This work was funded by Fundação de Amparo à Pesquisa do Estado de Goiás (public call no. 05/2012) and was conducted during a scholarship supported by the Program CAPES-Brazilian Federal Agency for Support and Evaluation of Graduate Education within the Ministry of Education of Brazil.

About the Author

Ms. Saivish is a biomedical researcher in the Laboratory of Virology of the Federal University of Goiás–Jataí Regional. Her area of interest is the development of viral diagnostic methods for emergent arboviruses and hantavirus.

Address for correspondence: Eduardo Montoya-Diaz, Veterinary Medicine Division, Paul-Ehrlich-Institut, Paul-Ehrlich-Str. 51-59, 63225 Langen, Germany; email: eduardo.montoyadiaz@pei.de; Marcos Lázaro Moreli, Laboratório de Virologia, Universidade Federal de Goiás-Regional Jataí, Câmpus Jatobá, Cidade Universitária, BR 364, km 195, nº 3800, CEP 75801-615, Goiás, Brazil; email: marcoslmoreli@gmail.com

References

1. Figueiredo LTM. The recent arbovirus disease epidemic in Brazil. Rev Soc Bras Med Trop. 2015;48:233–4. https://doi.org/10.1590/0037-8682-0179-2015
2. Keasey SL, Pugh CL, Jensen SMR, Smith JL, Hontz RD, Durbin AP, et al. Antibody responses to Zika virus infections in environments of flavivirus endemicity. Clin Vaccine Immunol. 2017;24:e00036–17. https://doi.org/10.1128/CVI.00036-17
3. Medeiros DBA, Nunes MRT, Vasconcelos PFC, Chang GJ, Kuno G. Complete genome characterization of Rocio virus (*Flavivirus*: Flaviviridae), a Brazilian flavivirus isolated from a fatal case of encephalitis during an epidemic in São Paulo state. J Gen Virol. 2007;88:2237–46. https://doi.org/10.1099/vir.0.82883-0
4. Amarilla AA, Santos-Junior NN, Figueiredo ML, Luiz JPM, Fumagalli MJ, Colón DF, et al. CCR2 plays a protective role in Rocio virus-induced encephalitis by promoting macrophage infiltration into the brain. J Infect Dis. 2019;219:2015–25. https://doi.org/10.1093/infdis/jiz029
5. Amarilla AA, Fumagalli MJ, Figueiredo ML, Lima-Junior DS, Santos-Junior NN, Alfonso HL, et al. Ilheus and Saint Louis encephalitis viruses elicit cross-protection against a lethal Rocio virus challenge in mice. PLoS One. 2018;13:e0199071. https://doi.org/10.1371/journal.pone.0199071
6. Sistema Único de Saúde. BRASIL. Informe técnico semanal: dengue, chikungunya e zika [cited 2019 Apr 2]. http://www.saude.goiania.go.gov.br/docs/divulgacao/Informe_Semanal_Den_Chik_Zika_SE_52_01_19_18_01_19.pdf
7. de Morais Bronzoni RV, Baleotti FG, Ribeiro Nogueira RM, Nunes M, Moraes Figueiredo LT. Duplex reverse transcription-PCR followed by nested PCR assays for detection and identification of Brazilian alphaviruses and flaviviruses. J Clin Microbiol. 2005;43:696–702. https://doi.org/10.1128/JCM.43.2.696-702.2005
8. Casseb AR, Cruz AV, Jesus IS, Chiang JO, Martins LC, Silva SP, et al. Seroprevalence of flaviviruses antibodies in water buffaloes (*Bubalus bubalis*) in Brazilian Amazon. J Venom Anim Toxins Incl Trop Dis. 2014;20:9. https://doi.org/10.1186/1678-9199-20-9
9. Pauvolid-Corrêa A, Campos Z, Juliano R, Velez J, Nogueira RMR, Komar N. Serological evidence of widespread circulation of West Nile virus and other flaviviruses in equines of the Pantanal, Brazil. PLoS Negl Trop Dis. 2014;8:e2706. https://doi.org/10.1371/journal.pntd.0002706

