OPEN ACCESS
Freely Available Online

JOURNAL OF ZOOLOGICAL RESEARCH
ISSN NO: 2694-2275

Research

DOI: 10.14302/issn.2694-2275.jzr-20-3537

Investigation of Emerging Risk Factors and Isolation of Potential Pathogenic Bacteria from Domestic Dog Stool in Port Harcourt Metropolis, Niger Delta

Azuonwu O[1,*], Kemsi B[1], Njoku-Tony R.F[2], G.N. Wokem[1]

[1]Department of Medical Laboratory Science, Medical Bacteriology/Virology/Parasitology Unit, Rivers State University, Nkpolu-Oroworukwo, Port Harcourt, Nigeria.

[2]Department of Environmental Management, Federal University of Technology, Owerri, Imo State, Nigeria

Abstract

This study investigated the potential pathogenic bacteria that are associated with domestic dog stool in Port Harcourt Metropolis. Convenience sampling techniques were used for sample collection outcome. A total of fifty dog stool samples were collected aseptically into a sterile stool container from different locations (Agip Estate, Rumuokoro Community, Government Residential Area, Sand-fill Borokiri, Port Harcourt Township, and Rivers State University lecturers' quarters) all within Port Harcourt City. Bacteriological analysis was determined using standard microbiological analytical and identification techniques. Statistical analysis was performed using Statistical Package for Social Science version 21 for frequency, percentage, prevalence rate and correlation at 0.01 and 0.05 level of significance. Potential pathogens with associated percentages that were isolated are *E coli* (20.0%), *Klebsiella species* (16.0%), *Pseudomonas species* (4.0%), *Proteus species* (28.0%), *Bacillus* species (4.0%), *Staphylococcus aureus* (14.0%), and *u*nidentified [other *Staphylococcus* species] (4.0%). However, the research further revealed that *Proteus species* (28.0%), was the most prevalent pathogen, while *Bacillus species* (4.0%), *Pseudomonas species* (4.0%), and *Streptococcus species* (4.0%), were the least prevalent among pet dogs studied. The correlation analysis showed no significant relationship between isolates with socio-demographic data of pet owner and Pet biodata respectively. From the analysis, correlation coefficient values of .269 and .124 were obtained for Age of Pet Owner and Gender of Owner respectively. It also show a direct correlation but by implication, a very weak, non-significant ($p<0.05$) relationship existed between the organisms isolated and the variables (Age of Pet Owner and Gender of Pet Owner). However, no relationship exists between isolates and visit to vet Doctor (r-0.038; $p>0.05$). Furthermore, negative non-significant correlation ($p>0.05$) was observed for marital status of Pet Owner ($r=-.158$) and Age of Pet ($r=-.023$) and isolate. Also, correlation association between isolates and some risk factors using the correlation analysis matrix revealed an indication of an indirect but moderate association between isolates and Caressing ($r=-.347$, $p=0.01$). However, other risk factors like vaccination ($r=.042$), Feeding Pattern($r=.125$), Pet Bathing ($r=.220$) and Eating with pet in same plate ($r=.146$), did not prove statistical significance at $p>0.05$. The results from the study strongly suggest that pet dogs carry potential pathogenic organisms in their faecal matter that can serve as a source of infection to the pet owners. It is, therefore, very critical that these pets should be treated and possibly vaccinated frequently, even as their faecal matters should be well disposed to prevent possible zoonotic infectious epidemic outbreak in our global communities.

Corresponding author: Azuonw Obioma, Department of Medical Laboratory Science, Medical Bacteriology/Virology / Parasitology Unit, Rivers State University, Nkpolu-Oroworukwo, Port Harcourt, Nigeria, Tel. +234 8035519688, Email: bimajacobs@yahoo.co.uk

Keywords: Zoonotic infection, Potential Pathogens, Demostic Dogs, Faecal matter, Risk Factors.

Received: Aug 28, 2020 **Accepted:** Sep 15, 2020 **Published:** Sep 17, 2020

Editor: Patricio De, Universidad de Chile.

Introduction

Interestingly, animal pets which are also known as companion animals are those class of animals that are literally kept, primarily for some person's company, protection and even for entertainment purposes rather than using them as a working animal, livestock, or laboratory animal for experimental purposes.

Nonetheless, as at about 15 years ago, it was originally believed that the first domesticated wolves appeared in the Middle East, however, according to an article published by a Swedish geneticist, it was reported that canine domesticated outcome may have first occurred between 27,000 to 40,000 years ago [1].

Nevertheless, many evidence-based studies have confirmed the pivotal roles of animal pets in human socio-psychological lives and general wellbeing respectively. It was predicted that over 60% of the European families own an animal pet in their houses and potentially, the majority of these households kept a dog even during old age.

