Human – monkey interaction on a University campus in Nigeria: An avenue for zoonotic disease transmission at the human wildlife interface?

B Ogunro[1]*, B Olugasa[2], F Olaleru[3] & F Oladiti[4]

[1.] *Veterinary Teaching Hospital, University of Ibadan, Ibadan, Nigeria*
[2.] *Department of Veterinary Public Health and Preventive Medicine, Faculty of Veterinary medicine, University of Ibadan, Ibadan, Nigeria*
[3.] *Department of Zoology, Faculty of Science, University of Lagos, Lagos, Nigeria*
[4.] *Department of Animal science, Faculty of Agriculture and Forestry, University of Ibadan, Ibadan, Nigeria*

*Correspondence: Tel.: +2348036051866; E-mail: ogunrob@gmail.com

Abstract

Monkeys are potential sources of infectious diseases to humans. Mona monkeys frequently gain access to human dwellings within the University of Lagos campus. This study was conducted to assess the level of human-monkey interaction with a view to determining if such interaction will create an avenue for zoonotic disease transmission from monkeys to humans resident in this human-wildlife interface. Information on frequency and closeness of human – monkey interaction was gathered from 395 respondents using a semi-structured questionnaire and in-depth interviews. These were used to determine respondents' attitude towards the monkeys as well as their knowledge on monkey related zoonoses. Responses from the questionnaire were entered into and analysed using EPI INFO[TM] version 7.2.0.1 statistical software. Categorical data were summarised as tables and bar chart. Chi Square, Fisher exact tests and binary logistic regression were used to test for significance and deduce relationships among variables. Statistical significance was determined at 95% Confidence interval. Most of the respondents (63.5%) were undergraduates; while 70.1% of all respondents were residents on campus. Only 19.8% and 6.6% of the respondents had close and risky contacts respectively, while 11.1% and 8.3% had negligible and minimal contacts respectively. Majority of the respondents (69.1%) had inadequate knowledge about monkey related zoonoses Only 39% were aware that monkeys could transmit disease to humans and 2% believed that monkeys could not transmit diseases to humans. Campus residents have significantly closer contacts with monkeys than visitors (p<0.05, OR=0.32). Residents were three times more likely to have had any form of contact with monkeys than non-residents. There was no significant difference between the frequency of risky human-monkey contacts among visitors and residents. The low level of awareness about zoonotic disease among the respondents could be ameliorated through public health awareness campaigns by health workers and conservationists.

Keywords: Conservation, Human–wildlife interface, Mona monkeys, Public health, Zoonosis

Introduction

Infectious diseases are the most important threats to human life, especially in the tropics (Brachman, 2003; Mabey *et al.,* 2004). These groups of diseases have been emerging and reemerging in recent times (Woolhouse & Gowtage-Sequeria*,* 2005; Jones *et al*., 2008; Thomas *et al*., 2016). A large proportion of infectious diseases, some of which have reached frightening epidemic proportions in recent times,

and may be zoonotic, capable of infecting man from other vertebrate hosts and vice-versa (Coker *et al.,* 2000; Daszak *et al.,* 2000; Venkatesan *et al.*, 2010; Saegerman *et al*., 2012). The 2014/2015 Ebola epidemic is a sad reminder of one of such incidences; a zoonotic disease outbreak which claimed over 11,000 human lives and left undesirable sequelae in its trail (CDC, 2014; Mohammed *et al*., 2017).

Wildlife has an important role to play in zoonotic disease emergence, reemergence and sustenance (Moudgil & Singla, 2013). A report revealed that 71.8% of emerging zoonoses originate from wildlife (Jones *et al*., 2008). Of the wildlife species, non-human primates share the closest phylogenetic relationship with humans and they have therefore become a center for zoonotic disease focus globally (Wolfe *et al*., 1998; Singh *et al*., 2009; Calvignac-Spencer *et al*., 2012). Since these genetically close species share several dozens of infectious agents with capacity to readily cross the species barriers (Conly & Johnston, 2008), the human-primate interface is an area of critical importance not only to human health but also to primate conservation (Jones-Engel *et al.,* 2011; Friant *et al.,* 2015).

