Zoonotic diseases of bat origin: knowledge and practices of persons living in same house with ceiling-dwelling bats in Ebonyi State, Southeast Nigeria

Ogugua Akwoba Joseph[1], Anyaoha Chidiebere[1], Chukwudi Uzoma Chinwe[2], Chukwudi C. Ijeoma[3], Chah F. Kennedy[4], and Asuzu U. Isaac[5]

[1]Department of Veterinary Public Health and Preventive Medicine

[2]Department of Veterinary Pathology

[3]Department of Veterinary Medicine

[4]Department of Veterinary Microbiology and Immunology

[5]Department of Veterinary Pharmacology and Toxicology, University of Nigeria, Nsukka

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ABSTRACT

Introduction

Bats possess unique immune system thereby hosting numerous infectious agents as true reservoirs for emerging infectious diseases. Human activities have increased bat-human interactions, heightening the risk of zoonotic spillovers. However, data on the knowledge and practices of people living close to bats in Nigeria is scarce.

Methods

This study assessed knowledge and practices for disease emergence and transmission among residents of houses with ceiling-dwelling bats in Ebonyi State, Nigeria. A cross-sectional survey conducted across five communities in three local government areas of the state interviewed 128 individuals living in houses with ceiling-dwelling bats using a validated interviewer-administered questionnaire. The instrument captured 25 variables including socio-demographics (8), knowledge of bat-borne zoonoses (8), and risk-related practices (9). Additional on-site interviewer observations. Knowledge and practice indices with scores ≥ 0.5 were categorized as "good knowledge" or "safe practices." Associations were tested for using Chi-square or Fisher's exact tests.

Results

Of the 128 participants, 68.8% demonstrated good knowledge of bat-borne zoonotic diseases. Occupation was strongly associated with knowledge (χ^2=17.52; p=0.0001). Participants with tertiary (85.7%) and no formal education (100%) showed higher knowledge, with a strong association between education level and knowledge (χ^2 = 11.80; p = 0.006). Risky practices were reported by 12.5% of respondents, especially farmers (25.5%). A strong association (χ^2 = 10.478; p = 0.004) was observed between occupation and practices.

Conclusions

While most residents showed good knowledge and safe practices, targeted interventions are needed for high-risk groups, particularly farmers, to reduce zoonotic disease transmission from bats.

Keywords: Zoonotic disease, Knowledge, Practices, Bats, Ceiling, Ebonyi State

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INTRODUCTION

Bats are mammals belonging to the order Chiroptera and its suborders, Megachiroptera and Microchiroptera (Fenton and Simmons, 2015; Wilson and Mittermeier, 2019). They are the second most varied order of mammals, accounting for over 25% of all mammalian species and having a nearly worldwide distribution (Turmelle and Olival, 2009). Bats are integral in controlling pests, pollinating plants, and dispersing seeds, all of which are crucial for preserving the ecological balance (Bonilla-Aldana *et al.*, 2020).

Bats possess a distinct immune system and genetic make-up which have conferred on them the ability to play host to a variety of infectious agents without showing clinical signs of disease (Irving et al., 2021). There is a growing global interest in bats because of their recognized role as reservoirs for several viruses including those associated with the emergence of diseases such as severe acute respiratory syndrome coronavirus (SARS-CoV) and severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) (Hu *et al*., 2021), Middle East respiratory syndrome (MERS), Ebola, Nipah and Hendra (Banerjee *et al*., 2019; Ochani *et al*., 2019), rabies (Streicker *et al.*, 2016), and the 2019 coronavirus pandemic -COVID-19 (10) (Zhou *et al*., 2020). Bats have also stood out as potential carriers of zoonotic bacteria, such as Bartonella spp.

(Veikkolainen *et al*., 2014), *Yersinia pestis*, and *Mycobacterium tuberculosis* (Banskar *et al*., 2016), *Leptospira spp*. (Silva-Ramos *et al*., 2022; Esteves *et al*., 2022; Mayer *et al*., 2017), *Brucella spp.* (Bai *et al*., 2017), *Borrelia spp.* (Muñoz-Leal *et al.*, 2021). These infectious agents can potentially be transferred from bats to humans and livestock via intermediate hosts or direct contact with faeces and urine (Szentivanyi et al., 2023; Allocati et al., 2016). Being mammals and having the ability to fly long distances, coupled with increasing proximity to humans, bats are recognized as hosts frequently capable of transmitting pathogenic microorganisms to humans (Federici *et al.*, 2022).

Anthropogenic activities such as habitat destruction, urbanization, and changes in land use have brought bats close to humans, thus, resulting in increased likelihood of human-bat interactions. As pointed out by Jackson et al. (2024) prolonged, frequent, and intense interactions between bats, humans, and domestic animals, provides exposure opportunities for zoonotic spillover events.

Hunting of bats for consumption as bush meat and use of their products in traditional medicine is a widespread practice in many parts of the world particularly Africa, Asia and across the islands of Oceania (Mildenstein et al., 2016). These practices, along with poor hygiene and limited knowledge of the potential of acquiring zoonotic diseases of bat origin further increases the risk of pathogen transmission and disease emergence.

The knowledge and practices of residents in close proximity to bats are therefore crucial in preventing the risks of zoonotic disease transmission. This study examines the knowledge and practices of persons living in close contact with bats in Ebony State, South East, Nigeria.

Materials and methods

Research Design

The work adopted the cross-sectional study design.

Study area

The study was conducted in Ebonyi State, Nigeria. Ebony State is located in South East Nigeria between Latitude 6°15´N and Longitude 8°05´E (Okoli and Ogugua, 2023). Most towns in Ebonyi are rural, with farming being the predominant occupation (Figure 1).

