi State, [2]Department of Child Health, University of Benin Teaching Hospital, Benin City, Edo State, Nigeria

Abstract

Background and Objectives: High rat burden and control methods may influence Lassa virus transmission in endemic communities. This study was aimed at determining the prevalence of household rat infestation and its control methods in a Lassa fever endemic region, Southeast, Nigeria. **Materials and Methods:** The study participants were caregivers who sought care in a tertiary health institution in Abakiliki (a Lassa fever endemic community) in Southeast, Nigeria. An interviewer-administered structured questionnaire was used to collect information regarding the presence of rats in homes and methods of its control. The analysis was done using SPSS version 22. Multivariate Binary Logistic Regression was used to assess the predictors of the presence of rats in homes. The level of statistical significance was set at $P < 0.05$. **Results:** Of the 384 participants, 316 reported the presence of rats in their homes, giving a household rats' prevalence rate of 82.3%. The use of rat poison alone was the most common method of rat control in their homes. The odds of having a rat in their household was two times more in the lower socioeconomic class than in the upper socioeconomic class (odds ratio [OR] = 2.21, 95% confidence interval [CI]: 1.25–6.42, $P = 0.010$) and 4 times more among caregivers that did not store foodstuff in airtight containers (OR = 4.05, 95% CI: 1.38–8.30, $P = 0.005$). **Conclusion:** The prevalence of household rats' infestation was high and could postulate a high reservoir for the Lassa fever virus in the study locale. Improved food storage methods and environmental hygiene alongside the use of rat poison and trap by caregivers could reduce household rat infestation.

Keywords: Control, endemic, Lassa fever, rat

Introduction

Lassa fever is a disease caused by the Lassa virus. The rodent *Mastomys natalensis* is the specie of rat commonly infected with this virus serving as its natural reservoir. The rat is found in East, Central, and West Africa, where Lassa fever is prevalent.[1] Several species of the rat were also observed in certain localities with Lassa fever outbreaks in Nigeria and Guinea and were thought to be the possible reservoirs of the Lassa virus.[2,3] Rats have remained the only natural reservoir for the Lassa fever virus known to man.[1,3,4] In Nigeria, 17 states are said to be endemic for Lassa fever with Edo, Ondo, and Ebonyi states having more than 75% of the cases reported and case fatality rates of 14.6%, 24.2%, and 23.4%, respectively.[5] Rats that are infected with the Lassa virus shed the virus in its urine and feces, and human beings are infected with the Lassa virus when the rat's urine and feces contaminate their food and water.[1]

Researchers observed that hunting and consumption of rats, poor housing, and poor environmental hygiene were risk factors to a household rat infestation.[6,7] Since there is no known vaccine for Lassa fever disease, control of rats and modification of human behavior are invaluable in preventing infection caused by the Lassa virus.[6] Previous studies have documented the use of rodent trapping, rodenticides, and environmental hygiene,[8] domestic cats and dogs[9] house repairs, and rodent-proof storage containers as methods of rat controls.[10] A more holistic method that entails trapping of rats, cleaning up the environment and sealing up cracked ceilings, house repairs, and proper food storage, is encouraged.

Access this article online

Quick Response Code:

Website: www.njmonline.org

DOI: 10.4103/NJM.NJM_138_20

Address for correspondence: Dr. Maria-Lauretta Chito Orji, Department of Paediatrics, Alex-Ekwueme Federal University Teaching Hospital, Abakaliki, Ebonyi State, Nigeria.
E-mail: drlauretta2002@gmail.com

How to cite this article: Orji MLC, Nwaneri DU, Obu DC, Anyanwu OU. Household rat infestation and methods of its control in a lassa fever endemic community in Southeast Nigeria. Niger J Med 2020;29:601-6.