Undoubtedly, as continuously documented, dogs have been kept as pets for over 14 centuries as documented by some studies. Nonetheless, dependable evidence has shown that owning a pet can increase the physical activity and general body fitness of pet owners, and consequently reduced serum cholesterol, lower triglyceride levels, even as cardiovascular diseases outcome are well managed and reduced through regular physical activity as the pet owner walks down the streets with their pets most times on regular basis [2]. Furthermore, dogs have several positive outcomes on the psycho-social and psychical health of their owners, besides the good gains of owning a dog pet, many diseases among humans are attributed to dogs especially zoonotic diseases, which are of critical public health importance in the scale of priority towards community protection [3]. Nonetheless, it is strongly believed that Children and Immuno-compromised individuals are especially at an increased risk of developing zoonotic infections, probably due to their poor or weak developed defence mechanism. Furthermore, several studies have demonstrated that domestic dogs have a significant role in developing zoonotic disease and hospitalization of citizens in rural and urban Communities respectively. This is also very evident and seriously worsened in developing communities where access to functioning animal clinic and trained manpower towards improving the health of the animal pets, remains a huge challenge [4]. Canine puppies under one year of age are highly susceptible to gastrointestinal infections. Acute diarrhoea is one of the most common clinical manifestations, potentially leading to severe dehydration and death [5]. However, several studied well-known pathogens that are associated with acute gastro-enteritis such as Salmonella species, *Campylobacter* species, *Clostridium perfringens* and beta-hemolytic *Escherichia coli* are associated with diarrhoea in dogs, but faecal presence of these bacteria in dogs and their clinical manifestation with respect to diarrhoea varies, probably due to variations in strains and species involved [6]. However, the supposedly risk factors for acute infectious diarrhoea in dogs, include the type of breed, gender, vaccination outcome history, age, season, environmental factor/hygiene and whether the dogs sleep inside the house or lives and sleep in the open without a dog house for protection. However, these risk factors for infection with specific enteropathogens have mainly been reported in dogs, housed in shelter or breeding facilities. It is firmly believed that the history and pattern of risk factors for privately owned dogs that are adequately taken care of with good shelter and prompt vaccination may differ significantly, due to variations in the condition of living and clinical care as also suggested by Bagshaw et al. [7].

Bacteria from dogs are usually transmitted from animals to humans through the following modes; the transfer through animal bites and scratches, through direct faecal-oral route, contaminated animal food product, improper food handling, and inadequate cooking, farmers and animal health workers (that is veterinarians) are at increased risk of exposure to certain zoonotic pathogens and they may contract zoonotic bacteria in the process. Furthermore, they could also become carriers of zoonotic bacteria that can be spread to other humans in the community, also vectors, frequently arthropods, such as mosquitoes, ticks, fleas, and lice can actively or passively transmit bacterial zoonotic diseases to humans, soil and water resources, which potentially contaminate the top soil that serves as a source of manure content of the soil, this is a huge great risk that could promote different variety of zoonotic bacteria infection, thus, creating a massive potentials of zoonotic bugs and immense pool of resistance genes that are available for the transfer of bacteria that could cause human diseases over time [8]. A large number of diseases that affect humans today are probably seems to be originating from animals, although pets come with many benefits, however, pets sometimes carry harmful germs that can make people sick. It is a known fact that diseases that are gotten from animals to man are called zoonotic diseases and it is difficult to know which animals could be carrying zoonotic diseases, especially since animals carrying these germs often look healthy and normal, in the case of healthy carrier [9]. Pets offer comfort and companionship, and we cannot help but love them. While pets can benefit our health in several ways, they also have the potential to spread infection and cause various human illnesses [10]. Faeces from dog serve as a potential source of threat to Public Health. This is because these pathogens when disposed to the environment carelessly can accidentally gain entrance into the body and could cause serious infection. However, according to CDC [11], Sleeping with and "kissing" animals puts the pets owners at a high risk, which would capsulate into some critical clinical issues, even when it appears that those dogs are potentially looking healthy. Furthermore, according to "Zoonosis in the Bedroom," a study published by CDC [12], which states that about 75% of all emerging human infections are originating from animals, and about 60% of all human existing infections are zoonotic in nature. Nonetheless, since 2009, CDC's Animal-Human interface project (AHIP), has continued to provide robust consultancy guideline to country partners, on animal and public health issues, directly or through health education and training of Nigerian clinical personals in the area of field epidemiology and medical laboratory expertise, especially in the southern part of Nigeria, which Rivers State is an integral important part [13]. Nevertheless, the epidemiological outbreak of leptospirosis was observed in Nigeria between February and October 2009 within which, there was an appreciable increase in morbidity and mortality in dogs in a national kennel in Abuja, Nigeria as reported by Emmanuel [14]. Undoubtedly, pets such as dogs carry certain bacteria, viruses, parasites, and fungi that can potentially cause illness, if transmitted to humans. Humans get these animal-borne diseases, when they are bitten or scratched or have direct contact with an animal's waste or saliva [9]. These diseases can affect humans in many ways. They are of the greatest concern to young children, infants, pregnant women, and people whose immune systems have been compromised by illness or disease of terminal outcome. Infants and kids within the age bracket, between 0-5 years old are the most vulnerable to the infection. This is probably because their immune systems are still developing, and some infections that may probably promote mild illness in adult, may be potentially very critical, and devastating in infants with low immunity [15]. It is strongly believed that regular washing of hands with soap before eating and after touching animals (particularly from farms, petting zoo, or exotic species), after removing soiled clothing, contact with soil and after using the rest room, would be helping towards infection control. Furthermore, the use of hand sanitizer and also the application of sound barrier nursing mechanism of reducing the number of bacteria may be a good tool, but may be inadequate for removing organic debris, which is where bacteria, viruses, fungi, or parasites can hide. Also, those involved in the management of pet faeces at all level should try as much as possible to scoop the litter box at least every 24 hours, and it should also be well decontaminated to improve the environmental sanitation and personal hygiene of the immediate environment [16]. Nonetheless, there is visible dearth of data cum research information's on the above subject matter in the region, thus, majority of the available research literatures focused on pathogens of human origin bacteriology, with little or nothing on the bacteriology of zoonotic infections from dogs stool droppings to man. Hence, the focus of this study was to isolate and identify the potential pathogenic bacteria that are associated with the faecal matter of domestic pet dogs in Port Harcourt metropolis. It is firmly believed that data generated from this study would stimulate much-needed curiosity, and evidence-based action plan towards the provision of critical infrastructure and sustainable policies that would promote prompt diagnosis and clinical management of zoonotic illness, that could be associated with poor handling and management of animal's faecal droppings in the region.