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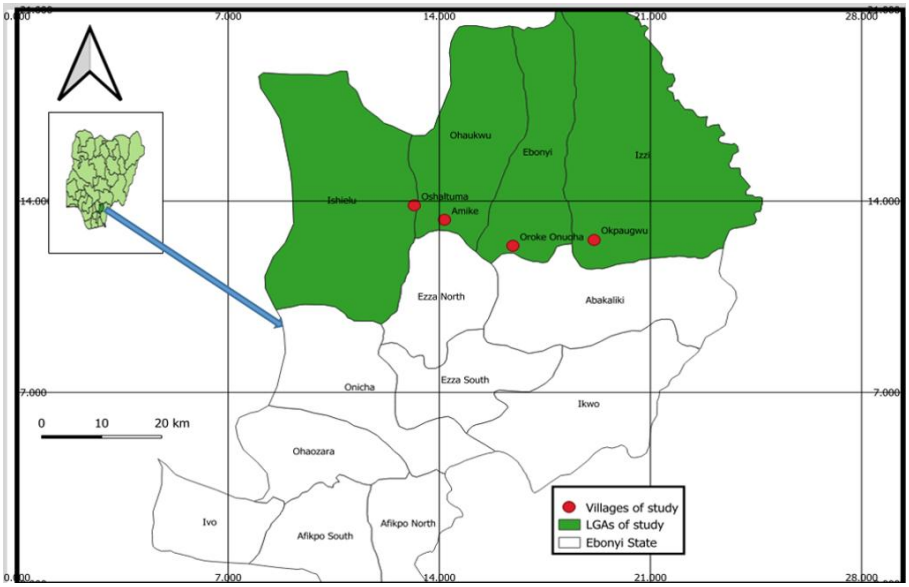

Figure 1: Map of Ebonyi State showing the study site

Sampling and questionnaire administration

Only villages with houses whose ceilings serve as roost sites for bats were chosen for the study. Oral informed consent was obtained from participants who were 18 years or older and residing in such houses. The questionnaire was administered through interviews with only those occupants who consented.

Inclusion and exclusion criteria

Individuals who live in houses having bats in the ceilings, above 18 years of age, and in the right frame of mind to make logical decisions were included, while those not meeting the above criteria were excluded.

Instrument of data collection

The instrument was researcher-prepared. To confirm its validity, a panel of experts involving one expert in the area of health education, two in the area of veterinary public health, and two in virology reviewed and assessed the questions for the relevance of the items to emerging viral diseases, response format and confirm them to be representative of the important aspects of the study. The responses from the experts were used to revise and modify the tool, which was then pilot-tested on a sample of individuals sharing the same building with bats in an area outside the study areas. The pilot study aimed to evaluate the effectiveness of the instruments and to identify the problems/benefits associated with the design. The data collected were used to evaluate the internal consistency of the scales using Cronbach's coefficient alpha, which showed an acceptable level of 0.8. Additionally, the content validity of the scales was also established. The questionnaire consisted of sections on the demographic characteristics of the respondents as well as their knowledge, practices, and observations made to corroborate the responses were also noted.

The demographic characteristics were made of 8 items, including occupation, age, sex, and level of education. To assess the knowledge of the respondents on zoonotic diseases of bat origin, 8 structured questions were presented, while the respondents' practices regarding disease emergence and transmission from bats were evaluated using 9 structured questions. In both cases, the respondents were required to indicate "yes", "no", or "I do not know" against each item. For each knowledge question, a correct answer was scored one (1) while a wrong answer was scored zero (0). For each practice item, a good (not risky) practice was scored one (1) while a bad (risky) practice was scored zero (0). In both cases, all "I do not know" responses were scored zero (0). The knowledge index (KI) for each respondent was determined by dividing the total score of the respondent by the number of knowledge questions (Chah et al., 2022). Similarly, the practice index (PI) for each respondent was determined by dividing the total score of the respondent by the number of practice questions. Any respondent with a KI or PI of greater than or equal to 0.5 was classified as having good knowledge or good practice, while

those with indices less than 0.5 were categorized as those with poor knowledge or involved in bad or risky practices. All non-structured questions were not scored but included in descriptive analyses of the data.

Ethical approval

Ethical approval for the study was obtained from the Ethics Committee of the Department of Veterinary Public Health and Preventive Medicine, University of Nigeria, Nsukka, with reference No: VPHPM/UNN/23/203.

Data analysis

Data generated were analysed with descriptive statistics, while Chi-square/Fisher's exact test was used to determine the association between participants' occupation, sex, and highest level of education, and the knowledge of zoonotic diseases of bat origin, and practices relating to disease emergence from bats using SPSS version 23 software. Statistical significance was accepted at $p < 0.05$.

RESULTS

Socio-demographic characteristics of the participants

The socio-demographic characteristics of the participants are presented in Table 1. The single most popular occupation of the participants was farming (37.50%), although 46.88% represented a mixture of those in other occupations. The majority (75.00%) of the participants were males; and 53.13% of them had achieved a secondary education level. The majority (56.25%) of the respondents were found to have occupied the buildings for more than three years, while 62.50% indicated that they spend between 5 to 10 hours daily in the houses. The number of persons sleeping in one room ranged from 1 - 4, with 3 persons per room being the most common (47.66%) sleeping arrangement in the study area.