Submitted: 24-Jul-2020 **Revised:** 18-Aug-2020
Accepted: 08-Oct-2020 **Published:** 24-Dec-2020

Ebonyi State is one of the states in Nigeria noted for several Lassa fever outbreaks and currently ranked third among states with the high prevalence rates of Lassa fever in Nigeria.[5,11] Despite the huge burden of the disease, little is known about the household rats' infestation and methods of its control in the communities where the Lassa fever outbreak is common. A hospital-based record in Abakaliki showed that a total of 56 cases of Lassa fever disease were seen from 10 Local Government Areas (LGA) in 2018. In 2019, 85 cases were observed in 12 LGA with Izzi, Abakaliki, Ohaozara, and Ikwo LGA having the majority of the cases. One major research question is, "Could a high burden of household rats' infestation explain the high Lassa fever disease outbreaks in this endemic region?" In a view to answering this research question, this study was designed to determine the prevalence rate of household rats' infestation as well as identifying the various methods of its control in the study locale. It is also set to describe the relationship between household rats' infestation and some hygiene-related practices such as storing foodstuff in airtight containers, the closing of windows/doors at night, the spread of foodstuff on the ground, and rat consumption among respondents living in Lassa endemic communities. It is expected that findings will guide the health education of the populace which may reduce Lassa virus transmission in endemic communities.

Materials and Methods

This study was a cross-sectional hospital-based study carried out from April 2019 to March 2020. Study participants were caregivers who visited the Alex-Ekwueme Federal University Teaching Hospital Abakiliki (AE-FUTHA), Ebonyi State for one form of illness or the other but reside in any of the 13 LGA of Ebonyi State with a record of Lassa fever outbreaks in the last two years. AE-FUTHA oversees patients from all the 13 LGAs in the State.

Ebonyi State is one of the six states created from parts of both Enugu and Abia States in 1996 by the then Federal Military Government. It has three senatorial districts (North, South, and Central) and 13 LGAs and has a total population of about 2,176,947 inhabitants.[12] The inhabitants are mainly Igbo speaking, and the LGA with the most common Lassa fever outbreaks are Izzi, Abakiliki, Ohaozara, and Ikwo. Some communities in these LGA are semiurban with few urban slums, while the large majority is rural. Houses were both made of block/cement and were both story buildings and bungalows. Some of the roads in the communities were tarred with good drainage, but some of the communities, especially the semiurban and rural, were surrounded by bushes. The populace is mainly civil servants, traders and some others are subsistence farmers and artisans. Although the peak incidence of Lassa fever disease is during the dry season, sporadic cases have been reported in the rainy season in Ebonyi state.

The sample size was calculated using a prevalence rate of 50.0% where the prevalence rate is unknown. The sample size was determined by the formula for sample size appropriate for an infinite population (i.e., >10,000).[13]

$n = Z^2pq/d^2$.

Where n = sample size when the population is > 10,000

Z = the standard normal deviate, usually set at 1.96 (which corresponds to 95% CI)

p = the proportion in the target population with the presence of household rats

$q = 1 - p$

$=1–0.5 = 0.5$

d = degree of accuracy desired, which for this study is set at 0.05 (proportion of the sampling error tolerated)

Thus $n = \frac{(1.96)^2(0.50)(0.5)}{(0.05)^2} = 384$.

Caregivers of children aged 17 years and below that presented to the children outpatient clinic of AE-FUTHA, who are residing in Ebonyi State, and who gave written informed consent were included in the study. The recruitment of subjects was done consecutively until the sample size was reached. Case notes of the recruited subjects were tagged with a number to avoid double recruitment.

Collection of data was carried out using an interviewer-administered structured questionnaire that contained information on sociodemographics, presence of rats in the house, place of residence, type of house, and other hygienic practices. The socio-economic classification of caregivers was determined using the classification by Oyedeji[14] which classified subjects into five groups namely I to V using the average sum of maternal and paternal education and occupation. These groups were then categorized into upper social class if the average sum is I–III and lower social class if IV–V.

Ethical considerations

Ethical approval was sought and obtained before commencement of study from the Human Research and Ethical Committee of AE-FUTHA (REC APPROVAL NUMBER 24/06/2017-28/04/2019). The study was explained to mothers/caregivers and only those who gave informed written consent were included in the study.

