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# AN ASSESSMENT OF THE IMPACT OF RODENT INFESTATIONS ON PUBLIC HEALTH IN ABUJA MUNICIPAL AREA COUNCIL (A.M.A.C) NIGERIA

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***ABSTRACT***

***This study assessed the level of rat infestation associated with housing and waste disposal seen in Abuja based on respondent's information and bacteriological analysis from the oral and anal region of rodents within the AMAC area council. Two hundred and ten (210) well-structured questionnaires were strategically administered to the five communities within Abuja Municipal Area Council (AMAC), Abuja but 200 respondents returned their questionnaire. Fifty (50) rats were captured alive using adhesive glue boards and 100 samples were collected from oral and anal swabs. The survey revealed that a large percentage of the respondents are males (77.5%) between the age of 35-44 (33%) and civil servants (42%). Residents from Nyanya, Airport Road and Around Asokoro reported 85%, 70% and 45% respectively of rat infestation. waste disposal methods normally used are the Abuja Environmental Protection Board (AEPB) waste disposal (54%) and open dumping method (35.5%). Chi-square test revealed a significant relationship between rodent infestation and disease transmission. All organism isolated were gram negative bacteria and had the following isolation rates Enterobacter cloacae (35%), Escheriacia coli at (19%), Salmonella spp (4%), Pseudomonas aeruginosa (10%) and Providencia stuartii (12 %), Enterobacter hormaechi (11%) and Proteus mirabilis (9%) respectively. All isolated organism was 100% resistant to Oxytetracycline while P. aeruginosa shows a 90% resistance to anicilin respectively. Conclusively, our investigation has revealed a relationship between rat infestation and diseases presence.***

**Keywords**: Domestic Rat, Homes, Infestation, waste, public health

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## INTRODUCTION

Rodent infestations provide both a health danger and a financial burden, particularly for low-income households (Bamigboye 2006). Aside from the danger of destroying property and causing nuisance, the possibility of transferring zoonotic diseases is genuine (Bonner *et al.*, 2007). Rodents are vertebrates that gnaw on objects with teeth designed specifically for the task (Nowak, 1999). The three commensal rodent species regarded to be more problematic pests in both urban and rural areas are the brown rat (*Rattus norvegicus*), the roof rat (*Rattus rattus*), and the house mouse (*Mus musculus*). There are few things more upsetting than discovering one or more rodents inside one's wardrobe, food safe, or a bookcase. Mice and rats, which are most usually found around human habitations, are

widely feared and despised. They have been known to cause extensive damage to home items and assets, including books, food, clothing, and fabrics. Although most people are not concerned about the presence of rats in their houses, their ability to create major health problems leaves much to be desired (Orji *et al.,* 2020). While most people are aware of the presence of rodents in their houses, they appear powerless since most people rarely make an effort to get rid of them. Langton *et al.* (2001) discovered that between 42% and 50% of people in metropolitan and high population density areas appear to have accepted to live permanently with rats as they seem not have bothered much about controlling them. It has been established that rodents are most likely to occur where there is poor structural maintenance, poor hygiene, improper storage and disposal of wastes, and ample harbourage due to unsanitary stacking of food items as well as congestion of rooms with different kinds of disused articles (Murphy and Oldbury, 2002). Rodents are nearly ubiquitous and can harbor major zoonotic illnesses such leptospirosis, leishmaniasis, relapsing fever, tularemia, bubonic plague, Q fever, salmonellosis, and hantavirus (Bradman *et al*., 2005). Though this are lesser-known diseases compared to the commonly known Lassa fever disease, which is still a cause for public health concern. Rodents also cause asthma, a health issue that affects children in low-income urban settings, through allergens present in mouse urine and hair (Perzanowski *et al*., 2008). These diseases can be transferred to people through the animal's touch or bite, direct contact with their feces, urine, and saliva, the bite of their vectors (ticks, mosquitoes, fleas), or the consumption of food or drink contaminated with their feces or urine. Most of these disorders do not pose a major hazard if diagnosed and treated early (Mbanong *et al*. 2002). In addition to transmitting diseases, rat bites are painful and cause physiological trauma to their victims, thus the importance of having enough knowledge about these diseases. The growing public health concern about rodent-borne zoonoses, combined with the deterioration of waste disposal systems in many Nigerian urban areas, justifies a thorough investigation of rodent infestation to determine distribution, identify risk factors, and investigate their role in disease epidemiology (Onyido *et al,* 2009).