Knowledge of zoonotic diseases of animal/bat origin

The distribution of the participants based on their knowledge of zoonotic diseases of animal origin is shown in Table 2. Among the respondents, 90.63% knew that animals can transmit disease to man, while 9.36% did not know that diseases can transmitted to humans by animals. The animals named by the participants to be capable of transmitting diseases include dogs (43.8%), bats (6.2%), and other animals (50%). The majority (62.50%) of the participants reported that transmission is through the consumption of food of animal origin. Nearly 38% of the respondents agreed that human contact with bat faeces can lead to disease transmission, while 28.13% and 38.38% did not agree or did not know, respectively. The majority (75%) of the respondents indicated that bats can harbour diseases, with 92 (71.88%) admitting that bats can transmit disease to humans. Although 92 of the participants admitted that bats can transmit disease to humans, 52% of this number did not believe that such transmission could affect them. Among the 92 participants who agreed that bats can transmit disease to humans, 100%, 52.17%, and 8.70% named Coronavirus, Ebola virus and Rabies, respectively, as diseases that can be transmitted to man. About 59% of the respondents reported that viral diseases transmitted by bats are curable while 37.5% did not know. Prayer was reported by 43.75% of the respondents as the best form of treatment for diseases transmitted by bats.

The majority (68.8%) of the 128 participants had good knowledge of bats as sources of zoonotic disease, including coronavirus. The proportions of the various categories of participants with good or bad knowledge on zoonotic diseases of bat origin are presented in Table 3. Half (50.0%) of the 48 farmers and all (100.0%) of the 20 teachers had good knowledge of zoonotic diseases. There was a strong association ($X^2 = 17.52$; $p = 0.000$) between the knowledge and occupation of participants. The proportion of respondents with good knowledge of disease/disease transmission from bats was higher in the older age categories; however, the association between this knowledge and age group was not significant ($p > 0.05$). Although a higher proportion of females (75.0%) than males (66.7%) had good knowledge of zoonotic disease transmission, the association between gender and knowledge was not significant ($p > 0.05$). All 8 (100.0) and 24 (85.7%) of the 28 participants with no formal and tertiary education, respectively, had good knowledge, while 50.0% of those with primary and 64.7% with

secondary education had good knowledge. There was a strong association (X^2 = 11.80; p = 0.006) between knowledge of zoonotic disease and the educational level of participants.

Practices of the participants relating to zoonotic disease transmission from bats

The distribution of respondents according to practices relating to zoonotic diseases from bats in Ebonyi State, Nigeria, is presented in Table 4. Contact with bats and bat faeces was reported by 31.3% and 21.9% of the respondents, respectively. Other reported practices that can facilitate transmission of diseases from bats to humans include: handling of bats (21.9%), eating of game from the wild (71.9%), eating of bats (15.6%), and non-protection of wounds while handling or processing of bats or game (6.3%).

Overall, 16 (12.5%) of the 128 respondents were engaged in bad or risky practices, while 87.5% were involved in good practices. The demographic characteristics of participants and their practices regarding zoonotic disease transmission from bats are shown in Table 5. None of the 20 teachers and 12 (25.5%) of the farmers were engaged in bad practices; there was a strong association (X^2 = 10.478, p = 0.04) between participants' occupation and practices regarding zoonotic disease transmission. The proportion of participants recorded to be involved in bad practices decreased with the age of the participant; none of those in the 50 and above age groups reported risky practices. However, no significant association (p > 0.05) between age group and practice regarding zoonotic disease transmission was observed. Equal proportions (12.5%) of males and females were engaged in bad practices. None of the respondents with no formal or primary education reported being involved in risky practices, unlike those with secondary (17.6%) and tertiary (14.3%) education.

DISCUSSION

The findings in this study showed that most of the participants were farmers. In Nigeria, most of the farmers are located in the rural communities where agricultural activities are carried out (Ahmed et al., 2021, UNICEF, 2008). These rural areas are devoid of anthropogenic noise and artificial light, thereby favouring the establishment of bat roosts in the ceilings of houses in the quiet neighbourhoods (Starik and Göttert, 2022). It was therefore not surprising that the occupation of most participants was farming. The study recorded the dominant age group to be between 30 and 49, this being the most active working population age group (Echebiri and Mbanasor, 2003). This finding is contrary to that of Aphunu and Atuma (2010) who observed the predominant rural population to be in the average of 50 years of age in Delta State, Nigeria. Although farming is reported to be unattractive to young people in Nigeria (Daudu et al., 2009, Shuaibu et al., 2011), the current economic downturn in Nigeria, coupled with high unemployment rate in urban areas and increase in food prices, seems to have motivated a higher number of this active age group to pursue farming in the study area. The study found more male than female participants, a finding that is contrary to observation of Shuaibu et al. (2011) in Nigeria and Vo et al. (2023) in Norway where women were more likely to respond to questionnaire. However, the predominance of male respondents in this study may reflect traditional gender roles in rural settings in Nigeria where men are often the heads of family and therefore primary decision-makers and more likely to interact researchers and address questions concerning the household. In terms of educational attainment, good proportion of the participants had at least a secondary education. Similar findings were reported by Adegbite (2017) for farmers in South West Nigeria. Attainment of a higher educational level often leads to better health awareness and favourable health-seeking behaviors (Zimmerman and Woolf, 2014; Raghupathi and Raghupathi, 2020). The finding in this study that on the average, three persons occupied one room indicate that there was no overcrowding by Nigeria standards where occupancy of rooms in many communities are 7 – 10 per room on the average in the cities (Makinde et al., 2016) nor by European standards (Eurostat, 2014). However, the recommended standard for persons per room (PPR) for respiratory infectious disease is 1-1.5 PPR (The UK Office of the Deputy Prime Minister, 2004). Overcrowded accommodation increases the likelihood of aerosol disease transmission (Abubakar et al., 2012). Moreover, for contagious diseases, physical contact drives the pattern of transmissibility, and the more the contact, the higher the chances of disease transmission (Hu et al., 2013). The number of persons per room observed in this study therefore portends a public health risk due to possible disease transmission and spread among the population interviewed.