Epidemiology of Lassa Fever and Factors Associated with Deaths, Bauchi State, Nigeria, 2015–2018

Mohammed A. Abdulkarim, Sufiyan M. Babale, Chukwuma D. Umeokonkwo, Eniola A. Bamgboye, Adebobola T. Bashorun, Auwal A. Usman, Muhammad S. Balogun

Author affiliations: Gombe State Ministry of Health, Gombe, Nigeria (M.A. Abdulkarim); Nigeria Field Epidemiology and Laboratory Training Program, Abuja, Nigeria (M.A. Abdulkarim, A.T. Bashorun, A.A. Usman, M.S. Balogun); Ahmadu Bello University, Zaria, Nigeria (S.M. Babale); Federal Teaching Hospital, Abakaliki, Nigeria (C.D. Umeokonkwo); University of Ibadan, Ibadan, Nigeria (E.A. Bamgboye)

DOI: https://doi.org/10.3201/eid2604.190678

We report the epidemiology of Lassa fever in Bauchi State, a disease-endemic region, in Nigeria. Since 2015, major increases in Lassa fever attack rate and in the case-fatality rate have occurred in this state. A delay in seeking care by a case-patient for >7 days after symptom onset was the major predictor of death.

In recent years, Lassa fever (LF) outbreaks in Nigeria have become more frequent and larger in magnitude; the outbreak in 2018 was described as the largest in history (*1*). Bauchi State, which had never reported an LF case before 2012, has quickly become one of the high-risk states for LF in this country (*2*). We report LF epidemiology in Bauchi State and identify factors associated with death.

We retrospectively reviewed data for LF cases during January 2015–December 2018 obtained from the platform for integrated disease surveillance and

response for Bauchi State. The source of the data has 100% completeness for variables of interest (sociodemographic characteristics, laboratory results, outcome of illness, health facility of admission, date of onset of illness, date care was sought, date of death, first health center, clinical features at initial examination, outcomes of laboratory investigations, and treatment outcomes).

We analyzed data by using Epi Info version 7.2 software (https://www.cdc.gov/epiinfo/support/downloads.html). We calculated frequencies and proportions and examined the relationship between the outcome variable (death) and the risk factors (including sociodemographics) by using the χ^2 test. We included significant variables ($p< 0.1$) by bivariate analysis and the biologically plausible ones (sex and age) in an unconditional logistic regression model; $\alpha = 0.05$ was considered the level of significance.

A total of 368 suspected LF cases were reported in Bauchi State during January 2015–December 2018, of which 76 were confirmed. The mean ± SD age for confirmed case-patients was 30.7 ± 15.8 years, and most (81.6%) case-patients were 15–64 years of age. This age group had the highest age-specific attack rate (1.8 cases/100,000 persons), and patients <5 years of age had the lowest attack rate (0.2 cases/100,000 persons). Most (54.0%) patients were male; the attack rate was 1.2 cases/100,000 persons for male sex and 1.1 cases/100,000 persons for female sex. The overall case-fatality rate (CFR) was 54.0% (41/76) and was highest (66.6%) for persons <5 years of age (Appendix Figure 1, https://wwwnc.cdc.gov/EID/article/26/4/19-0678-App1.pdf). All LF cases were reported from districts contiguously located in the southern parts of the state (Appendix Figure 2).

Overall, more cases were reported in the early and late months of the year compared with the middle months (Appendix Figure 3). The CFR trend for LF showed a major increase from 33.3% in 2015 to 53.3% in 2018 (linear trend χ^2 4.8; $p = 0.03$), and the attack rate increased from 0.1 cases/100,000 persons during 2015 to 0.4 cases/100,000 persons during 2018 (linear trend χ^2 14.0; $p<0.01$). We found by multivariate analysis that a delay in seeking care for >7 days after onset of illness (adjusted odds ratio 6.2, 95% CI 1.40–27.60) or for ≥24 hours after onset of bleeding (adjusted odds ratio 6.4, 95% CI 1.40–29.44) were independent predictors for dying from LF (Table).