Methodology

Sample Area

Samples for this study were collected from six (6) different locations inPort Harcourt (Agip Estates, RumuokoroCommunity, GRA Residential Area, Sandfill Borokiri, Port Harcourt Township and RSU lecturers' quarters). Port Harcourt is the capital of Rivers State, Southern Nigeria. It lies along the Bonny River (an eastern distributary of the Niger River) 41 miles (66 km) upstream from the Gulf of Guinea and is located in the Niger Delta. The area that became Port Harcourt was created in 1912; it was before then, the farmlands and fishing zone of the Diobu communities inheritance, an integral part of the Ikwerre ethnic nationality of Rivers State. In 1956 crude oil was discovered in commercial quantities at Oloibiri, an Ijaw settlement in old Rivers State. The oil discovery, therefore, stimulated the growth of Port Harcourt's economy and expansion of critical infrastructures in the region, however, the first shipment of Nigeria crude oil was exported through the city of Port Harcourt in 1958. Nonetheless, through the benefits of the Nigerian petroleum industry further developed Port Harcourt to the enviable height of what is known today as the garden city of Nigeria. However, some of the oil firms that currently have offices in the city of Port Harcourt include Royal Dutch Shell, Agip and Chevron [17]. Fig 1.

Sample Collection/Experimental

The dog faecal samples were collected aseptically into the sterile wide-mouth bottles and were transferred immediately to the laboratory for bacteriological processing and culture in an ice parked bottle to prevent unwanted replication of the pathogens. The samples were collected from 50 pet dogs from different locations at random and were cultured on Blood, Chocolate MacConkey, and Salmonella – Shigella, Deoxycholate citrate and Nutrient Agar respectively. They were incubated for 24hours at 37^{o}C and observed for growth. Total heterotrophic count of each plate was done and the organisms were sub-cultured and isolated. The identification of the pathogens was done using Gram staining reaction, Microscopy, Catalase test, Citrate test, Coagulase test, Indole test, Oxidase test and Mannitol salt agar as described by Cheesbrough [18].

Structured Questionnaire

A well-structured questionnaire was used to collect the demographic data of the dogs and their owner after an oral consent was given to participate in the study

Data Analysis

Data were arranged in tables using Microsoft Excel and transferred into Statistical Package for Social Science (SPSS) version 21 for statistical analysis for frequency and percentage outcome. Correlation was performed at 0.05 level of significance. Results were presented in tables and charts as seen below in the results section.

Results

The results obtained from the isolation of potential pathogenic bacteria that are associated with domestic dog stool, revealed the presence of gram-negative rod bacteria, gram-positive rod bacteria and gram-positive cocci. There was no gram-negative cocci bacterium isolated.

Table 1, below showed the different percentage of the age, sex, education, marital status and employment status of pet owners. It revealed that

Figure 1. Map of Rivers State (Red spot indicates the study location).