Unlike most spoilage of foodstuffs and crops, much of the rodent damage to urban infrastructure that causes economic loss is hidden from the public and may not always be attributed to rodent activity. Because of this, it is difficult to quantify the costs of rodent infestations. Thus, while a cost–benefit analysis can be applied to determine the best response to a problem, in this instance it lacks important data. Also, making an investment can be difficult when present costs are compared with future benefits (Sandmo, 2000). The direct and indirect costs of structural damage caused by rats can be substantial (DEFRA, 2006). Rats are known to cause damage to buildings and installations, with a significant risk of fire and electrocution as the result of damage to cables (Colvin in Martindale, 2001). Burrowing rats can cause landslides on embankments; they can also cause the collapse of banks of canals and ditches, leading to flooding (Meehan, 1984). A poor-quality urban environment, such as one with substantial rat infestations, also means additional stress for its inhabitants. This could contribute to social unrest. Thus, the cost to society should include the social cost (including health and well-being) of rat infestations. Hence, the present study attempts to carry out a survey and microbiological analysis of rodent infestation and to assess the level of awareness of the residence in Abuja, Nigeria.

## MATERIALS AND METHODS

### Study Area

A cross-sectional respondent-based study was conducted in selected residential areas in Abuja, Nigeria between May and June 2018. The study was carried out within Abuja Municipal Area Council, which is the largest area council within the Federal Capital Territory, the areas include: Airport Road, Garki, Wuse, Nyanya, and Asokoro (Fig1)

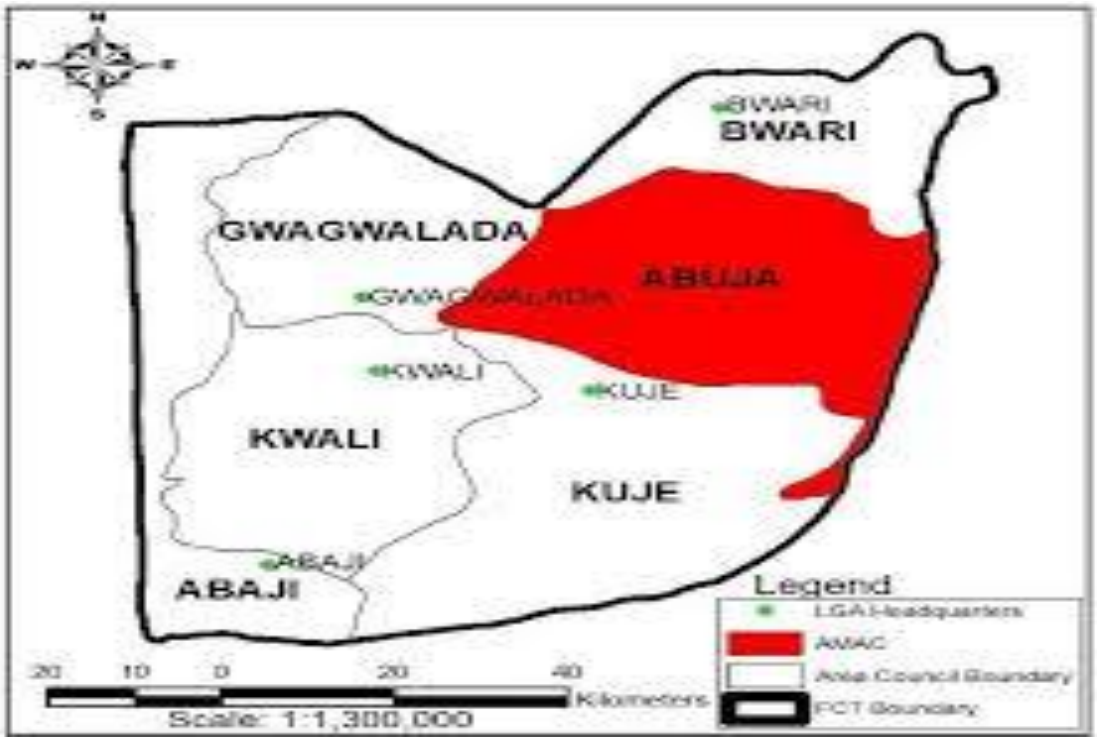


**Figure 1: The map of Abuja showing its Local Government Areas (Red coloration indicating the study areas)**

**Sample Population**

The sample population is made up of Residents within Abuja municipal area council, and also rodents within this area.