Habitat loss, exotic pet keeping and religious/cultural practices have increased the frequency and intimacy of non-human primate-human contact globally (Fuentes, 2007; Conly & Johnston, 2008; Karesh, 2009). With urbanization and tourism at the center, this poses a huge potential for interspecies pathogen transmission; many incidences of which have been documented (Conly & Johnston, 2008; Moudgil *et al*., 2014).

In Nigeria, the scenario is not totally different. The frequent hunting/poaching, trade in bush meat and exotic pet ownership puts Nigeria in similar, though less precarious situations, when compared with countries in south and south east Asia and in the south Pacific Islands where monkey temples abound with more frequent and closer interactions between non-human primates and humans (Conly & Johnston, 2008; Nyanganji *et al*., 2011; Friant *et al.,* 2015). The monkeys, whose population was recently estimated at 68 animals, have been in existence on the site before the establishment of the institution (Onadeko *et al.,* 2014). There have also been several incidences of the monkeys entering students' hostels as well as lecture rooms, sometimes causing panic among students (Olaleru, 2015). However, there is a dearth of infotmation on the health risk posed by the close proximity of monkeys to humans in Nigeria. This study aimed to examine human-monkey interaction in the University of Lagos, one of the oldest university campuses in Nigeria, located in a very populous city.

Materials and Methods
Study location
This study was conducted on the University of Lagos, Akoka campus, southwest Nigeria. The University which was established in 1962 is one of Nigeria's foremost universities. The student and staff population are currently 45,000 and 4,000 individuals respectively, making her one of the most populous universities in the country (Ihenetu, 2015). The university with geographical coordinates, 6.5193°N, 3.3963°E, is located in Lagos, one of the most populous cities in Nigeria. Originally a mangrove swamp/tropical rainforest habitat, mona monkey (*Cercopithecus mona*) is the only non-human primate on the University of Lagos campus (Onadeko *et al.,* 2014).

Questionnaire administration and data collection
This study employed a descriptive cross sectional design involving both visitors and residents on the University of Lagos campus. A self-administered, semi-structured questionnaire was used for data collection. The one-page questionnaire, which contained 22 questions, was designed to obtain data on socio-demographic characteristics, opinions on monkey-human cohabitation and interaction, frequency and degree of contact with monkeys. Socio-demographics have been shown to impact on human-monkey interactions (Conly & Johnson, 2008). A random incidental sample of 405 respondents was selected during 1st to 16th December, 2016. Visitors could not be differentiated from residents prior to sampling. The number of respondents chosen was guided by the protocol for minimum sample size determination for infinite population using expected prevalence of 50%, an absolute precision of 0.05 at 95% confidence interval (CI) (Thrusfield, 2007).

Eight key informant interviews were also carried out from among the residents. The informants include two female students, two male students, two security guards and two zoologists. The interviews were recorded on paper because our informants felt more comfortable with it. The interviews were meant to find out details on the interaction between monkeys and residents. Questions asked included:

1. On what part of the campus can one find monkeys?
2. Why do you think there are a lot of monkeys in those locations?
3. Is their population reducing or increasing in recent times?
4. What do you think is responsible for the change in population of the monkeys?
5. Have you observed any incidence of poaching on the monkeys?
6. Describe the daily and seasonal pattern of movement of the monkeys.

Responses to these questions gave clues to guide our observations and also provided useful information for example, confidential security reports on monkey poaching on campus.

Visual observation of interaction between monkeys and people was carried out in two locations (behind Arts Block and along the fence of the UBA Park) on campus where our key informants said the monkeys were abundant. Daily movements of the monkeys were observed at dawn and dusk because the monkeys had been observed to encroach into human dwellings at dusk and retreat to the nearby bushes at dawn (Onadeko *et al*., 2014).