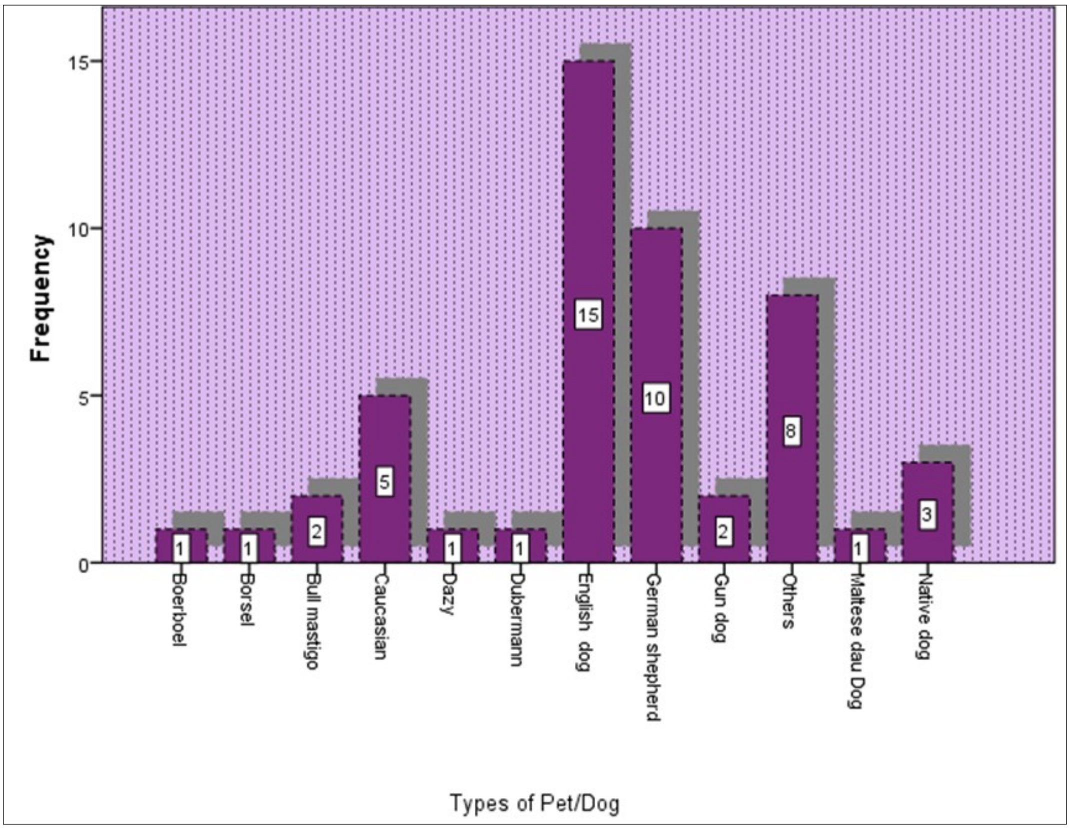

Figure 2. Showing type of Pet Dogs in the Study Population

Table 1. The Biodata of Pet Owners in the Study Population

Variable	Classification	Frequency	Percentage
Age	12-17years	2	4.0
	18-24years	5	10.0
	25-34years	30	60.0
	35-49years	8	16.0
	50years and Above	5	10.0
Sex	Female	36	72.0
	Male	14	28.0
Education	Non-formal	5	10.0
	Primary	1	2.0
	Secondary	4	8.0
	Tertiary	40	80.0
Marital Status	Married	41	82.0
	Single	9	18.0
Employment status	Employed Full Time	9	18.0
	Employed Part-Time	3	6.0
	Not Employed	3	6.0
	Retired	1	2.0
	Self Employed	10	20.0
	Student	24	48.0

Table 2. Overall Prevalence of Bacteria Isolated from Pet Dogs

Isolates	Number	Prevalence (%)	**Remark**
Bacillus spp	2	4.0	Lowest Prevalent [a]
Escherichia coli	10	20.0	
Klebsiella spp	8	16.0	
Proteus spp	14	28.0	Highest Prevalent
Pseudomonas	2	4.0	Lowest Prevalent [b]
Staph aureus	7	14.0	
Other Staph spp	5	10.0	
Streptococcus spp	2	4.0	Lowest Prevalent [c]

Superscripts a, b & c have similar prevalence rates

25-34 years of age had the highest percentage (60.0%) of the age bracket of people that owned domestic dogs. For gender, females were highest pet owners (72.0%). The table also showed that 80% of the pet owners have acquired tertiary education, even as 82.0% are married. Most the pet owners are fully employed (18.0%) according to the result obtained from the study. However, the highest percentages of pet owners were observed among students (48.0%), seconded by the self-employed (20.0%) while the least occurred among the retired (2.0%) set of the studied population.

The bar chart (figure 2) below showed the percentage of different species of the pets with English dog having the highest percentage (30%), and Doberman, Boerboel, Dazy, Borsel and Maltese having the lowest percentage (2%) respectively. It also showed the sex of different pet (female 58.0% being highest). It showed that most of the pets are within the age of 1-2 years and they visited the veterinary doctor mostly once in a month. The table also showed that most of the pets are vaccinated once in a month (62.0%) and 35.0% of the pets are fed with homemade meal, while 76.0% of the pets were bathed once a week, 88.0% visited the veterinary clinic for ill-health resolution, 74.0% of the pets are being pecked by their owners, 82.0% are being caressed, 72.0% the pets are not allowed into the house while 98.0% of the pets are not allowed to eat in the same plate with the owners.

Table 2 showed the overall prevalence of isolates from the different pets with *Proteus spp*. having the highest prevalence (28.0%), followed by *Escherichia coli* (20.0%), *Klebsiella spp*. (16.0%), *Staphylococcus aureus* (14.0%), Other unidentified spp. (10.0%), while *Bacillus spp*., *Pseudomonas spp*., and *Streptococcus spp* having the lowest prevalence of 4.0%.