**Sample Size Determination**

The sample size was determined by using the formula described by Scott smith (2013).

$$N = \frac{Z^2pq}{d^2} \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

where:

n= Desired sample size

z= 1.96 (normal distribution) from table

P= expected prevalence of desire or percentage picking choice = 16% =0.16 for questionnaire and 7% = 0.07 for oral and anal sample)

q= 1- Prevalence

d= Margin of error (5% = 0.05)

$$n = \frac{(1.96 \times 1.96) \times 0.16 \times (1-0.16)}{(0.05 \times 0.05)} = 206$$

for the survey work

$$n = \frac{(1.96 \times 1.96) \times 0.07 \times (1-0.07)}{(0.05 \times 0.05)} = 100$$

for the bacteriological analysis

**Sampling Techniques**

A multi-stage sampling technique were used for this study, 210 persons were selected from five towns within the area council for administration of questionnaire and also 100 samples of both oral and anal swab from rodents was also obtained for microbiological analysis. These five towns were carefully selected using purposive random sampling method to give a good illustration of the population distribution within the area council. In each town, 40 houses were selected using a cluster sampling method in each of the towns and one respondent would be selected from each house to answer various questions on the questionnaire.

**Data Collection**

The questionnaire was divided into three sections, A, B and C. Section A elicits background information about the respondent and questions relating to infestation within the house. Section B seeks information about the respondent methods of waste disposal in relation to infestation. Section C seeks to know if respondents are aware of possible diseases or infection as a result of rodent infestation and if

they have at any point in time contacted any of these diseases. Two hundred and ten (210) copies questionnaires were administered, however, 10 of them were found not to be usable. At the end, 200 questionnaires were found to be usable. This represent 90% of the total questionnaire distributed and was found to be adequate for the analysis.

**Laboratory Procedure**

Fifty (50) rats were captured alive using adhesive glue boards. They were subsequently restrained with hands fortified with hand gloves for oral and anal sample collections. The oral and anal regions were sterilized with methylated spirit for aseptic collection of samples and to reduce contamination. A sterile swab stick was then inserted into the anus and mouth and rolled gently for sample collection. A total One hundred (100) samples were collected including; fifty oral swab and fifty anal swabs from different location. The samples were transported to Animal care laboratory Nyanya Abuja and were bacteriologically processed under 24 h of collection to reduce contamination and to ensure viability of organisms. The samples were processed for bacteria isolation and identification using standard morphological, biochemical screening and serological procedures (Garcia and Isenberg, 2007; Cheesbrough, 2002)

The oral and anal samples were allowed to stand in nutrient broth for 4hrs and then streaked on Tryptone soya general purpose Agar, non-selective media providing enough nutrient to allow for a wide variety of micro-organism to grow and subsequently incubated at 37°C for 24 h for primary isolation. Lactose fermenters were sub-cultured to Eosine Methylene Blue agar and incubated at 37°C for 24 h. Organisms that produced metallic sheen colonies on EMB were stored for further biochemical identification. Discrete colonies of Lactose and non- Lactose fermenters were also sub cultured on Tryptose agar slope for further identification. All the Gram-negative isolates were identified with Oxoid Microbact GNB 24E® (MB24E) and accompanying computer software package (Oxoid Microbact®) 2000 version 2.03 according to the manufacturer's procedures. All the suspected Salmonella species were subjected to slide agglutination test by standard method using Polyvalent Salmonella Antisera (Difcom Salmonella O Antiserum Poly A-I and V1) (Cheesbrough, 2002; Andrews *et al.*, 2005). The list of the reagents included in the kits and used in this study are: Catalase, Oxidase, Indole, EMB, Citrate, Xylose, Voges Proskeur, Urea, Starch, $H_2S$, Glucose, Lactose, and Lysine