Ethical consideration
Informed consent was sought and obtained before administration of questionnaires to respondents. The introductory paragraph of the questionnaire contained statements on "Confidentiality and consent". In addition, respondents were requested to append their signatures on a provided space on the questionnaire as a sign of willingness to participate in the study. Ethical permission for this study was granted by the University of Lagos College of Medicine Health Research Ethics Committee (REF: CM/HREC/PHM/09/16/048).

Data analysis
Ninety one percent (n = 445) of potential respondents approached consented to participate in the study. Of this, 97.5% (395/405) signed the consent statement. Only the 395 of the responses were considered valid and used for the final analysis. The unsigned responses were not analysed.

Questionnaire responses were entered into and analysed using EPI INFO^{TM} version 7.2.0.1(CDC, USA). To ensure quality control, field validation and skip logic tools were employed during the questionnaire design and data entry. Descriptive statistics such as tables and bar chart were used to display categorical data. Chi Square and Fisher exact tests were used to compare categorical data. Binary Logistic regression was employed to test for association between dichotomous variables. Statistical significance was determined at 95% CI.

To assess the degree of contact between people and monkeys, the scale summarized in Table 1 was designed and used.

The following definitions of "Adequate knowledge" and "Inadequate knowledge" were used:
Adequate knowledge: Referred to "Yes" response to 'Can a person contact disease from monkeys?', and selection of one monkey associated zoonoses.
Inadequate knowledge: Referred to "No" or "I don't know" response to 'Can humans contact diseases from monkeys?', or inability to select at least one monkey associated zoonoses.

Table 1: Human-monkey contact score sheet for respondents on University of Lagos

Category	Description	Numerical score
No contact	No physical contact with monkeys and no encroachment of monkeys into residence	0
Negligible contact	No physical contact with monkeys and monthly, seasonal or rare encroachment of monkeys into residence	1
Minimal contact	No physical contact with monkeys but daily or weekly encroachment of monkeys into residence	2
Close contact	Touched live monkey with bare hands	3
Risky contact	Bitten, scratched by monkey or touched dead monkey with bare hands	4

Results

Table 2 shows the socio-demography of respondents. The age range of respondents was 15 to 72 years (average = 24 years) and almost two-third (64.6%) belonged to the 15-24 years age group. There were more male respondents (58.7%) than females. Christians were 83.0% of the respondents while 15.2% were Muslims with only (1.8%) of respondents belonging to other religions (including two Buddhists). Most (63.5%) people interviewed were undergraduate students. Almost three-quarter (70.1%) of all respondents were residents on campus.

Table 3 shows the human-monkey contacts. More than half (54.2%) of the respondents did not have any contact with monkeys while 11.1% and 8.3% had negligible and minimal contact respectively. About one-fifth (19.8%) and one-fifteenth (6.6%) of the respondents had close and risky contact respectively.

The opinion of respondents on human-monkey interactions is outlined in Table 4. On cohabitation of monkeys and humans 47.8% are in support. while 27.1% support the eating of monkey meat. More than half (51.5%) of the respondents were of the opinion that monkeys should not be allowed to encroach human dwellings whereas 38.7% of the respondents opined that humans should be allowed to encroach on monkey habitats. Almost half (46.1%) of the respondents said monkeys on

Table 2: Socio-demography of respondents at University of Lagos

Variable	Frequency	Percentage
Age group (Years)		
15-24	255	64.6
25-34	100	25.3
35-44	28	7.1
45-54	6	1.5
>54	6	1.5
Total	395	100
Gender		
Female	163	41.3
Male	232	58.7
Total	395	100
Religion		
Christian	328	83.0
Muslim	60	15.2
Others	7	1.8
Total	395	100
Level of Education attained		
Primary	1	0.2
Secondary	24	6.1
OND/NCE/Undergraduate	251	63.5
Graduate	69	17.5
Postgraduate	50	12.7
Total	395	100
Status on campus		
Resident	277	70.1
Visitor	118	29.9
Total	395	100