This study demonstrated that LF has become a highly fatal disease in Nigeria. With the productive age group being the most affected by LF, its socioeconomic impact in the affected communities should be of concern (*3*). A similar age distribution was reported in a study from the neighboring Plateau State in Nigeria, which reviewed confirmed LF cases reported during 2012–2016 (*4*). However, our findings were different from those for a study from Sierra Leone in 2014, in which children and adolescents were more affected (*5*). This finding was probably caused by a difference in cultural environment between the 2 settings.

The southward geographic distribution of LF cases in the study area might be related to the distinctive Sudan savanna vegetation in that part of Bauchi State, which is characterized by higher annual rainfall (which has been shown to influence the incidence of

Table. Independent predictors of dying from Lassa fever, Bauchi State, Nigeria, 2015–2018*

Variable	No. (%) died, n = 41	No. (%) survived, n = 35	Unadjusted OR (95% CI)	Adjusted OR (95% CI)
Sex				
M	21 (51.2)	20 (48.8)	0.8 (0.32–1.95)	0.8 (0.18–3.70)
F	20 (57.1)	15 (42.9)		
Age group				
Productive	33 (53.2)	29 (46.8)	0.9 (0.26–2.75)	1.2 (0.22–6.68)
Dependent	8 (57.1)	6 (42.9)		
Place of residence				
Rural	27 (48.2)	29 (51.8)	0.4 (0.13–1.19)	0.4 (0.08–2.27)
Urban	14 (70.0)	6 (30.0)		
First place of admission				
Tertiary hospital	27 (46.6)	31 (53.4)	**0.2 (0.07–0.85)**	0.2 (0.02–1.45)
Other	14 (77.8)	4 (22.2)		
Bleeding episode†				
Yes	34 (60.7)	22 (39.3)	2.2 (0.73–6.66)	NI
No	7 (41.2)	10 (58.8)		
Duration between seeking care and onset of illness, d				
>7	25 (73.5)	9 (26.5)	**4.5 (1.69–12.08)**	**6.2 (1.40–27.60)**
≤7	16 (38.1)	26 (61.9)		
Duration between seeking care and any bleeding episode, h‡				
≥24	25 (80.6)	6 (19.4)	**7.4 (2.21–24.81)**	**6.4 (1.40–29.44)**
<24	9 (36.0)	16 (64.0)		

*Bold indicates significance ($p<0.05$). NI, not included in a regression model; OR odds ratio.
†n = 73 for this variable because of missing values. Variable not included in the regression model ($p>0.1$).
‡n = 56 for this variable because not all case-patients had a bleeding episode.

the disease) compared with the Sahel savanna vegetation in the central and northern parts of Africa (*6*,*7*). Furthermore, the intensive agricultural activities in the southern districts and the common postharvest practice of drying crops in open spaces in these hilly areas probably favor food contamination by the disease vector.

Our finding that a delay in seeking care of ≥24 hours after onset of bleeding was a strong predictor of death among cases is a concern. LF has some common early symptoms similar to those of other febrile diseases, especially malaria, that are frequently encountered in most LF-endemic settings (*8*). An LF diagnosis is often delayed because health workers suspect these other febrile diseases (*8*). Furthermore, Bauchi State has the highest CFR in Nigeria, nearly double the national average (28.9%) (*2*,*9*). A similarly high CFR was reported in a previous study in Sierra Leone in a region affected by conflicts where the health infrastructure was poor (*5*). Finally, the designated LF treatment center in Bauchi State lacks adequately trained personnel and other essential resources to effectively manage complications once they occur. If one considers that a delay in seeking care has been demonstrated to be a predictor of death in this study, the high CFR in Bauchi State could have been lower if the treatment center was better equipped or if cases could be diagnosed earlier.

Acknowledgments

We thank the Bauchi State Ministry of Health for providing support during this study.