**Antimicrobial susceptibility test**

From test culture on a non-selective media (Mueller Hilton, Oxoid, United Kingdom) an antibiotic sensitivity test was carried out on the isolated culture using 12 antibiotics Disc: Neomycin, streptomycin, erythromycin, colistin and oxytetracycline (X), Anitylodox (Y), Augmentin (Aug), Gentamicin (Gen), Enrofloxacin (Enro), Oxytetracycline (OxyT), Anicilin (Ani), Furaltadone (Fura). Interpretation of susceptibility patterns on other anti-microbial disks was done using guidelines laid down by the Clinical Laboratory Standards Institute (CLSI, 2017), which provide break points corresponding to zone of inhibition diameter and an interpretation guideline from the manufacturer. antibiotics disc. Inhibition zones categorized as "intermediate" were reported as "susceptible" to make a better clinical sense of the AMR status of the organism.

**Data Analysis**

The responses to the questions on the questionnaire were analyzed using frequency tables and simple percentage method. The simple percentages were calculated by dividing the number of responses for an option by the total number of respondents of a question and then multiply by 100. Statistical Package for Social Sciences (SPSS) was used to compute the chi-square in order to enhance precision.

**RESULTS**

**Demographic data**

The demographic data for the respondents are presented in Table 1, the findings indicate that Majority of the respondents are males (77.5%) while (22.5%) are females, between the age of 35-44 (33%) followed by 45-54 (30. Most of the respondents were civil servants (42%) followed by others (33%) which consists of lawyers, private business owners, medical doctors, while trader/farmers and students are (8.5%) and

(16.5%) respectively. Those with no formal education constitute (6%), primary/high school education (15.5%), Diploma/Degree (58.5%), Postgraduate respondents were (20%).

**Table 1: Demographic Data for the respondents**

| Parameters | | Frequency (n= 200). | Percentage % |
|---|---|---|---|
| **Gender** | Male | 157 | 78.5 |
| | Female | 43 | 21.5 |
| **Age** | 18-24 | 7 | 3.5 |
| | 25-34 | 29 | 14.5 |
| | 35-44 | 66 | 33 |
| | 45-54 | 60 | 30 |
| | 55-64 | 23 | 11.5 |
| | 65+ | 15 | 7.5 |
| **Occupation** | Farmers/Traders | 17 | 8.5 |
| | Civil Servants | 84 | 42 |
| | Students | 33 | 16.5 |
| | Others | 66 | 33 |
| **Level of Education** | No Formal Education | 12 | 6 |
| | Pry/Sec Education | 31 | 15.5 |
| | Diploma/Degree | 117 | 58.5 |
| | Postgraduate | 40 | 20 |

Presence of Domestic rat in Homes investigated and Their percentages in homes is presented in Figure 2. Generally, domestic rats are present in the homes of a significant portion of the respondents a total of 32 (80%) respondents from Nyanya axis reported a high case of rodent infesting their homes, followed by respondents living along Airport Road 30 (75%), respondents living around Asokoro have the least infestation rate of 18 (45%) out of the 200 houses visited in this study. Table 2 indicated the evidences that suggested rats' infestation in the homes surveyed. 19% of the respondent noticed rats running around in various part of the house, while 14% found rat dropping either in cupboard, drawers, and even inside places where food are being stored. 11.5% respondent claimed they usually hear rat noises sometimes on the roof or in places where food is being stored, another 20% of the respondents found out that their food stuffs, furniture and books were usually eating or destroyed by these rodents, while 35.5% claimed that there is no evidence of infestation where they reside.