Data analysis

The data collected were entered into Statistical Package for the Social Sciences (version 22, IBM SPSS, Chicago, USA). The sociodemographics of caregivers and methods of rat controls were presented as frequency tables and charts respectively. Bivariate analysis was used to determine the relationships between sociodemographics and the presence of rats in homes as well as the relationship between hygienic practices at home and the presence of rats in homes. Statistically significant findings from the Chi-square (χ^2) test were further subjected to a multivariate binary logistic regression analysis and adjusted

odds ratios which were carried out to assess the various predictors of household rat's infestation. The level of statistical significance was set at $P < 0.05$ at a 95% confidence level.

Results

Of the 384 caregivers that participated in the study, the mean age was 33.37 ± 7.61 years, with a male to female ratio of 1:2.4. Participants from lower socio-economic class were 223 (58.1%), residents dwelling in urban areas were 301 (78.4%), and those living in the bungalow were 224 (58.4%) as shown in Table 1.

A total of 316 caregivers reported the presence of rats in their homes, giving a prevalence of household rats' infestation of 82.3%. Two hundred and nine (66.1%) caregivers use only rat poison as their method of rat control, 68 (21.5%) used rat trap, while 31 (9.8%) caregivers used a combination of predators such as cats, killing rats on-site, and repairing damaged ceilings, which were depicted as 'others' in the bar chart [Figure 1].

Table 2 shows the relationship between the presence of rats in homes and sociodemographic. A total of 198 (88.8%) caregivers from the lower socioeconomic class reported rats in their homes compared to 118 (73.3%) from the upper socioeconomic class. Similarly, 200 (89.3%) caregivers who live in bungalow apartments reported rats in their homes compared to 116 (72.5%) of their colleagues that live in story buildings. There were statistically significant relationships between the presence of rats in homes and the socioeconomic class (P=<0.001) and the presence of rats in homes and type of housing (P =< 0.001).

A total of 159 (89.3%) of the caregivers who sometimes leave their windows and/or doors open at night and 105 (89.0%) of them spread their foodstuffs on the ground to dry had rats in their homes. Thirty-seven (94.9%) study participants that sometimes use rats for meals had rats in their homes and 137 (91.9%) that sometimes do not store foodstuffs in airtight containers reported the presence of rats in homes. There were significant relations between the presence of rats in homes and leaving windows and/or doors open at night ($P = 0.002$), spreading of foodstuffs on the ground to dry ($P = 0.022$), and foodstuffs not stored in an airtight container (P = <0.001) [Table 3].

The predictors of the presence of rats in the homes as shown in Table 4 were socioeconomic class (OR = 2.21, 95% CI: 1.25–6.42 $P = 0.010$), type of housing (OR = 0.43, 95% CI: 1.60-–4.91, $P = 0.004$), and not storing foodstuff in airtight container (OR = 4.05, 95% CI: 1.38–8.30, $P = 0.005$).

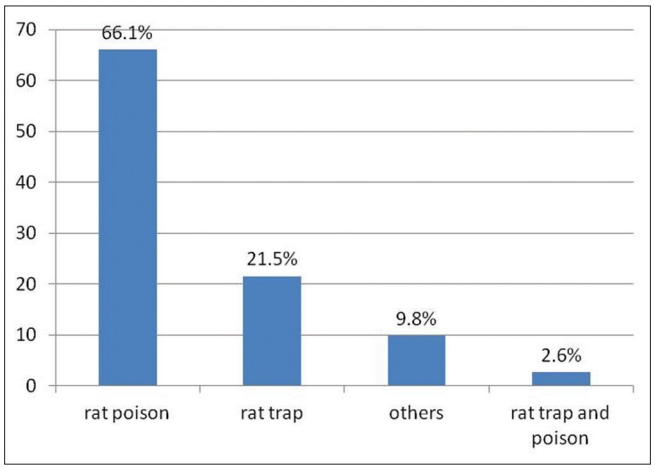

Figure 1: Methods of rat control

Discussion

This study observed a high prevalence of household rat infestation. A report from an urban rodent survey by the Centers for Disease Control and Prevention noted that areas with rat infestation rates above 25% were considered high risks to rodent-borne diseases.[15] Aside from being reservoirs for infectious diseases such as Lassa fever, rats contaminate