Table 3: Human-monkey contact categories among respondents

Row label	Variable	Residents only		Visitors only		Residents and Visitors	
		Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
A	Any form of contact	149	53.8	32	27.1	181	45.2
B	No contact	128	46.2	86	72.9	214	54.2
C	Negligible contact	40	14.4	4	3.4	44	11.1
D	Minimal contact	32	11.6	1	0.8	33	8.3
E	Close contact	59	21.3	19	16.1	78	19.8
F	Risky contact	18	6.5	8	6.8	26	6.6
	Total*	277	100	118	100	395	100

*Sum of cells A to F

Table 4: Opinion of respondents on human-monkey interactions

Variable	Response frequency (percentage)			
	Yes	No	No response	Total
Keeping of monkey as pet at home should be allowed	189 (47.8%)	199 (50.4)%	7 (1.8)%	395 (100%)
Eating of monkey meat should be banned	274 (69.4%)	107 (27.1%)	14 (3.5%)	395 (100%)
Monkeys should be allowed to encroach human dwellings	179 (45.3%)	202 (51.1%)	14 (3.5%)	395 (100%)
Humans should be allowed to encroach monkey habitats	153 (38.7%)	230 (58.2%)	12 (3.0%)	395 (100%)
Monkeys on campus constitute a nuisance	182 (46.1%)	193 (48.8%)	20 (5.1%)	395 (100%)

Table 5: Binary logistic regression correlates of degree of human-monkey contact among respondents

Variable	Odd ratio	95% CI	p-value
Gender			
Male	1.12	0.75-1.66	0.581
Female	1		
Status on campus			
Visitor	0.32	0.2-0.51	0.000[*]
Resident	1		
Religion			
Muslim	0.49	0.27-0.88	0.018[*]
Others	0.80	0.18-3.62	0.581
Christian	1		
Level of education			
Graduate/Postgraduate	1.24	0.807-1.910	0.325
Below graduate	1		
Knowledge of monkey related zoonoses			
Inadequate knowledge	0.86	0.56-1.32	0.500
Adequate knowledge	1		

*Significant at p<0.05

campus were a nuisance. Majority (69.1%) of the respondents had inadequate knowledge about monkey related zoonoses. Only 39.0% showed awareness that monkeys transmit disease to humans while 2% were of the opinion that monkeys do not transmit disease to humans. Only 29.9% of the respondents selected a zoonotic disease transmissible by monkeys with 86.4% selecting only ebola as a monkey related zoonosis. Only 0.76% of the respondents identified all three monkey related zoonoses.

Table 5 shows that campus residents have significantly closer contacts with monkeys than visitors (p<0.05, OR=0.32).

Chi Square test on data from Table 3 revealed that residents were three times more likely to have had any form of contact with monkeys than non-residents (OR 3.1, CI 2.0-5.0). Figure 1 shows the proportion of residents and visitors who have experienced different categories of contact with monkeys. However, there was no significant difference between the frequency of risky human-monkey contacts among visitors and residents.