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Despite the low percentage (6.2%) of participants who could specifically name bats as animals capable of transmitting diseases, 75 % and 71.88 % admitted that bats can harbour diseases and transmit the same to humans. This observation suggests that the participants were generally aware of the potential health risks associated with bats (eg, Rabies, Ebola disease and Covid-19) even without specific knowledge about bats as disease vectors. All the participants who indicated that bats can transmit disease to humans named coronavirus as the disease that can be transmitted. Recognition of coronavirus as a bat-related zoonotic agent may not be unconnected with the recent Covid-19 pandemic, which has been the focus of global public health campaigns resulting in increased awareness of bats-associated health risks. A high proportion of the participants (43.75 %) in this study believed that viral diseases transmitted by bats can best be treated with prayers, while a small percentage (15.63 %) reported that such diseases can be treated with traditional medicines. As reported by Onuoha et al. (2024), 62.1 % of participants in a community in Ebonyi State believed that specific rituals or traditional healing practices are effective in treating illnesses, and individuals are more likely to seek care from traditional healers or engage in alternative medical practices. During the COVID-19 outbreak, 57.9 % of participants in Iran employed prayer to reduce pandemic-related anxiety (Mahlagha et al., 2022). Thus, cultural or religious beliefs significantly influence health-seeking behaviours and should therefore be considered when designing effective public health interventions. A statistically significant associations between knowledge level and both education ($p = 0.006$) and occupation ($p = 0.000$) of the participants were observed. This finding emphasizes the role of these demographic characteristics in shaping the knowledge of zoonotic diseases of bat origin in Ebonyi State. It is surprising to note that all the participants with no formal education had good knowledge of disease transmission from bats. This finding may be attributed to the fact that only eight participants without formal education were involved, and this fewness in number could have affected the outcome and may not be a true representation of the larger population. All the teachers demonstrated good knowledge of zoonotic diseases of bat origin, likely due to their access to information and educational materials. Those with good education are more likely to be exposed to information, which is enhanced by the current availability of information on social media. Education confers better knowledge about general health and health risks (Peters et al., 2010) because education teaches ‘one to think’, imparting one with cognitive and decision-making abilities responsible for improving health (Lleras-Muney, 2005). Although there was no significant association ($p>0.05$) between age and knowledge level of bat-associated zoonotic diseases, the percentage of participants with good knowledge increased with their age. This finding is similar to that of Gonzalez-Herrera et al. (2022) who observed that the knowledge of COVID-19 among Spanish participants increased with age.

A high proportion of the participants engaged in good practices that may prevent possible exposure to diseases of bat origin. Nevertheless, risky practices were still observed, such as contact with bats (31.25%), contact with bats’ faeces (21.88%), handling bats (21.88%), and eating bats (15.63%). These practices are potential exposure routes for zoonotic viruses and bacteria (Wang and Anderson, 2019; Hardmisier et al., 2021; Huang et al., 2022).

Bush meat consumption is very common in Nigeria (Martin, 1983; Omare et al., 2015; Ogundimu and Oduntan, 2017). Wild life, however, represents a reservoir of uncharted zoonotic pathogens that pose a significant threat to public health (Hilderink and de Winter, 2021). It is known that almost 75% of emerging infectious diseases are zoonotic, and the majority of these (71.8%) are of wild animal origin (Rosenthal et al., 2015). The result was also in sync with the observations of Akem and Pemunta (2020) who also recorded game consumption among their participants. Consumption of game, therefore, poses a threat to spill over of zoonotic epidemics and possible disease emergence. While the world is just recovering from COVID-19, believed to have originated from the bat, the potential emergence of another zoonotic pathogen of pandemic nature has become more apparent given the continued exposure to these animals as recorded in this study. Ignoring academic warnings of the possible emergence of zoonotic coronavirus disease of pandemic nature resulted in the outbreak of COVID-19 (Mahroum et al., 2022) that brought about the death of millions of people and devastated the world economy (Hilderink and de Winter, 2021). The fact is that many people who live with bats on their ceiling and have livestock in the compound may result in disease emergence due to the possibility of viruses from different hosts infecting a cell and exchanging genetic materials, a process referred to as recombination. Recombination brings about increased host range, emergence of new viruses, alteration of transmission vector, increase in virulence and pathogenesis (Pérez-Losada et al., 2015). The COVID–19 pandemic was suspected to have emerged through the recombination of bat and pangolin coronaviruses (Yang et al., 2023). Therefore, keeping livestock/pets and consumption of game meat portends a risk of such recombination between similar viruses.

Occupation was significantly associated with risky practices ($p = 0.004$), with none of the teachers engaged in risky practices, while farmers were more engaged in bad or risky practices. During the study, farmers pointed out that they use bat faeces as manure in their farmlands, emphasizing high yields from bat-faeces fertilized fields. Although the practices of the participants regarding zoonotic disease transmission from bats were not significantly ($p > 0.05$) influenced by age, the proportion of participants engaged in risky practices decreased with age. The older age categories were likely more cautious about their vulnerability to COVID-19 and therefore avoided risky practices. The observation that none of the participants with no formal or primary education reported being engaged in risky practices compared with 17.6 % and 14.3 % for those with secondary and tertiary, respectively, is quite unusual. However, it is interesting to note that 100 % of the participants with no formal education had good knowledge of zoonotic disease/disease transmission from bats, which could have contributed to their failure to indulge in risky practices.