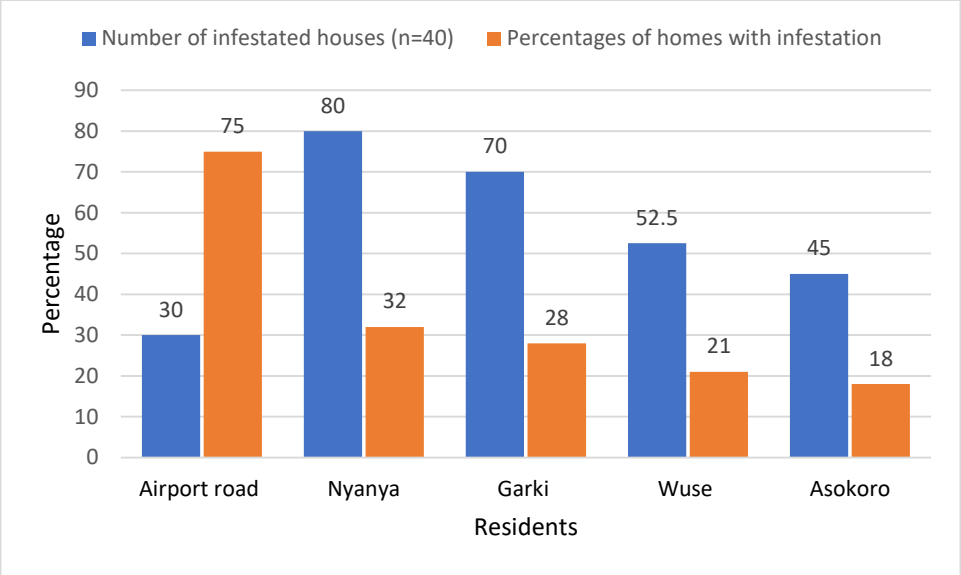


**Figure 2: The distribution and infestation level of house investigated**

**Table 2 Respondents Noticeable evidence of rodent infestation**

| Indication of Rodents infestation | Frequency | Percentage (%) |
|---|---|---|
| Rat runs noticed in rooms Rat dropping found | 38 | 19 |
| around the house | 28 | 14 |
| Rat noise heard | 23 | 11.5 |
| Rat bites on food stuffs/furniture/books | 40 | 20 |
| No evidence of infestation | 71 | 35.5 |
| Total | 200 | 100 |

From Figure 3, 35.5% of the total respondent practice and open dump method of waste disposal, while 9% said they heap and burn their refuse after a period of time, 54% subscribe to the Abuja Environmental Protection Board and other waste disposal unit, with this their refuse is been dispose of weekly, while 3% practice other method of waste disposal mainly burying in a landfill.

From Table 3, all organism isolated was gram negative bacteria. *Enterobacter cloacae* have the highest rate of isolation at 35%, followed by *Escheriacia coli* at (19%), others include *Salmonella spp* with 4%, *Pseudomonas aeruginosa* with 10% and *Providencia stuartii* which have a 12 % isolation rate. *Enterobacter hormaechi* had 11% isolation, *Proteus mirabilis* had 9% isolation rate.

All isolated organism was 100% resistant to Oxytetracycline while *P. aeruginosa* shows a 90% resistance to anicilin respectively. *Salmonella spp*, *E. cloacae*, *P. mirabilis*, *E. hormaechei* and was 100% sensitive to drug X. All other drugs tested also showed some level of sensitivity on this organism (Table 4).