From the interviews, it was gathered that the population and frequency of encroachment of the monkeys into the residential and academic areas of the university have been on the decline. This situation was attributed to the recent erecting of
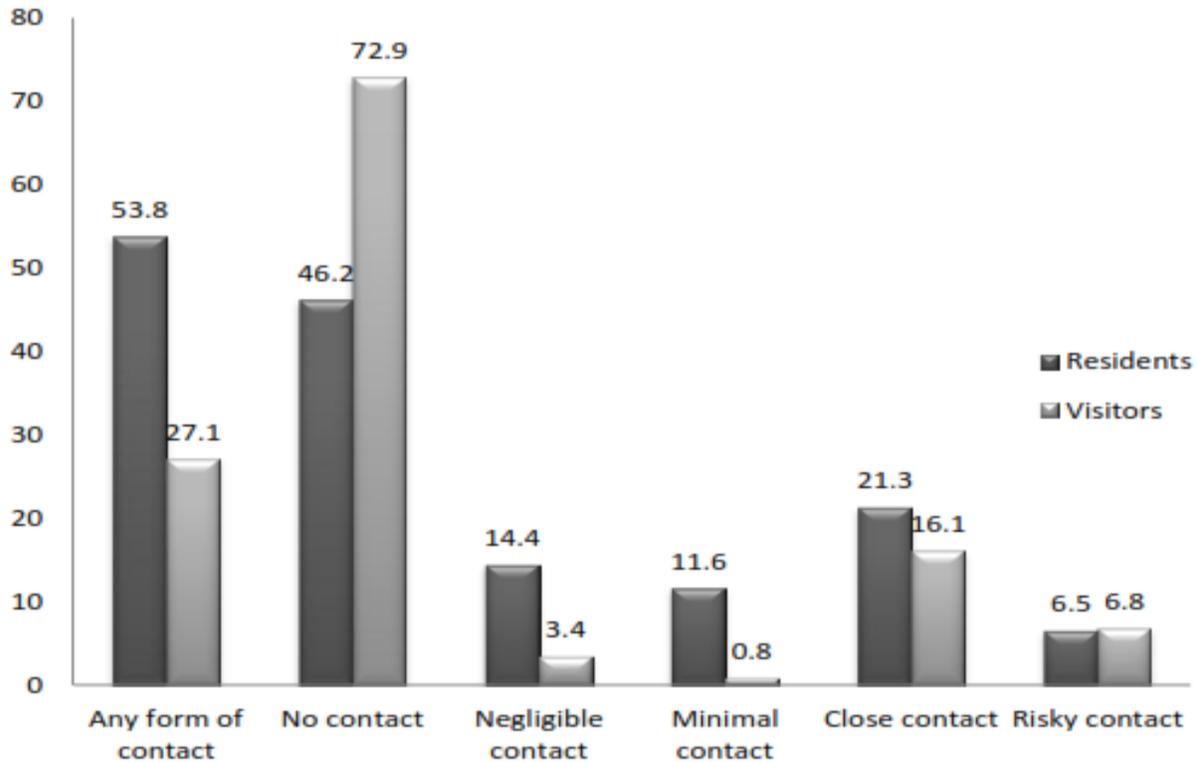
Figure 1: Percentage of residents and visitors to the University of Lagos campus who have experienced different categories of contact with monkeys

more building along the fringes of the campus, which used to serve as the hideout for the monkeys, and partly due to poaching.

Discussion

The large proportion of respondents who have come in close and especially risky contact with monkeys is a cause for concern, as supported by biological plausibility reasoning, zoonotic disease transmission may be facilitated by proximity, degree of physical contact between animals and humans (Conly and Johnson, 2008). A recent study conducted in south eastern Nigeria showed a higher proportion (87%) of respondents having close contact with non-human primates (Friant *et al.,* 2015). It is likely that monkey-human interface in rural and hunting communities facilitates higher rate of monkey-human contacts than in urban settings. This is also corroborated by another study in north eastern Nigeria (Nyanganji *et al*., 2011). Our finding however suggests that frequent and close contact does not necessarily imply risky contact since many respondents reported having frequent encounter with monkeys without being scratched or bitten. The species of monkey concerned and the reaction of humans to the presence of the monkeys are likely factors which would determine whether a benign contact can lead to scratches or bites (Fuentes, 2007). As expected, residents were multiple folds as likely to have close contact with monkeys as visitors. However, the finding of insignificant difference in the frequency of risky monkey-human contact between the two categories may imply that residents on campus are not at significantly greater risk of contracting monkey related zoonoses than the general public. This is also corroborated by the fact that no resident fell ill shortly after contact with moneys on campus.

The support for monkey meat eating as well as monkey poaching on campus is not good news for conservationists, since bushmeat hunting is a threat to wildlife conservation and increases risk of zoonotic infections in humans (Friant *et al.,* 2015). In fact, monkeys are more vulnerable than other wildlife because, apart from serving as source of meat they are most frequently used as medicine by locals (Nyanganji *et al*., 2011; Friant *et al.,* 2015).

It was observed that respondents regarded monkeys as a nuisance and they did not agree to keeping of monkeys as pets. This was similar to the findings of Olaleru (2016) where 76.2% of respondents in the same location of study showed that the monkeys

were a nuisance. Matsuda (2007) gave a similar report from Lama forest.