Table 3 showed the relationship between isolates with socio-demographic data of pet owner and pet biodata. From the analysis, correlation coefficient values of .269 and .124 were obtained for age of pet owner and gender of pet owner respectively. It showed a direct correlation but by implication, a very weak, non-significant ($p<0.05$) relationship exist between the organisms isolated and the variables (Age of Pet Owner and Gender of Pet Owner). However, no relationship exists between isolates and visit to Vet.Dr ($r=-.0.38$; $p>0.05$). Furthermore, negative non-significant correlation ($p>0.05$) was observed for Marital Status of Pet Owner ($r=-.158$), Employment Status of Pet Owner ($r=-.277$), Pet Type ($r=-.111$) and Age of Pet ($r=-.023$) and isolate. See table 3for details.

Table 4 illustrates the association between isolates and some risk factors using the correlation analysis. The study revealed an indication of an indirect but moderate association between isolates and Caressing ($r=-.347$, $p=0.01$). However, other risk factors

Table 3. Correlation between Isolates and Pet Owners Biodata with Pet Biodata

Variable	Category	Correlation	p-value	Remark
Pet Owners Biodata	Age of Pet Owner	.269	0.06	Not Significant
	Gender of Pet Owner	.124	0.39	Not Significant
	Marital Status of Pet Owner	-.158	0.27	Not Significant
	Employment Status of Pet Owner	-.277	0.05	Not Significant
Pet Biodata	Pet Type	-.111	0.44	Not Significant
	Sex of Pet	.187	0.19	Not Significant
	Age of Pet	-.023	0.87	Not Significant
	Visit to Vet Doctor	.038	0.79	Not Significant

Interpretation: 1=perfect correlation, 0.9-0.7=strong, 0.6-0.4=moderate, 0.3-0.1=weak, 0= no correlation. Negative (-) = Inverse/Opposite direction; Positive=Direct/parallel relationship

like Vaccination (r=.042), Feeding Pattern(r=.125), Pet Bathing (r=.220), Resolution of ill health (r=-.154), Pecking of Pet (r=), Pets allowed into house (r=.090) and Eat with pet in same plate (r=.146), did not prove statistical significance (p>0.05). Others are seen in table 4.

Discussion

Increasingly, the scattering of the dog faecal droppings in the remote and urban community settings, may represent an important source of potential microbial pathogenic contaminants for both the dog owners and the community environmental space at large. The study, however, revealed that most of the pet owners are within the age bracket of 25-34 years. These tend to disagree with the work of Martins *et al.,* [19], who reported that most pet's owners are within the age bracket of 18-24 years. Nonetheless, the variation in age here may be due to the fact that most of the pet owners are students, and in this present studied location, most students fall within the age (25-34 years) which is quite different from Western countries where people go to school very early and also finished in good time, since the industrial strike of academic and non-academic staff hardly affect the smooth running of an academic sessions, unlike in Nigeria where frequent industrial strikes will always delay students from finishing in good time. Also, the study revealed that most pet owners are females (58.0%). This agreed with the work carried out by Kristen & Chang [20], who reported that most of the pet owners are females (52%). This similarity may probably be linked to the fact that females mostly need company than males which encourages them to keep pets around them, probably for protection, than their male counterpart who can always protect themselves during external aggression or threat. Nevertheless, most of the pet owners are students in tertiary institutions or have just finished, this is similar with the work done by Bassette & Taber-Doughty [21], who also reported that most pet owners are college students. Nonetheless, this may perhaps be linked to the evidence-based perception that strongly suggests that people in this category increasingly suffer from emotional burden, stress and anxiety and therefore, most times needs these pets to play with, so as to ease stress and tension of life especially, academic and social burden alike. Also, the research revealed that most pet owners are married couples, and this is in agreement with the study carried out by Glyn & June [22]. This is probably because most of these couples sometimes keep these pets for security reasons aside from companion purposes. Furthermore, from our study, it was revealed that when it comes to employment status, most of the pet owners are students. This is in consonance with the work done by Lynette & Mariko [23]. This is probably because people

Table 4. Correlation of Isolates with Risk Factors			
Variable	**Correlation**	p-value	**Remark**
Vaccination	.042	0.77	Not Significant
Feeding Pattern	.125	0.38	Not Significant
Pet Bathing	.220	0.12	Not Significant
Resolution of ill health	-.154	0.29	Not Significant
Pecking of Pet	0.04	0.93	Not Significant
Caressing	-.347*	0.01	Significant
Pets allowed into house	.090	0.54	Not Significant
Eat with pet in same plate	.146	0.31	Not Significant

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailead).

that are fully employed are busy working with the multinational companies or as civil servants who are fully employed in functional ministries, hence they may not have much time to spend with their pets, due to the nature of their jobs on a daily basis and therefore, will literally feel tired when they got home, unlike the students that are a little bit flexible in management of their time. They stroll down the streets and drive around the city with their dog pets in the evening hours as a source of fun and show off that they got a beautiful pet to count on.