CONCLUSION

In Ebonyi State, Southeast Nigeria, most residents living in houses with ceiling-dwelling bats, particularly those with tertiary education and teachers, demonstrated good knowledge of zoonotic disease transmission from bats. Although most participants were engaged in safe practices, a good proportion, particularly farmers, undertook risky practices that could enhance disease transmission from bats to them and their livestock. Practices such as handling of bats, contact with bat faeces, consumption of bush meat, and cohabitation with bats and livestock within the same household were observed. These interactions pose serious public health risks as they create opportunities for zoonotic spill-over events, potentially triggering future outbreaks. The strong associations observed between participants' knowledge and their educational level, as well as between risky practices and occupation, emphasize the need for tailored public health interventions. Thus, enlightenment campaigns and behavioural change communication, targeting high-risk groups such as farmers and rural dwellers, could play a significant role in bridging the gap between knowledge and practice, thereby mitigating the risk of zoonotic disease emergence.

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Conflict of interest Statement

The authors declare no conflict of interest

REFERENCES

1. Abubakar I., Gautret P., Brunette G., Blumberg L., Johnson D., Poumerol G., Memish Z., Barbeschi M., and Khan A. (2012). Global perspectives for prevention of infectious diseases associated with mass gatherings, The Lancet Infectious Diseases. 12: 66.
2. Adegbite, B A (2017). Effects of Age Categories on Farmers' Involvement in Arable Crop Farming Activities in South West, Nigeria. Accessed 1/2/24 from http://196.220.128.81:8080/xmlui/handle/123456789/3717
3. Ahmed AO, Gbadebo, OV, Iselobhor, F, and Tokede AM (2021). An Appraisal of Nigeria's Rural Development Programmes and Policies: Lessons Learnt and the way forward. FUTY Journal of the Environment, 15(1):83-92.
4. Akem ES and Pemunta NV (2020). The bat meat chain and perceptions of the risk of contracting Ebola in the Mount Cameroon region. BMC Public Health 20:593 https://doi.org/10.1186/s12889-020-08460-8
5. Allocati N, Petrucci AG, Di Giovanni P, Masulli M, Di Ilio C, and De Laurenzi V (2016). Bat-man disease transmission: zoonotic pathogens from wildlife reservoirs to human populations. *Cell Death Discov*. 2016 Jun 27;2:16048. doi: 10.1038/cddiscovery.2016.48. PMID: 27551536; PMCID: PMC4979447.

6. Aphunu A. and Atoma C. N. (2010) Rural Youths' Involvement in Agricultural Production In Delta Central Agricultural Zone: Challenge To Agricultural Extension Development In Delta State. Journal of Agricultural Extension Vol. 14 (2), 46 - 55
7. Bai, Y.; Urushadze, L.; Osikowicz, L.; McKee, C.; Kuzmin, I.; Kandaurov, A.; Babuadze, G.; Natradze, I.; Imnadze, P.; Kosoy, M. (2017). Molecular Survey of Bacterial Zoonotic Agents in Bats from the Country of Georgia (Caucasus*). PLoS ONE,* **12**, e0171175.
8. Banerjee, A.; Kulcsar, K.; Misra, V.; Frieman, M.; Mossman, K. (2019). Bats and Coronaviruses. *Viruses*, **11**, 41
9. Banskar, S., Mourya, D. T., and Shouche, Y. S. (2016). Bacterial diversity indicates dietary overlap among bats of different feeding habits. *Microbiological Research*, **182**, 99–108. doi: 10.1016/j.micres.2015.10.006
10. Bonilla-Aldana, K.; Jimenez-Diaz, D.; Patel, S.K.; Dhama, K.; Rabaan, A.A.; Sah, R.; Sierra, M.; Zambrano, L.I.; Arteaga-Livias, K.; Rodriguez-Morales, L. (2020). Importance of Bats in Wildlife: Not Just Carriers of Pandemic SARS-CoV-2 and Other Viruses. *Journal of Pure and Applied Microbiology*, **14**(Suppl. S1), 709–712.
11. Chah, J. M., Sandra C. Nwankwo, Irenonsen O. Uddin, and Kennedy F. Chah (2022): Knowledge and practices regarding antibiotic use among small-scale poultry farmers in Enugu State, Nigeria. Heliyon 8 (2022) e09342. https://doi.org/10.1016/j.heliyon.2022.e09342
12. Daudu S, Okwoche VA, Adegboye OG. 2009. Role of Youths in Agricultural Development in Makurdi Local Government Area of Benue State. Journal of Agricultural Extension, 13(2):107-112.
13. Echebiri, R.N.; Mbanasor, J.A. (2003). Rural age distribution and farm labour supply in food crop production systems in Abia State, Nigeria Tropical and Subtropical Agroecosystems, 2(3):129-136
14. Esteves, S.B.; Gaeta, N.C.; Batista, J.M.N.; Dias, R.A.; Heinemann, M.B. (2022). *Leptospira sp.* infection in bats: A systematic review and meta-analysis. *Transboundary and Emerging Diseases*, **65**, e2456–e2473.
15. Federici, L., Masulli, M., De Laurenzi, V., and Allocati, N. (2022). An overview of bats microbiota and its implication in transmissible diseases Frontiers in Microbiology, **13**, 1012189.
16. Fenton, M. B., and Simmons, N. B. (2015). Bats: A world of science and mystery. The University of Chicago Press.
17. González-Herrera A, Rodríguez-Blázquez C, Romay-Barja M, Falcon-Romero M, Ayala A and Forjaz MJ. (2022). Age diferences in knowledge, attitudes and preventive practices during the COVID-19 pandemic in Spain. Nature Reports. 12:20863
18. Hardmeier I., Aeberhand N., Qi W., Schoenbaechler K., Kraettli H., Hatt J-M., Fraefel Cand Kubacki J. (2021) Metagenomic analysis of faecal and tissue samples from 18 endemic bat species in Switzerland revealed a diverse virus composition including potentially zoonotic viruses. PloS ONE 16: e0252534. https://doi.org/10.1371/journal pone.0252534.
19. Hilderink MH, and de Winter II (2021). No need to beat around the bushmeat–The role of wildlife trade and conservation initiatives in the emergence of zoonotic diseases. Heliyon 7:e07692. https://doi.org/10.1016 /j.heliyon.2021.e07692
20. Hu H, Nigmatulina K, and Eckhoff P. (2013). The scaling of contact rates with population density for the infectious disease models. Mathematical Biosciences 244: 125–134
21. Hu, B., Guo, H., Zhou, P., Shi, Z.L. (2021). Characteristics of SARS-CoV-2 and COVID-19. *Nature Reviews Microbiology*, **19**, 141–154.
22. Huang, Y., Sun, Y., Huang, Q., Lv, X., Pu, J., Zhu, W., Lu, S., Jin, D., Liu, L., Zhengli Shi, Z.
23. Yang, J., and Xua, J. (2022). The threat of potentially pathogenic bacteria in the feces of bats. Microbiology Spectrum, 10: 10.1128/spectrum.01802-22
24. Irving, A.T., Ahn, M., Goh, G., Anderson, D.E.1. and Wang L. 2021. Lessons from the host defenses of bats, a unique viral reservoir. Nature 589:363 - 370. https://doi.org/10.1038/s41586-020-03128-0
25. Jackson RT, Lunn TJ, DeAnglis IK, Ogola JG, Webala PW, Forbes KM (2024) Frequent and intense human-bat interactions occur in buildings of rural Kenya. PLoS Negl Trop Dis 18(2): e0011988. https://doi.org/10.1371/journal.pntd.0011988
26. Lleras-Muney, A. (2005). The relationship between education and adult mortality in the United States. Review of Economic Studies, 72, 189–221.
27. Mahlagha Dehghan, Alireza Ghanbari, Fatemeh Ghaedi Heidari, Parvin Mangolian Shahrbabaki, and Mohammad Ali Zakeri (2022). Use of complementary and alternative medicine in general population