Table 1: Sociodemographics of study participants

Sociodemographics	Frequency (n=384), n (%)
Age (years)	
<35	263 (68.5)
36–45	100 (26.0)
>45	21 (5.5)
Gender	
Male	113 (29.4)
Female	271 (70.6)
Place of residence	
Urban	301 (78.4)
Rural	83 (21.6)
Socioeconomic class	
Upper	161 (41.9)
Lower	223 (58.1)
Type of accommodation	
Story building	160 (41.6)
Bungalow	224 (58.4)

Table 2: Bivariate analysis to determine the relationship between the presence of rats in household and sociodemographic

Sociodemographics	Presence of rat in houses (%)		χ^2	P
	Yes	No		
Socio-economic class				
Upper	118 (73.3)	43 (26.7)	15.41	<0.001*
Lower	198 (88.8)	25 (11.2)		
Place of residence				
Urban	243 (80.7)	58 (19.3)	2.33	0.127
Rural	73 (88.0)	10 (12.0)		
Type of housing				
Story building	116 (72.5)	44 (27.5)	18.05	<0.001*
Bungalow	200 (89.3)	24 (10.7)		

*Significant

Table 3: Bivariate analysis to determine the relationship between the presence of rats in homes and various hygiene-related practices in the homes

Practices at home	Presence of rat in houses (%)		χ^2	*P*
	Yes	No		
Open windows/doors at night				
Always	134 (77.5)	39 (22.5)	12.41	0.002*
Sometimes	159 (89.3)	19 (10.7)		
Never	23 (69.7)	10 (30.3)		
Spread of Food outside				
Yes	105 (89.0)	13 (11.0)	5.23	0.022*
No	211 (79.3)	55 (20.7)		
Use of rat as food				
Sometimes	37 (94.9)	2 (5.1)	4.79	0.083
Never	279 (80.9)	66 (19.1)		
Foodstuffs stored in airtight containers				
Always	37 (77.1)	11 (22.9)	15.61	<0.001*
Sometimes	137 (91.9)	12 (8.1)		
Never	142 (75.9)	45 (24.1)		

*Significant

Table 4: Multivariate binary logistic regression analysis of risk factors to the presence of rats in the house

Risk factors	Coefficients	Adjusted OR	95% CI	*P*
Social class	0.852	2.21	1.25–6.42	0.010*
Spread foodstuff outside	0.204	0.720	1.02–3.95	0.376
Type of housing	−0.856	0.428	1.60–4.91	0.004*
Food storage in airtight container				
Always	Reference			
Sometimes	0.866	2.38	1.06–3.40	0.018*
Never	1.400	4.05	1.38–8.30	0.005*
Opening windows/doors at night				
Always	−260	0.771	0.66–3.40	0.571
Sometimes	−994	0.370	0.36–2.19	0.040*
Never	Reference			