Public awareness campaigns are required to improve knowledge about zoonoses among both resident and visitors. The positive effect of the 2014/2015 nationwide ebola awareness campaign can be appreciated if we consider that most of the respondents recognized only ebola as a monkey related zoonoses. When compared with the findings of Friant *et al.* (2015), our respondents had better awareness about the zoonotic risk posed to humans by close contacts with monkeys. More than half of the respondents were unaware that monkeys could transmit disease to humans. This difference may be attributed to higher literacy rates of our subjects. We could not explain why Muslims have significantly closer contact with monkeys than adherents of other religions. Though Buddhists are noted for their reverence of monkeys (Conly & Johnston, 2008) they represented a mere 0.5% of our respondents.

In conclusion, there have been various degrees of interactions between monkeys and humans on University of Lagos campus, Akoka. However, they seem to be insufficient to consider the campus a hot spot for monkey related zoonotic disease transmission despite the location being a human – wildlife interface. However, more needs to be done to increase zoonotic disease awareness on campus as the knowledge of inhabitants are largely inadequate. In the spirit of pro-activeness, there is also the need to screen the monkeys for zoonotic pathogens in order to determine if the degree of contact in this setting can be considered risky. It is not clear if the monkeys are suffering from zoonotic diseases. The health status of the monkeys needs to be studied.

Acknowledgement

References

Brachman PS (2003). Infectious diseases—past, present, and future. *International Journal of Epidemiology,* 32 (5): 684-686.

Calvignac-Spencer S, Leendertz SAJ, Gillespie TR & Leendertz FH (2012). Wild great apes as sentinels and sources of infectious disease. *Clinical Microbiology and Infection*, **18**(6): 521–527.

CDC (Centers for Disease Control) (2014). Ebola Outbreak in West Africa-Case Counts. www.cdc.gov/vhf/ebola/outbreaks/2014-west-africa/case-counts.html, retrieved 01-01- 2017.

Coker AO, Isokpehi RD, Thomas BN, Fagbenro-Beyioku AF & Omilabu SA (2000). Zoonotic infections in Nigeria: Overview from a medical perspective. *Acta Tropica.* **76**(1): 59-63.

Conly JM & Johnston BL (2008). The infectious diseases consequences of monkey business. *Canadian Journal of Infectious Diseases and Medical Microbiology*, **19**(1): 12-14.

Daszak P, Cunningham AA & Hyatt AD (2000). Wildlife ecology: Emerging infectious diseases of wildlife: threats to biodiversity and human health. *Science*, doi:10.1126/ science.287.5452.443.

Friant S, Paige SB & Goldberg TL (2015). Drivers of bushmeat hunting and perceptions of zoonoses in Nigerian hunting communities. *PloS Neglected Tropical Diseases*, **9**(5):e0003792,

Fuentes A (2007). Monkey and Human Interconnections: The Wild, the Captive, and the In-between. *In*: Where the Wild Things are now: Domestication Reconsidered (R Cassidy, M Mullin, editors) Berg publishers, New York. Pp 123-45.

Ihenetu D (2015). Unilag: All you need to know about the University of Lagos. https://nigerianscholars.com/2015/07/all-you-need-to-know-about-the-university-of-lagos-unilag.htm, retrieved 20-01-2017.

Jones KE, Patel NG, Levy MA, Storeygard A, Balk D, Gittleman JL & Daszak P (2008). Global trends in emerging infectious diseases. *Nature*, **451**(7181), 990-993.

Jones-Engel L, Engel GA & Fuentes A (2011). An Ethnoprimatological Approach to Interactions between Human and Non-human primates. *In*: Field and Laboratory Methods in Primatology: A PRACTICAL guide (M Joanna, JM Setchell, DJ Curtis), Cambridge University Press. UK. Pp 21-30.

Karesh WB (2009). The bushmeat trade: Increased opportunities for transmission of zoonotic disease. *Mount Sinai Journal of Medicine*, **76**(5): 429-434.