during COVID-19 outbreak: A survey in Iran. Journal of Integrative Medicine, 20: 45-51. https://doi.org/10.1016/j.joim.2021.11.004.
28. Mahroum, N., Seida, I., Esirgün, S.N., and Bragazzi, N,L. (2022). The COVID-19 pandemic - How many times were we warned before? Eur J Intern Med., 105:8-14. doi: 10.1016/j.ejim.2022.07.009.
29. Makinde, O., Björkqvist, K. and Österman, K. (2016). Overcrowding as a risk factor for domestic violence and antisocial behaviour among adolescents in Ejigbo, Lagos, Nigeria. Glob Ment Health (Camb). . doi: 10.1017/gmh.2016.10. .
30. Martin, G.H.G. (1983). Bushmeat in Nigeria as a Natural Resource with Environmental Implications Source: Environmental Conservation 10 (2):125-132
31. Mayer, F.Q.; Dos Reis, E.M.; Bezerra, A.V.A.; Cerva, C.; Rosa, J.; Cibulski, S.P.; Lima, F.E.S.; Pacheco, S.M.; Rodrigues, R.O. (2017). Pathogenic *Leptospira* spp. in bats: Molecular investigation in Southern Brazil. *Comparative Immunology, Microbiology and Infectious Diseases*, **52**, 14–18.
32. Mildenstein, T., Tanshi, I. and Racey, P.A. (2016). Exploitation of Bats for Bushmeat and Medicine. In book: Bats in the Anthropocene: Conservation of Bats in a Changing World (pp.325-375). DOI:10.1007/978-3-319-25220-9_12
33. Muñoz-Leal, S.; Faccini-Martínez, Á.A.; Pérez-Torres, J.; Chala-Quintero, S.M.; Herrera-Sepúlveda, M.T.; Cuervo, C.; Labruna, M.B. (2021). Novel *Borrelia genotypes* in bats from the Macaregua Cave, Colombia. *Zoonoses and Public Health*, **68**, 12–18.
34. Ochani, R.K.; Batra, S.; Shaikh, A.; Asad, A. (2019). Nipah virus—The rising epidemic: A review. *Le Infezioni in Medicina*, **27**, 117–127.
35. Ogundimu O.A. and Oduntan O.O. (2017). Factors Contributing to the Consumption of Bushmeat in Odeda Local Government Area, Ogun State, Nigeria. Journal of Agriculture, Forestry and the Social Sciences (JOAFSS); 15(1):33-45.
36. Omare KB, Anthony O and Moses TF (2015). A survey on the economic importance of Bush meat marketing in Nigeria. International Journal of Agricultural Extension and Rural Development. 2 (7):137-140.
37. Onuoha, O. O., Okereke, O. J., Ngwoke G. O., and Ekpechu, J. O. A. (2024). Influence of Cultural Factors on Health Seeking Behavior in Ebonyi State, South East, Nigeria: The Ishiagu-Ebonyi Exemplar. Nigerian Journal of Social Psychology, 7: 298-310.
38. Okoli SC and Ogugua AJ (2023). Investigation of furunculosis in cultured catfish. PAMJ - One Health.;11(15). 10.11604/pamj-oh.2023.11.15.41095
39. Pérez-Losada M, Arenas M, Galán JC, Palero F, González-Candelas F. (2015). Recombination in viruses: Mechanisms, methods of study, and evolutionary consequences. Infection, Genetics and Evolution 30:296–307
40. Peters E, Baker DP, Dieckmann NF, Leon J, and Collins J (2010). Explaining the Effect of Education on Health: A Field Study in Ghana. Psychological Science 21(10):1369–1376
41. Raghupathi, V. and Raghupathi, W. (2020). The influence of education on health: an empericl assessment of OECD countries for the period 1995-2015. Arch. Publ. Hlth., 78. https.//doi.org/10.1186/s13690-020-00402-5
42. Rosenthal SR, Ostfeld RS, McGarvey ST, Lurie MN, Smith KF (2015). Redefining disease emergence to improve prioritization and macro-ecological analyses, One Health 1:17–23.
43. Shuaibu, A. Umar and B. Z. and Abubakar (2011). Assesment of Youths' Attitude to Agriculture as a Career: A Case Study Of Tangaza Local Government Area of Sokoto State, Nigeria. H. Journal of Agriculture and Environment,7: 1-7
44. Silva-Ramos, C.R.; Chala-Quintero, S.M.; Faccini-Martínez, Á.A.; Hidalgo, M.; Pulido-Villamarín, A.D.P.; Pérez-Torres, J.; Cuervo, C. (2022). Pathogenic Leptospira Species in Bats: Molecular Detection in a Colombian Cave. *Tropical Medicine and Infectious Disease*, **7**, 84.
45. Starik N and Göttert T (2022) Bats adjust echolocation and social call design as a response to urban environments. *Front. Ecol. Evol.* **10**, 939408. https://doi.org/10.3389/fevo.2022.939408.
46. Streicker, D.G.; Winternitz, J.C.; Satterfield, D.A.; Condori-Condori, R.E.; Broos, A.; Tello, C.; Recuenco, S.; Velasco-Villa, A.; Altizer, S.; Valderrama, W. (2016). Host-pathogen evolutionary signatures reveal dynamics and future invasions of vampire bat rabies. Proceedings of the National Academy of Sciences, 113, 10926–10931.