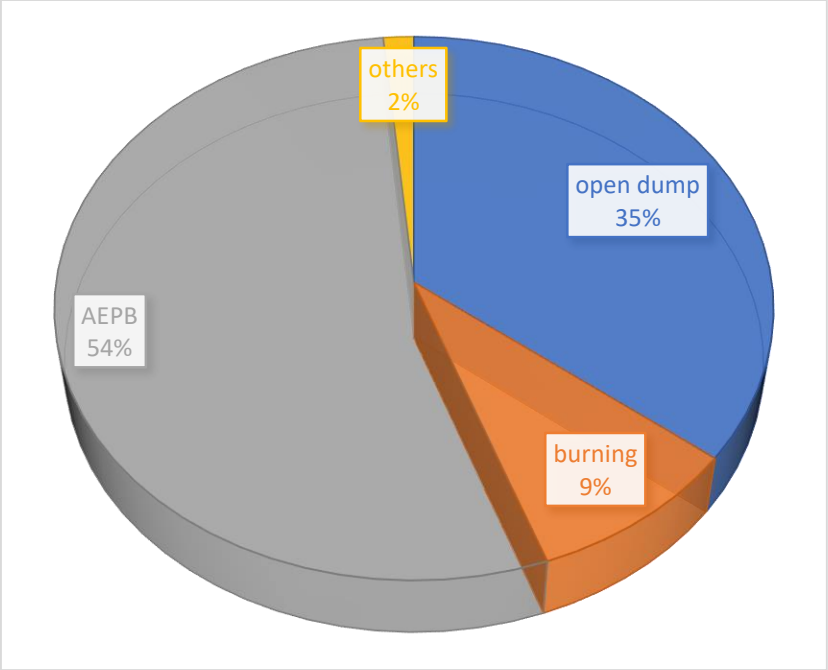


**Figure 3: Method of waste disposal**

**Table 3: Percentages of bacteria isolated from the mouth and anus of rats**

| Bacteria | No/ percentages (%) |
|---|---|
| *Salmonella spp* | 4 (4) |
| *Escherichia coli* | 19 (19) |
| *Providencia stuartii* | 12 (12) |
| *Enterobacter cloacae* | 35 (35) |
| *Proteus mirabilis* | 9 (9) |
| *Pseudomonas aeruginosa* | 10(10) |
| *Enterobacter hormaechei* | 11(11) |
| | **100** |

**Table 4: Antimicrobial susceptibility test carried out on bacteria found in rats**

| Bacterial isolates | Antimicrobial Sensitivity/Resistance (%) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **X** | **Y** | **Aug** | **Gen** | **Enro** | **OxyT** | **Ani** | **Fura** |
| Salmonella spp(n=4) | 4(100) | 2(50) | 3(75) | 2(50) | 1(25) | 0(0) | 0(0) | 1(25) |
| Escherichia coli(n=19) | 15(79) | 19(100) | 7(37) | 8(42) | 6(32) | 0(0) | 0(0) | 5(26) |
| *Providencia stuartii* (n=12) | 8(67) | 12(100) | 6(50) | 12(100) | 9(75) | 0(0) | 0(0) | 7(58) |
| *E. cloacae* (n=35) | 35(100) | 0(0) | 30(85) | 20(57) | 17(49) | 0(0) | 0(0) | 35(100) |
| *Proteus mirabilis* (n=9) | 9(100) | 5(56) | 3(33) | 9(100) | 9(100) | 0(0) | 0(0) | 9(100) |
| *P. aeruginosa* (n=10) | 8(80) | 5(50) | 7(70) | 10(100) | 10(100) | 0(0) | 1(10) | 5(50) |
| *E. hormaechei* (n=11) | 11(100) | 4(35) | 9(82) | 5(45) | 5(45) | 0(0) | 0(0) | 11(100) |

*X' is a combination of 5 antibiotics: Neomycin, streptomycin, erythromycin, colistin and oxytetracycline and Y is Anitylodox, Aug= Augmentin, Gen= Gentamicin, Enro= Enrofloxacin, OxyT= Oxytetracyclin, Ani= Anicilin, Fura= Furaltadone*

**DISCUSSION**

Rats are important as carriers and transmitters of a number of pathogens to humans and livestock, as well as pet animals, thereby posing public health hazards to humans (Meerburg *et al*. 2009). Evidence of rodent infestation has been strongly associated with Lassa fever incidence in homes (Bonner *et al.,* 2007). Other health implications of rodent infestation are that they are reservoirs for a variety of zoonotic diseases like *Toxoplasma goondi, Escherichia coli, Salmonella spp.,* etc. (Murphy *et al*., 2007). The involvement of rodents in transmission of life-threatening infections is epidemiologically significant and could be responsible for increasing the incidence of emerging infectious diseases.

The result from this study shows that 80% of the respondents agreed that there is a relationship between the amount of refuse within their house and environment and the level of rodents infesting their house. That is to say, they are aware that a poor environmental condition and improper waste disposal are big factors in infestation. Residents who practice the open dump method of waste disposal recorded the highest rate of rodent infestation; they accepted that the open refuse dump serves as a breeding ground for this rodent, which could lead to the spread of disease. This finding is in line with the assertion of Olaniran (1995) that the link between environment and health is fairly understood by the average person in most developed and developing nations of the world. It has been reported that human environments, such as shrubs and refuse dumps, attract rodents for shelter and refuge (Onyido *et al.,* 2009). Poor external hygiene may act as a risk factor for rodent infestation of residential homes, transmission of the lassa virus, and precipitation of asthmatic attacks (Bonner *et al*., 2007).