Mabey D, Peeling RW, Ustianowski A & Perkins MD (2004). Tropical infectious diseases: Diagnostics for the developing world. *Nature Reviews Microbiology* **2**(3): 231-240.

Matsuda RG (2007). Behaviour and Ecology of the Mona Monkey in the Seasonally Dry Lama Forest, Republic of Benin. PhD dissertation submitted to the Department of Anthropology, Brooklyn College, Graduate School of The University of New York. Pp 1-351.

Mohammed H, Vandy AO, Stretch R, Otieno D, Prajapati M, Calderon M & Vandi M (2017). Sequelae and other conditions in ebola virus disease survivours, Sierra Leone, 2015. *Emerging Infectious Diseases* **23**(1):66-73.

Moudgil AD & Singla LD (2013) Role of neglected wildlife disease ecology in emergence and resurgence of parasitic diseases. *Trends in Parasitology Research,* **2**(2): 18-23.

Moudgil AD, Singla LD & Singh MP (2014) *In vitro* study targeting developmental embryonation pattern of eggs of ascarid species of wild animals. *Applied Biological Research* **16**(2): 237-241.

Nyanganji G, Fowler A, McNamara A & Sommer V (2011). Monkeys and Apes as Animals and Humans: Ethno-Primatology in Nigeria's Taraba Region *In*: Primates of Gashaka, Developments in Primatology: Progress and Prospects, Springer Science+Business Media, LLC, New York, USA. Pp 1-35.

Olaleru F (2015). Adaptation to foods by Mona monkeys (*Cercopithecus mona*) in a fragmented urban habitat in Lagos, Nigeria. *In*: Proceedings for the tenth University of Lagos Annual Research and Conference Fair held at the Multipurpose Halls, University of Lagos, Nigeria (BO Silva, SA Okunuga, LA Adams, editors). Pp 215-222.

Olaleru F (2016). Nutritional Ecology and the Conservation of Mona monkey (*Cercopithecus mona*, *Schreber*, 1774) in selected urban, semi-urban and wild habitats of southwestern Nigeria. PhD thesis submitted to the Department of Zoology, Faculty of Science, University of Lagos, Nigeria. Pp 1-336.

Onadeko AB, Olaleru F & Bada O (2014). The distribution of Mona monkeys (*Cercopithecus mona*, Screber, 1774) in the University of Lagos campus, Akoka, Lagos. *Ethiopian Journal of Biological Sciences*, **13**(1): 49-56.

Saegerman C, Dal Pozzo F & Humblet M-F (2012). Reducing hazards for humans from animals: Emerging and re-emerging zoonoses. *Italian Journal of Public Health*, **9**(2):25-28.

Singh P, Singla LD**,** Gupta MP, Sharma S & Sharma DR (2009). Epidemiology and chemotherapy of parasitic infections in wild omnivores in the Mahendra Choudhury Zoological Park, Chhat Bir, Punjab. *Journal of Threatened Taxa,***1** (1): 62-64.

Thomas DL, Santiago GA, Abeyeta R, Hinojosa S, Torres-Velasquez B, Adam JK, Evert N, Caraballo E, Hunsperger E, Muñoz-Jordán JL & Smith B (2016). Reemergence of Dengue in Southern Texas, 2013. *Emerging Infectious Diseases*, **22**(6): 1002-1007.

Thrusfield M (2007). *Veterinary Epidemiology*. Third Ed. Blackwell Science Limited, UK. Pp 1-233.

Venkatesan G, Balamurugan V, Gandhale PN, Singh RK & Bhanuprakash V (2010). Viral zoonosis: A comprehensive review. *Asian Journal of Animal and Veterinary Advances,* **5**(2): 77-92.

Wolfe ND, Escalante AA, Karesh WB, Kilbourn A, Spielman A & Lal AA (1998). Wild primate populations in emerging infectious disease research: the missing link? *Emerging Infectious Diseases*, **4**(2): 149-58.

Woolhouse MEJ & Gowtage-Sequeria S (2005). Host range and emerging and reemerging pathogens. *Emerging Infectious Diseases*. **11**(12): 1842-1847.