This research also revealed that most dogs found in the area of study are English bulldog; this is in disagreement with the research carried out by Stephen [24], who showed that Labrador Retriever was the most prevalent in their study. However, this discrepancy could be as a result of the difference in geographical regions, climate conditions and sample size which enhances the prevalence of a particular dog species. Also, it was also found out that most of the pet dogs in the studied locations are not being vaccinated frequently. This does not agree with the work done by Horzinek et al., [25], who strongly suggested that pet dogs should be vaccinated frequently, possibly3-4 times a year so as to keep them healthy and free from contaminating the environment through their random and uncontrollable dropping of their faecal matter in the soil surfaces. Nonetheless, the difference in the low level of vaccination engagement among pet dogs in the studied locations, could be as a result of lack of knowledge, poverty or lack of veterinary trained experts and robust animal clinics in the region to carter for the health of the animals.

The study revealed the presence of *Bacillus spp*. 4.0%, *Escherichia coli*20.0%, *Klebsiella spp.* 16.0%, *Proteus spp*. 28.0%, *Pseudomonas spp*. 4.0%, *Staphylococcus aureus* 14.0%, other unidentified *Staphylococcus species*10.0% and *Streptococcus species* 4.0%. This is similar to the work done by Marks *et al.*,[6], who recovered *Bacillus spp.*, *Salmonella spp.*, *Campylobacter spp*. and *Escherichia coli* from dog faecal matter, although there were a little variation in prevalence pattern of the bacteria species which could be as a result of the difference in geographical regions, detection methods used, sample size or probably because of the way the pet dogs are being treated because during the course of our studies, it was found that about 56% of the pet dogs only visit the veterinary clinic once in a month and 62% of them only get vaccinated once in a year as the case may be. This could also contribute to the variation seen in Marks et al., [6] study. Furthermore, *Salmonella spp., Escherichia coli* and *Campylobacter spp*. has been reported to be most common pathogens associated with dog stool [26], although *Salmonella spp.* is easily and often recovered from dogs that eat rotten contaminated meats, even though it was not isolated from the present study. However, notwithstanding, this study is also in consonance with the research carried out by Julia *et al.*,[27], on the ecological characterization of the colonic microbiota of normal and diarrheic dogs, however, there was a discrepancy on the type of pathogens isolated (*Streptococcus spp., Bacillus spp., Enterococcus spp., Escherichia coli, Bifidobacteria Ruminococcus spp.* and *Prevotella*) respectively which could probably be as a result of methods of sample analysis employed. This is because molecular technique (Quantitative real-time PCR) was used which is strongly known to be very sensitive and discrete in identification and characterization of specific pathogens, unlike normal conventional methods explored in this present work, thus these also highlight the importance of improvement in the method of diagnostics approach in this part of the world in order to enhance specificity and sensitivity of pathogen recovery.

Furthermore, in another development Mirjamet in their study [28], also gave a good account of the prevalence of major pathogen found in dog stool (faecal matter), *Salmonella spp.* (0.6%), *Campylobacter spp*. (39.9%), and *Bacillus spp* (40%). These undoubtedly also looked similar to this present study, but the difference is somewhat an increase in prevalence pattern, which could be associated with the evidence-based facts of the molecular application approach employed by Mirjam *et al.*,[28] which was more sensitive and very specific in nature to identify pathogens in stool samples in their numbers within a given shortest possible time.

Nonetheless, from our study, it was revealed that *Proteus spp*. was the most prevalent enteropathogen in dog faecal matter, followed by *Escherichia coli* and *Klebsiella spp*. These strongly disagreed with the study of Edward [29], who reported that the most prevalent enteropathogen in dog faecal matter was *Salmonella spp.*, followed by *Campylobacter spp*. and *Escherichia coli* respectively. These outstanding variations may probably be due to feeding pattern of the pet dogs, treatment pattern, and the environmental conditions of the pets found here, and there with coherent sharp variation in treatment and maintenance outcome, even as the environmental sanitation practice and culture remains very critical factor of consideration, which also varies between developed countries and underdeveloped communities

Interestingly, the mean correlation of isolates with risk factors show that those that pecked their pets, caressed them, allowed them to enter the living room and eat in the same plate with the pets are at high risk of getting infections. Results from the study also highlighted that most of the pets are hardly vaccinated or rarely taken to the veterinary clinic for regular checkups. This is in accordance with risk factors associated with pet dogs as reported by Ghasemzadeh & Namazi, [30]. Furthermore, it is of very critical, to state without bias that almost if not all the pathogens isolated in this present study are of clinical importance towards promoting different array of disease in man and his animal husbandry. Thus, the importance of this organisms has been linked to urinary tract infection, wound infection, septicaemia and most importantly, is the systemic involvement of the pathogens in the promotion of the spread of nosocomial infection in our health facilities across the globe, thus the fear of the transfer of the drug resistance and multidrug resistance gens from the dogs to humans becomes very eminent due to the close direct contact of the dogs and their owner , thus such practice of closeness should be watched very closely and in good time too.