Out of 200 homes investigated, 65% of the population experienced rodent infestations, with only 10 reporting direct or indirect contact with a disease. Most respondents were aware of Lassa fever viral disease, with only 25% aware of lesser-known diseases, possibly due to the prevalence of this rodent. From the bacteriological analysis carried out on the oral and anal samples obtained from 50 rats within the area council, organisms discovered and isolated were gram-negative bacteria, and they include members of the family Enterobacteriacea, *Proteus spp.*, others including *Salmonella, Escherichia coli, Providencia stuartii, Pseudomonas aeruginosa,* most of these organisms have been reported to be pathogenic to humans. For example, *E. coli,* according to Todar (2007), can cause urinary tract infection (UTI), neonatal meningitis, and intestinal disease (gastroenteritis) in humans. A more current report also associated Proteus species with zoonotic urinary tract infection (Armbruster *et al.,* 2014). It was also associated with rheumatoid arthritis that is common in developing countries (Ebringer and Rashid, 2014). Enterobacter species have been reported to cause disease in humans (Nandi *et al*., 2013); some species of Enterobacter have also been isolated from patients' cerebrospinal fluid (Parodi *et al.,* 2003). Salmonellosis occurs in rats and can be transmitted to humans; rats infected with *Salmonella enteritidis* serve as a model for enteritis, typhoid fever, and other septicaemic diseases. *Pseudomonas aeruginosa*-infected rodents serve as models for numerous human diseases and conditions, including indwelling catheter infections, burn trauma, and cystic fibrosis. All of these infectious organisms displayed various forms of sensitivity and resistance to various antibiotic drugs tested on them. Antibiotic resistance is a serious public health problem; reduced effectiveness of antibiotics results in greater patient mortality rates, prolong hospitalization, and increase health care costs. Rodents associated with food animals are potential vectors of animal and human pathogens. Organic waste in and around animal production facilitates and provides excellent habitats for the growth and development of these rodents. Rodents have the ability to dismantle fecal bacteria, including human and animal pathogens and antibiotic-resistant strains, due to their unrestricted movement, mode of feeding, and attraction to residential areas. *E. coli* isolates displayed a high resistance to oxytetracycline (100%) and also anicilin; this was similar to the finding of Adesiyun *et al.* (1999) but showed a high sensitivity to drug X and gentamicin, which is in agreement with the published report by Gopee *et al.* (2000). *Salmonella spp.* in this

current study exhibited resistance to oxytetracycline and anicilin. Although the number of isolates recovered was low, it has been reported that rodents served as sources of multiresistant *Salmonella spp*. In cases and epidemics of human salmonellosis (Swanson *et al*. 2007). Resistance to antimicrobial agents has been reported by others (Sherley *et al.* 2000) to reflect the use of antimicrobial agents in human and animal populations. *Providencia stuartii* was highly resistant to oxytetracycline but highly sensitive to gentamicin; all *Enterobacter spp.* isolates were also highly resistant to oxytetracycline and anicilin, similar to the findings of Agersew Alemu *et al.* (2014). *Proteus spp.* was highly sensitive to Gentamicin, and *P. aeruginosa* was also highly sensitive to Gentamicin. Residents within AMAC have mixed responses on public enlightenment and education on proper hygiene and waste disposal. Some believe the government has done enough, while others feel the problem lies with residents' ignorance and unwillingness to implement these practices. Bamigboye (2006) found that many Nigerians still have negative attitudes towards environmental sanitation and believe a total behavioral change or stiffer penalties are needed. Orji *et al*. (2020) emphasized the importance of education in achieving environmental sanitation goals, emphasizing strategies such as analysis, sensitization, information, education, and motivation.

## CONCLUSION

Rodent infestation is a global issue, with most homes infected, causing damage to properties and food. Open dump residents have the highest infestation rates, possibly due to proximity. Bacterial analysis reveals diseases transmitted from rodents, including resistant strains, posing global and public health risks. Governments should educate the public on rodent diseases and emphasize good sanitary practices, while residents should prioritize cleanliness to promote healthy living and disease prevention.

## RECOMMENDATION

The government should provide large refuse receptacles to prevent indiscriminate open dumping, establish mobile courts for offenders, introduce monthly environmental sanitation, sponsor public health education programs, and promote good personal hygiene in schools and homes to prevent diseases from rodents.

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