*Significant. OR: Odds ratio, CI: Confidence interval

food and the environment with rat droppings.[1] Rats are very destructive in that they eat electric cable, exposing the naked wires to fire outbreaks. Despite that majority of the respondents live in urban areas, the household rats' infestation rate was high. This could be attributed to the fact that most of the respondents belonged to lower socioeconomic status and are more likely to live in urban slums and in bungalows. The urban slums are characterized by poor housing conditions, unplanned urbanization, dirty trash, and cans which may serve as harborages for rats.[16] This high rats' infestation observed in this study was similar to findings observed in Osogbo, Osun state (90.9%)[16] and Esan, Edo state (96.1%)[17] and 85.2% and 92.4% in urban slums and rural villages in Los Rios, Southern Chile,[18] respectively. Contrary to our findings, other researchers observed 70.6% in Benin City, Edo State,[19] 54% in Johannesburg, South Africa,[20] 45.9% in Salvador, Brazil,[21] and 41% in Kaohsiung City, Taiwan.[22] Differences in the socioeconomic status, standard of living, and quality of houses, personal and environmental hygiene of the respondents, as well as community awareness level of harmful effects of rodents and their active participation in its control, may have contributed to these varying prevalence rates. Improper waste disposal results in the creation of breeding places for rats, while poor levels of housing offer easy access to rodents, which is more common in urban areas.[16,23]

Socioeconomic status predicted the presence of rats in houses in this study. Researchers[20] in South Africa observed increased household rats' infestation is associated with lower income, living in informal areas, overcrowding, cracks in dwelling walls, and internal damps while having a cat in the home lowered the risk of reporting rodents. Similar associations between dwelling-specific variables and the prevalence of commensal rodents were recorded in another study.[24] A community-based study in Taiwan had reported bungalows, farmers or laborers, and total residential area of more than 105 m^2 as well as empty space, and resource recycling stations in the community were significant demographic and environmental factors associated with a rodent infestation.[22] In Brazil,[21] the presence of open sewers, easy access to food, harborage serving as suitable places for hiding nesting and entry points, dilapidated fences and walls, and holes in the roof were associated with a rodent infestation. Many of these variables are a socioeconomic proxy for underlying poverty, which supports the suggestion that rodents in effect, serve as an indicator of neighborhood deterioration.[25] A study[26] in South-Western Nigeria has shown that good housing standards and a clean environment are effective measures of tackling the spread of the Lassa fever disease and control of the rodents.

Control of rodents is very intricate as they are very secretive and not easily seen because many of them are nocturnal mammals.[27] In this study, the major method for the control of rats used as rat poison. Rat poisons are readily available in the market, sold at cheap prices, and are easy to prepare compared to other control measures. Hence, it may explain the reason for its preference by respondents among other control measures. Poisoning of rats with bait may not be ideal indoors as these rats may die inside the apartment and create an odor and fly problem. Rats poisons if not properly stored in homes may lead to accidental poisoning in children. This was similar to the findings in studies in Osun[16] and Edo states,[19] Nigeria. Although the content of these rat poisons is not known, there is a need to regulate their use at the community level to avoid environmental contamination and hazards from chemical poisoning.

Other methods of rats/rodent control should be encouraged such as rat traps and cats to control rats as observed in some studies in Esan, Edo State, Nigeria,[19] and Los Rios, Chile.[18] Awareness of more effective environmental hygiene or chemical rodenticides as a control measure should be intensified.[28] This is because rodents have been found to have high learning habits that enable them to avoid traps, bait

shyness/aversion to acute poisons, and avoidance of man's antic employed in controlling them. Proper management of empty spaces and resource recycling stations have been advocated in some communities with huge control successes.[21] Studies have also clearly demonstrated the superiority of environmental improvement over the use of poisons as a rat control technique.[23] Therefore, integrated rodent management based on sound eco-biology and ethnology of species should be utilized in other to address the burden of household rats' infestation at the community level.

This study found a significant association between household rats' infestation and keeping windows or doors of houses open at night and spreading of food on the floor outside houses. These practices should be discouraged. As regards the spreading of foodstuff on the floor, rats are omnivores and feed on the same food as humans. However, these rats shed saliva, urine, and feces on these food items which act as a reservoir for the germs such as the Lassa fever virus and have been observed as the major means of the disease.[1]

Of concern is the level of rat consumption observed in this study; where one out every 10 respondents consumed rat. Viral hemorrhagic fevers (Lassa fever inclusive) have been observed to be common in locations/communities where bush meats are highly consumed.[7] Processes involved in the killing, dressing, and preparing these delicacies have been observed as the risk to the transmission of the disease. A study[10] conducted in a rural area in the same locality had reported a rat consumption rate of 11.0%, Osun State 20.2%[16] while a study conducted in Benin City, Edo state[17] observed a lower consumption rate of 4.4%. These regions have been noted for epidemics of Lassa fever disease.[10,16,17]