47. Szentivanyi , T., McKee C., Jones, G. and Foster T. J. (2023). Trends in bacterial pathogems of bats: Global distribution and knowledge gaps. Transboundary and Emerging Diseases, Volume 2023 Issue 1. https://doi.org/10.1155/2023/9285855
48. The United Kingdom Office of the Deputy Prime Minister. 2004 "The Impact of Overcrowding on Health & Education: A Review of Evidence and Literature." Office of the Deputy Prime Minister Publications.
49. Turmelle, A. S., and Olival, K. J. (2009). Correlates of viral richness in bats (Order Chiroptera). *EcoHealth*, **6**, 522–539.
50. UNICEF (2008). Draft Country Programme document, Nigeria. E/ICEF/2008//P/L.7. UNICEF, Enugu.
51. Veikkolainen, V.; Vesterinen, E.J.; Lilley, T.M.; Pulliainen, A.T. (2014). Bats as reservoir hosts of human bacterial pathogen, *Bartonella mayotimonensis. Emerging Infectious Diseases*, **20**, 960–967.
52. Vo CQ, Samuelsen P, Sommerseth HL , Wisløf T, Wilsgaard T and Eggen AE. 2023. Comparing the sociodemographic characteristics of participants and non-participants in the population-based Tromsø Study. BMC Public Health. 23:994 https://doi.org/10.1186/s12889-023-15928-w
53. Wang L-F. and Anderson D.E. (2019). Viruses in bats and potential spillover to animals and humans. *Current Opinion in Virology*, 34:79-89. https://doi.org/10.1016/j.coviro.2018.12.007
54. Wilson, D. E., and Mittermeier, R. A. (Eds.). (2019). Handbook of the mammals of the world (Vol. 9). Lynx Edicions.
55. Yang J , Skaro M, Chen J, Zhan D, Lyu L, Gay S, Kandeil A, Ali M , Ghazi Kayali G, Stoianova K, Ji P , Alabady M, Bahl J, Liu L, Arnold J (2023). The species coalescent indicates possible bat and pangolin origins of the COVID-19 pandemic. *Sci Rep* **13**, 5571. https://doi.org/10.1038/s41598 -023-32622-4
56. Zhou, P.; Yang, X.L.; Wang, X.G.; Hu, B.; Zhang, L.; Zhang, W.; Si, H.R.; Zhu, Y.; Li, B.; Huang, C.L.; *et al*. (2020). A pneumonia outbreak associated with a new coronavirus of probable bat origin. *Nature*, **579**, 270–273.
57. Zimmerman E., and Woolf, S,H. (2014). Understanding the relationship between education and health. Natl. Acad. Med. Perspectives 4. Discussion Paper, Institute of Medicine, Washington DC. https://doi.org/10.31478/201406a

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume XI Issue VI June 2026

Tables:

Table 1 Socio-demographic Characteristics of the Respondents interviewed on zoonotic diseases of bat origin in Ebonyi State, Southeast, Nigeria (SEN)