Sadly, the trend of drug resistance pathogens isolated from ventinary industries are becoming a growing public health challenge across the world, nevertheless, it will be recalled that antibiotics gets into the animal systems through the metaphylactic use, which involves the application of antibiotics for infection control and for therapeutic use and for prophylactic use that involves it's application for disease prevention and lastly through the use of antibiotic drugs as a growth promoter or enhancer which literally involves the application of drug enhancing antibiotics for the enlargement in size and improvement of yield of the products. The interaction of these drugs introduced into the animals to improve their health status, turned to be dangerous in a long run as they tend to change the molecular structures of the compounds used in formulating the drugs, thereby bringing about a huge tolerance of the drugs by the pathogens that inhabit the systems of the animal.

Consequently, the exposure of such organism with the routine antibiotics in our health facilities would certainly meet resistance of different degrees in real live approach, thus increasing the crises of multidrug resistance problems across the globe.

Therefore, it is very important that these domestic pets be treated and vaccinated regularly, and also, pets and humans should not be allowed to eat in the same plate or sleep on the bed as these may serve as a major source of transmitting zoonotic infections to man.

Conclusion

The study revealed the presence of microorganisms such as *Bacillus spp*.4.0%, *Escherichia coli* 20.0%, *Klebsiella* spp. 16.0%, *Proteus spp* 28.0%, *Pseudomonas spp*. 4.0%, *Staphylococcus aureus* 14.0% and *Streptococcus spp*. 4.0%. This show that pet dogs carry potential pathogenic organisms in their faecal matter that can serve as a source of zoonotic infection to the pet owners, especially when the strains that are prevalence are of high virulence and pathogenicity. The correlation analysis show a relationship between isolates with some socio-demographic data of pet owner and Pet biodata respectively. From the analysis, correlation coefficient values of .269 and .124 were obtained for Age of Pet Owner and Gender of Pet Owner respectively. It show a direct correlation but by implication, a very weak, non-significant ($p<0.05$) relationship exist between the organisms isolated and the variables (Age of Pet Owner and Gender of Pet Owner). However, no relationship exists between isolates and Visit to Vet Dr (r-0.38; $p>0.05$). Furthermore, negative non-significant correlation ($p>0.05$) was observed for Marital Status of Pet Owner ($r=-.158$) and Age of Pet ($r=-.023$) and isolate. Also, further correlation association between isolates and some risk factors using the correlation analysis matrix revealed an indication of an indirect but moderate association between isolates and Caressing ($r=-.347$, $p=.013$). However, other risk factors like Vaccination ($r=.042$), Feeding Pattern($r=.125$), Pet Bathing ($r=.220$) and Eat with pet in same plate ($r=.146$), did not prove statistical significance ($p>0.05$).

Nonetheless, the contamination of the environment by dog faecal matters may massively pose a global public health threat, hence putting the general public at high risk of contracting zoonotic infections of myriad magnitude. It is therefore very pertinent that these pets should be treated frequently by a certified trained veterinary physician, and their faecal matter should be disposed of properly to prevent the exposure of the general public, especially in an era of emerging infectious diseases across the globe from animal linked origin (zoonosis).

Recommendation

Base on the research findings, the following recommendations will be helpful in containing zoonotic infections:

- Pets should be taken to the veterinary clinic frequently for checkup and vaccination in order to reduce the rate of zoonotic infections.
- Unethical practices such as caressing of pets, pecking them and eating in the same plate with the pets should be avoided.
- Pet owners should visit the veterinary doctor or public health officer regularly on the feeding pattern, treating pattern and ways of disposing of their faecal matter to avert the consequences of zoonotic diseases to the general public.
- Finally, whenever laboratory analysis is being carried out on dog faecal matter, it is advisable that molecular techniques should be included so as to uncover the hard to find pathogens.

Conflict of Interest

None was observed among authors.

Acknowledgements

We are sincerely grateful to the Dogs owners who cooperated with us maximally, without which this research would not have been possible. We are also grateful to many veterinary physicians who volunteered to work with us during sample collection and also allowed us to use their clinic during sample collection. We are also thankful to the Medical Laboratory Staff of

Microbiology Department, for their technical support during the sample analysis and identification of the pathogens.