Conclusion

The findings in this study showed that many households were infested with rats and this may not be unconnected with several Lassa fever outbreaks experienced in these LGAs of the past. Rat poison alone was the preferred control measure for rats. Households from the lower social class were twice likely to have rats' infestation than those from the upper social class. Not storing foodstuffs in an airtight container and living in bungalows were other predictors of household rats' infestations.

Recommendations

Combined methods of rat control using rat poison, trap, and environmental sanitation by the caregivers should be sought for rather than the mono-prong approach of use of rat poisoning. Household members are encouraged to store their foodstuffs in airtight containers and keep their doors and windows closed, especially toward evening hours as good means of preventing rat infestations. Government improvement of the socioeconomic class of community members and possible good housing schemes could reduce household rats' infestation.

Acknowledgment

We wish to acknowledge the medical officers that assisted in the filling of the questionnaires.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Centers for Disease Control and Prevention. Imported Lassa fever-new Jersey, 2004. MMWR Morb Mortal Wkly Rep 2004;53:894-7.
2. Tomori O, Fabiyi A, Sorungbe A, Smith A, M. cCormick JB. Viral Haemorrhagic fever antibodies in Nigerian Populations. Am J Trop Med Hyg 1988;38:407-10.
3. Fichet-Calvet E, Lecomte E, Kiovogui L, Soropogui B, Dove A, Kourouma F, *et al*. Fluctuations of abundance and Lassa virus prevalence in Mastomys natalensis in Guniea, WA. Vector-Borne Zoonotic Dis 2007;7:119-208.
4. Olayemi A, Cadar D, Magassouba N, Obadare A, Kourouma F, Oyeyiola A, *et al*. Small mammal diversity and dynamics within Nigeria, with emphasis on reservoirs of the Lassa virus. Syst Biodivers. 2017;15:1-10.
5. Ilori EA, Furuse Y, Ipadeola OB, Dan-Nwafor CC, Abubakar A, Womi-Eteng OE, *et al*. Epidemiologic and clinical features of Lassa fever outbreak in Nigeria, January 1-May 6, 2018. Emerg Infect Dis 2019;25:1066-74.
6. Mari Saez A, Cherif Haidara M, Camara A, Kourouma F, Sage M, Magassouba N, *et al*. Rodent control to fight Lassa fever: Evaluation and lessons learned from a 4-year study in Upper Guinea. PLoS Negl Trop Dis 2018;12:e0006829.
7. Ter Meulen J, Lukashevich I, Sidibe K, Inapogui A, Marx M, Dorlemann A, *et al*. Hunting of peridomestic rodents and consumption of their meat as possible risk factors for rodent-to-human transmission of Lassa virus in the Republic of Guinea. Am J Trop Med Hyg 1996;55:661-6.
8. Taylor PJ, Artntzen L, Hayter M, Iles M, Frean J, Belmain S. Understanding and managing sanitary risks due to rodents zoonoses in an African city: Beyond the Boston Model. Integr Zool 2008;3:38-50.
9. Mahlaba TA, Monadjem A, McCleery R, Belmain SR. Domestic cats and dogs create a landscape of fear for pest rodents around rural homesteads. PLoS One 2017;12:e0171593.
10. Ossai EN, Onwe OE, Okeagu NP, Ugwuoru AL, Eze TK, Nwede AS. Knowledge and preventive practices against Lassa fever among heads of households in Abakaliki metropolis, Southeast Nigeria: A cross-sectional study. Proc Singapore Healthc Proc Singapore Healthc 2020;29:73-80.
11. Ajayi NA, Nwigwe CG, Azuogu BN, Onyire BN, Nwonwu EU, Ogbonnaya LU, *et al*. Containing a Lassa fever epidemic in a resource-limited setting: Outbreak description and lessons learned from Abakaliki, Nigeria (January-March 2012). Int J Infect Dis 2013;17:e1011-6.
12. National Population Commission. Report of Nigeria national population commission on 2006 census. Popul Dev Rev 2007;33:206-10.
13. Araoye MO. Sample size determination. In: Research Methodology with Statistics for Health and Social Sciences. 1st ed.. Ilorin: Nathadex Publishers; 2004. p. 115-20.
14. Oyedeji GA. Socio-economic and cultural background of hospitalized children in Ilesha Nigeria. Niger J Paediatr 1985;12:111-8.
15. Centers for Disease Control and Prevention. Integrated Pest Management: Conducting Urban Rodent Surveys. Atlanta: Centers for Disease Control and Prevention; 2006. Available from: https://www.cdc.gov/nceh/ehs/Docs/IPM_Manual.pdf. [Last accessed on 2020 Jan 30].
16. Olalekan AW. Community awareness and perception towards rodent control: Implications for prevention and control of Lassa fever in urban slums of southwestern Nigeria. Malta J Heal Sci 2015;2:26-32.
17. Tobin E, Asogun D, Happi C, Ogbaini E, Gunther S. Risk factors for