Variables	Characteristics	Frequency	Percentage (%)
Occupation	Farmer	48	37.50
	Teacher	20	15.63
	Others	60	46.88
Age	18 - 29	20	15.63
	30 - 39	48	37.50
	40 - 49	36	28.13
	50 - 59	20	15.63
	60 and above	4	3.13
Sex	Male	96	75.00
	Female	32	25.00
Highest level of education	No formal education	8	6.25
	Primary	24	18.75
	Secondary	68	53.13
	Tertiary	28	21.88
Length of time of occupation of the building	<1 year	8	6.25
	1-3 years	48	37.50
	> 3 years	72	56.25
Time spend in the house daily	1-5hrs	16	12.50
	>5 -10 hrs	80	62.50
	> 10 hrs	32	25.00
Number of persons ;living in the house	1 person	64	50.00
	2 persons	60	46.88
	≥3 persons	4	3.12
Average number of persons per room	1 person	4	3.13
	2 persons	51	39.84
	3 persons	61	47.66
	4 persons	8	6.25
	5 persons	4	3.13

Table 2: Participants' knowledge on zoonotic diseases of bat origin in Ebonyi State, Southeast, Nigeria

Questions	Response	Frequency	Percentage
Can animals transmit disease to humans?	Yes No I don't know	116 0 12	90.63 0.00 9.36
Names of a nimals that can transmit disease to humans	Dog bat Other animals	56 8 64	43.8 6.2 50

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume XI Issue VI June 2026

Animal diseases can be transmitted to humans through which means?	Consumption of contaminated animal products. Inhalation I don't know Others (Specify)	80 20 16 12	62.50 15.63 12.50 9.38
Do bats harbour diseases?	Yes No I don't know	96 4 28	75.00 3.13 21.88
Bats can transmit disease to humans	Yes No I don't know	92 4 32	71.88 3.13 25.00
Names of diseases transmitted to humans by bat	Corona virus Ebola Rabies	92 48 8	100.0 52.17 8.70
Having contact with bat faeces can lead to disease transmission	Yes No I don't know	48 36 44	37.50 28.13 34.38
Possessing pets/livestock in same house inhabited by bats can lead to disease transmission to the pets/livestock	Yes No I don't know	76 4 48	59.38 3.13 37.50
Viral diseases transmitted to man from bats are curable	Yes No I don't know	76 4 48	59.38 3.13 37.50
What type of treatment do you think is best for them?	Modern medicine Traditional medicine Prayer Others (Specify)	52 20 56 0	40.63 15.63 43.75 0.00

Table 3: Participants'demographic characteristics and level of knowledge of zoonotic diseases of bat origin in Ebonyi State, Southeast, Nigeria

Characteristics	Knowledge level		p-value
	Good	Poor	
Occupation			
Farmer	24 (50.0)	24(50.0)	0.000
Teacher	20 (100.0)	0 (0.00)	
Others	44 (73.3)	16 (26.7)	
Age			
18 – 29	12 (60.0)	8 (40.0)	0.502
30 – 39	32 (66.7)	16 (33.3)	
40 – 49	24 (66.7)	12 (33.3)	
50 - 59	16 (80.0)	4 (20.0)	
60 and above	4 (100.0)	0 (0.0)	

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume XI Issue VI June 2026

Sex			
Male	64 (66.7)	32 (33.3)	0.509
Female	24 (75.0)	8 (25.0)	
Highest level of education			
No formal	8 (100.0)	0 (0.0)	0.006
Primary	12 (50.0)	12 (50.0)	
Secondary	44 (64.7)	24 (35.3)	
Tertiary	24 (85.7)	4 (14.3)	

Table 4: Practices respondents relating to zoonotic diseases from bats in Ebonyi State, Southeast, Nigeria

Questions	Response	Frequency	Percent
Do you have contact with the bats in the roof?	Yes. No I don't know	40 88 0	31.25 68.75
Do you come in contact with the bats' faeces?	Yes No	28 100	21.88 78.13
Have you ever handled a bats?	Yes No	28 100	21.88 78.13
Does the roof leak during the rain	Yes No I don't know	28 92 8	21.88 71.88 6.25
Do you have pets/livestock living in same house with you?	Yes No	84 44	65.63 34.38
Do you eat games from the wild?	Yes No I don't know	92 32 4	71.88 25.00 3.13
I always protect my wounds while handling or processing bats/game	Yes No	120 8	93.75 6.25
I do not eat while handling or processing animals	Yes No	124 4	96.88 3.13
Have you ever eaten a bat of any type?	Yes No	20 108	15.63 84.38

Table 5: Demographic characteristics of participants and their practices regarding zoonotic disease transmission from bats in Ebonyi State, Southeast, Nigeria

Characteristics	Practice category		p-value
	Good	Bad	
Occupation			
Farmer	36 (75.0)	12 (25.0)	0.004
Teacher	20 (100.0)	0 (0.00)	
Others	56 (93.3)	4 (6.7)	
Age			

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume XI Issue VI June 2026

18 – 29	16 (80.0)	4 (20.0)	0.249
30 – 39	40 (83.3)	8 (16.7)	
40 – 49	32 (88.9)	4 (11.1)	
50 - 59	20 (100.0)	0 (0.0)	
60 and above	4 (100.0)	0 (0.0)	
Sex			
Male	84 (87.5)	12 (12.5)	0.606
Female	28 (87.5)	4 (12.5)	
Highest level of education			
No formal	8 (100.0)	0 (0.0)	0.092
Primary	24 (100.0)	0 (0.0)	
Secondary	56 (82.4)	12 (17.6)	
Tertiary	24 (85.7)	4 (14.3)	