About the Author

Mr. Abdulkarim is a resident in the Nigeria Field Epidemiology and Laboratory Training Program and a consultant in the Department of Public Health, Gombe State Ministry of Health, Gombe, Nigeria. His research interests are emerging and reemerging infections and zoonoses.

References

1. Tambo E, Adetunde OT, Olalubi OA. Re-emerging Lassa fever outbreaks in Nigeria: re-enforcing "One Health" community surveillance and emergency response practice. Infect Dis Poverty. 2018;7:37. https://doi.org/10.1186/s40249-018-0421-8
2. Nigeria Centre for Disease Control (NCDC). 2019 Lassa fever outbreak situation report, 2019 [cited 2019 Jan 4]. https://ncdc.gov.ng/diseases/sitreps
3. Dauda G, Sodipo O, Lar L. Lassa fever: a recurring decimal in Plateau State, Nigeria. International Journal of Biomedical Research. 2018;9:197–201. https://doi.org/10.7439/ijbr.v9i5.4769
4. Richmond JK, Baglole DJ. Lassa fever: epidemiology, clinical features, and social consequences. BMJ. 2003;327:1271–5. https://doi.org/10.1136/bmj.327.7426.1271
5. Shaffer JG, Grant DS, Schieffelin JS, Boisen ML, Goba A, Hartnett JN, et al.; Viral Hemorrhagic Fever Consortium. Lassa fever in post-conflict Sierra Leone. PLoS Negl Trop Dis. 2014;8:e2748. https://doi.org/10.1371/journal.pntd.0002748
6. Fichet-Calvet E, Lecompte E, Koivogui L, Soropogui B, Doré A, Kourouma F, et al. Fluctuation of abundance and Lassa virus prevalence in *Mastomys natalensis* in Guinea, West Africa. Vector Borne Zoonotic Dis. 2007;7:119–28. https://doi.org/10.1089/vbz.2006.0520
7. Bauchi State Government. Bauchi State Strategic Health Development Plan, 2015–2020; 2015 [cited 2019 Apr 13]. http://www.mamaye.org/sites/default/files/evidence/BAUCHI SSHDP 29.01.11.pdf.
8. Dahmane A, van Griensven J, Van Herp M, Van den Bergh R, Nzomukunda Y, Prior J, et al. Constraints in the diagnosis and treatment of Lassa fever and the effect on mortality in hospitalized children and women with obstetric conditions in a rural district hospital in Sierra Leone. Trans R Soc Trop Med Hyg. 2014;108:126–32. https://doi.org/ 10.1093/trstmh/tru009
9. Okoro O. Burden and trend of Lassa fever in Nigeria: a secondary data analysis 2012–2017. Presented at: Lassa Fever International Conference; 2019 Jan 16–17; Abuja, Nigeria.

Address for correspondence: Mohammed A. Abdulkarim, Department of Public Health, Gombe State Ministry of Health, No. 1, Dukku Rd, Gombe, Gombe State, Nigeria; email: muhammad.kwamee@gmail.com

Plague Epizootic Dynamics in Chipmunk Fleas, Sierra Nevada Mountains, California, USA, 2013–2015

Talisin T. Hammond,[1] Kelly A. Liebman, Robert Payne, Helen K. Pigage, Kerry A. Padgett

Author affiliations: University of California, Berkeley, California, USA (T.T. Hammond); California Department of Public Health, Richmond, California, USA (K.A. Liebman, R. Payne, K.A. Padgett); University of Colorado, Colorado Springs, Colorado, USA (H.K. Pigage)

DOI: https://doi.org/10.3201/eid2604.190733

We describe *Yersinia pestis* minimum infection prevalence in fleas collected from *Tamias* spp. chipmunks in the Sierra Nevadas (California, USA) during 2013–2015. *Y. pestis*–positive fleas were detected only in 2015 (year of plague epizootic), mostly in *T. speciosus* chipmunks at high-elevation sites. Plague surveillance should include testing vectors for *Y. pestis*.

[1]Current affiliation: San Diego Zoo Institute for Conservation Research, Escondido, California, USA.