Lassa fever in endemic communities of Edo State, Nigeria. Int J Infect Dis 2014;21:258-9.
18. Muñoz-Zanzi C, Mason M, Encina C, Gonzalez M, Berg S. Household characteristics associated with rodent presence and Leptospira infection in rural and urban communities from Southern Chile. Am J Trop Med Hyg 2014;90:497-506.
19. Odigie E, Ighedosa S, Vincent OG, Usifoh S, Asemota D, Faboya T, *et al*. Risk perception of lassa fever and rodent control practices in a university campus in South-South Zone of Nigeria. Soc Exp Biol Niger 2007;17:14-22.
20. Jassat W, Naicker N, Naidoo S, Mathee A. Rodent control in urban communities in Johannesburg, South Africa: From research to action. Int J Environ Health Res 2013;23:474-83.
21. Santos NJ, Sousa E, Reis MG, Ko AI, Costa F. Rat infestation associated with environmental deficiencies in an urban slum community with high risk of leptospirosis transmission. Cad Saude Publica 2017;33:e00132115.
22. Pai HH, Hong YJ, Wang CH. A community-based surveillance on determinants of rodent infestation. Kaohsiung J Med Sci 2003;19:13-8.
23. Karija M, Shihua Q, Lukaw Y. The impact of poor municipal solid waste management practices and sanitation status on water quality and public health in cities of the least developed countries: The case of Juba, South Sudan. Int J Appl Sci Technol. 2013;3:87-99.
24. Langton SD, Cowan DP, Meyer AN. The occurrence of commensal rodents in dwellings as revealed by the 1996 English House Condition Survey. J Appl Ecol 2001;38:699-709.
25. Bonner PC, Schmidt WP, Belmain SR, Oshin B, Baglole D, Borchert M. Poor housing quality increases risk of rodent infestation and Lassa fever in refugee camps of Sierra Leone. Am J Trop Med Hyg 2007;77:169-75.
26. Olayinka S, Omotoso B, Osaretin A, Adewunmi E. Awareness of Lassa fever in a rural community in South West Nigeria. Sch J Appl Med Sci. 2015;3:1137-42.
27. Jain AP, Tripathic RS. An integrated approach to rodent pest management. In: Upadhyaya RK, Mukherjee KG, Dubey OP, editors. IPM System in Agriculture, vol 7 Animal Key Pests. New Delhi: Aditya Book pvt Ltd.; 2000. p. 275-307.
28. Adegoke OO, Ajibola OF, Ogundairo JA. Knowledge, attitude and practices of foodstuff sellers on Lassa fever in major markets in Ibadan. African J Psychol Study Soc 2017;20:165-76.