References

1. Young J K, Olson K A, Reading R P, Amgalanbaatar S. & Berger J (2011). "Is Wildlife Going to the Dogs? Impacts of feral and free-roaming dogs on wildlife populations*. BioScience*, 61(2), 125-132.
2. Katagiri S & Oliveira-Sequeira T (2011). Prevalence of dog intestinal parasites and risk perception of zoonotic infection by dog owners in São Paulo State, Brazil*.Zoonoses and Public Health*,55(8-10), 406-13.
3. Beth TR, Nokota M (2006). Pet companionship and depression: results from a United States Internet sample. Anthrozoos: *A Multidisciplinary Journal of the Interactions of People & Animals*,19(1), 50-64.
4. Moriello KA (2003). Zoonotic skin diseases of dogs and cats. AnimalHealth Research Reviews, 4(02), 157-68.
5. Hubbard K, Skelly BJ, Mckelvie J & Wood JLN (2007). Risk of vomiting and diarrhea in dogs. *Veterinary Record*, 161, 755-757.
6. Marks SL Rankin, SC Byrne BA &Weese JS (2011). Enteropathogenic bacteria in dogs and cats: diagnosis, epidemiology and control. *Journal of Veterinary International medicine*, 125, 11-1208.
7. Bagshaw C, Isdell AE, Thiruvaiyaru DS, Brisbin Jr L, Sanchez S (2014). Molecular detection of canine parvovirus in flies (Diptera) at open and closed canine facilities in the eastern United State. Preventive Veterinary Medicine, 114(3-4), 276-284.
8. Leon C & Kaya S (2004). Review: The Important bacterial zoonosis in "one health" concept. *Journal of USNational Institute of Health*, 2(1), 144.
9. Center for Disease Control (2018). Public health in action.Retrieved from https://www.cdcfoundation.org/what-public-health [Retrieved18th June 2020].
10. Honour W (2015). Pets: are you aware of the risk to human health.Retrieved from https://www.medicalnewstoday.com/article/292829.php. [Retrieved 9th August 2020].
11. Center for Disease Control, (2016). Animal (zoonotic).Retrieved from https://www.cdc.gov/parasites/animals.html [Retrieved7th August 2020].
12. Joan R (2011). Out of the sack, cat! Sleeping with pets carries diseases risk. Retrieved from http://www.nbcnews.com/id/41235440/ns/health-pet_health/t/out-sack-cat-sleeping-pets carries-disease-risk/#. W4VVPDknapY [Retrieved 13th June 2020].
13. Center for Disease Control (2012). Animal-human disease (zoonosis).Retrieved from https://www.cdc.gov/globalhealth/countries/ nigeria/what/zoo.htm [Retrieve 27th April 2020].
14. Emmanuel J A, Patrick N, Akin O & Olutayo O (2013). Factors associated with probable cluster of Leptospirosis among kennel workers in Abuja, Nigeria. Pan African Medical Journal, 16, 144.
15. Eppes SC (2016). Infection that pets carry. Retrieved from https://kidshealth.org/en/parents/pet-infections.html [Retrieved 11th June2020].
16. Alex M (2018). Top 10 ways to reduce zoonotic disease.Retrieved from https://www.petmd.com/dog/parasites/ways_to_reduce_zoo- notic_diseases [Retrieved 3rd August 2020].
17. Ekeinde A (2012). Slum demolition plan ups tension in Nigeria oil hub.Reuter Africa. p. 2.Archived.
18. Cheesbrough M (2006). District laboratory in tropical countries.Part2. Cambridge University Press, UK. pp. 143-157.
19. Martins CM, Mohamed A, Ana Marcia SG, Barros CC, Pampuch W S & Biondo AW (2013). Impact of demographic characteristics in pet ownership: Modeling animal count according to owners income and age. *Preventive Veterinary Medicine*, 109(3), 213-218.
20. Kristen CJ & Chang L (2018).Association between pet ownership and attitude toward pets with youth socioemotional outcomes.Original Research, 9.
21. Bassette LA & Taber-Doughty T (2013). The effects of a dog reading visitation program on academic engagement behavior in three elementary students with emotional and behavior disabilities: A single case design. *Child & Youth Care Forum*, 42(3), 239-256.

22. Glyn MC & June M (2019). A theoretical basis for health benefit of pet ownership: Attachment versus psychological support. Sage Knowledge.

23. Lynette AH & Mariko Y (2012). Euthanasia, pet loss, and grief for owners and veterinarians.MSD Veterinary Manual.

24. Stephen S (2014). Prevalence of specific dog breeds. Today's Veterinary Practice.

25. Horzinek MC, Schultz RD, Squires RA & Day M.J (2016) WSA- VA Guidelines for vaccination of dogs and cats. *Journal of Small Animal Practice*, 57(1).

26. Mahia AS (2009). Captive dogs as reservoirs of some bacteria.*Research Journal of Microbiology*, 4(6), 222-228.

27. Julia AB, Jamine JK, Judy AT, Nicholas IB, Murphy A J & Mansfield LS (2008). Ecological characterization of the colonic microbiota of normal and diarrheic dogs. *Interdisciplinary Perspectives of Infectious Diseases*, 17.

28. Mirjam D, Mughini-Gras L, Schurman N, Wim, N, Jaap, A W& Herman, E(2016). Enteropathogen infections in canine puppies (Co-occurrence, clinical relevance and risk factors. *Veterinary Microbiology*, 195, 115-122.

29. Edward, J (2004). Bacteria enteropathogens in dogs. World SmallAnimal Veterinary AssociationWorld Congress Proceeding.

30. Ghasemzadeh I & Namazi SH (2015). Review of bacterial and viral zoonotic infections transmitted by dogs. *Journal of Medicine and life*, 8(4), 1-5.