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ORIGINAL ARTICLE

Salmonella infection in clinically healthy dogs in Makurdi, Benue State, North-central Nigeria: A potential source of infection to humans

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ABSTRACT

Objective: The present study was initiated to ascertain the level of shedding of salmonellae by dogs in Makurdi area and to highlight the risk of infection for dog-owners.
Materials and Methods: Rectal swabs from 200 dogs from different locations in the study area were examined in the study. The samples were cultured for salmonellae using Rappaport-Vassiliadis enrichment broth (Oxoid) and brilliant green agar (Oxoid). Suspected *Salmonella* isolates were serologically identified.
Results: Overall, *Salmonellae* organisms were isolated from 11 (5.5%) of the 200 dogs sampled. Prevalence rates of 5.6% and 4.5% were recorded for apparently healthy and clinically sick dogs, respectively. *Salmonella* was respectively isolated from 4.1% to 9.1% of male and female dogs. Dogs aged 4 years and above recorded the highest prevalence rate. The study revealed a low prevalence rate in Nigerian local breed (mongrels) and high prevalence rates in exotic breeds of dogs.
Conclusion: The isolation of salmonellae in apparently healthy and clinically sick dogs in this study indicates a carrier status which may constitute a serious problem in disease control in the study area. The lower prevalence rate of *Salmonella* infection in mongrels could be an indication of resistance to *Salmonella* in local breeds of dogs and should generate interest in research in the pathogenicity and pathogenesis of salmonellae in mongrels.

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Introduction

Currently, there are more than 2,500 serotypes (serovars) of the genus *Salmonella* [1–3]. Members of the species *enterica* are the main causative agent of human gastro-enteritis [4]. Several studies [5–9] reported *Salmonella* infections as a serious cause of foodborne diseases in both humans and animals.

Several studies have been conducted worldwide to assess the prevalence of *Salmonella* infections in clinically healthy and diarrheic dogs [7,10,12–16]. Reimschuessel et al. [7] cited data from 95 studies in different parts of the world where fecal samples were taken from dogs under a variety of conditions, including those seen at clinics, in households, pet shops, shelters, laboratories, and an assortment of kennels, and working dogs, including therapy dogs and military dogs. In their reports, Reimschuessel et al. [7] pointed out that studies also varied greatly in isolation and detection methods.

Dogs typically contract *Salmonella* infection from eating contaminated foods, including unprocessed or raw dog food, especially raw meat contaminated by *Salmonella* [7]. Finley et al. [17] observed that when dogs are fed with *Salmonella*-contaminated feed, raw food, and commercially prepared dry foods, they can become infected and consequently shed the organism in their feces to contaminate the environment, domestic animals, other dogs, and even man [10]. Ojo and Adesotoye [14] also observed that dogs could acquire *Salmonella* infection during scavenging and thus, such dogs are likely to harbor more *Salmonella* serovars than non-scavengers kept under hygienic conditions.

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The rate of *Salmonella* infection in clinically healthy and hospitalized dogs has been estimated to range from 1% to 36% [10,18]. In recent studies in Nigeria, reported overall prevalence rates of 3.7% [14] and 43.7% [10].

Veterinarians and public health officials have recognized the shedding of salmonellae by dogs as a possible source of *Salmonella* infection for dogs and their communities [19–21]. There is a paucity of documented reports on the prevalence of *Salmonella* infection in Makurdi and Benue State in general. This study aimed to determine the prevalence and carrier status of *Salmonella* in dogs in Makurdi, Benue State, North-central Nigeria.

Materials and Methods

Study area

The study area was Makurdi in north-central Nigeria and the capital city of Benue State. Its geographic coordinates are longitude 8°32'00" and latitude 7°44'00" [22]. Makurdi is inhabited mainly by civil servants, paramilitary, soldiers, traders, fishermen, farmers, and craftsmen. A reasonable number of people in the area keep dogs.

Sample size and sampling

Maximum epidemiological coverage of animals from the study area was obtained by dividing the area into four parts (North, South, East, and West) for the purpose of this study and focusing on households that keep dogs. Dogs in all the households visited were sampled but required the agreement of the dog owners to make their dogs available.

One hundred and seventy-three households were visited for sample collection. Using plastic handle swabs, rectal swabs were collected from 200 dogs. The swabs were placed immediately into Rappaport-Vassiliadis enrichment broth (Oxoid®, CM0669B) and taken to the laboratory for isolation of *Salmonella* within 4 h of collection. During sample collection, the breed, sex, age, and health status of the dog were recorded.

Isolation and identification of Salmonellae

The rectal swabs inoculated into Rappaport-Vassiliadis enrichment broth were incubated aerobically at 37°C for 24 h. Subcultures from Rappaport-Vassiliadis enrichment broth were made onto brilliant green agar (Oxoid®, CM0263B) and incubated at 37°C for 24 h aerobically. The agar plates were examined for the growth of colonies after 24 h. From each of the selective agar plates, presumptive *Salmonella* colonies were selected for microscopy.

Non-lactose fermenting (pink) colonies that were Gram-negative coccobacilli, oxidase-negative, and catalase-positive were tentatively identified as *Salmonella* organisms and were streak-purified on nutrient agar (Oxoid®, CM0003B). Confirmation of these isolates was done by latex agglutination technique using Oxoid *Salmonella* Test Kit® (DR1108A). Isolates that showed agglutination in less than 1 min were

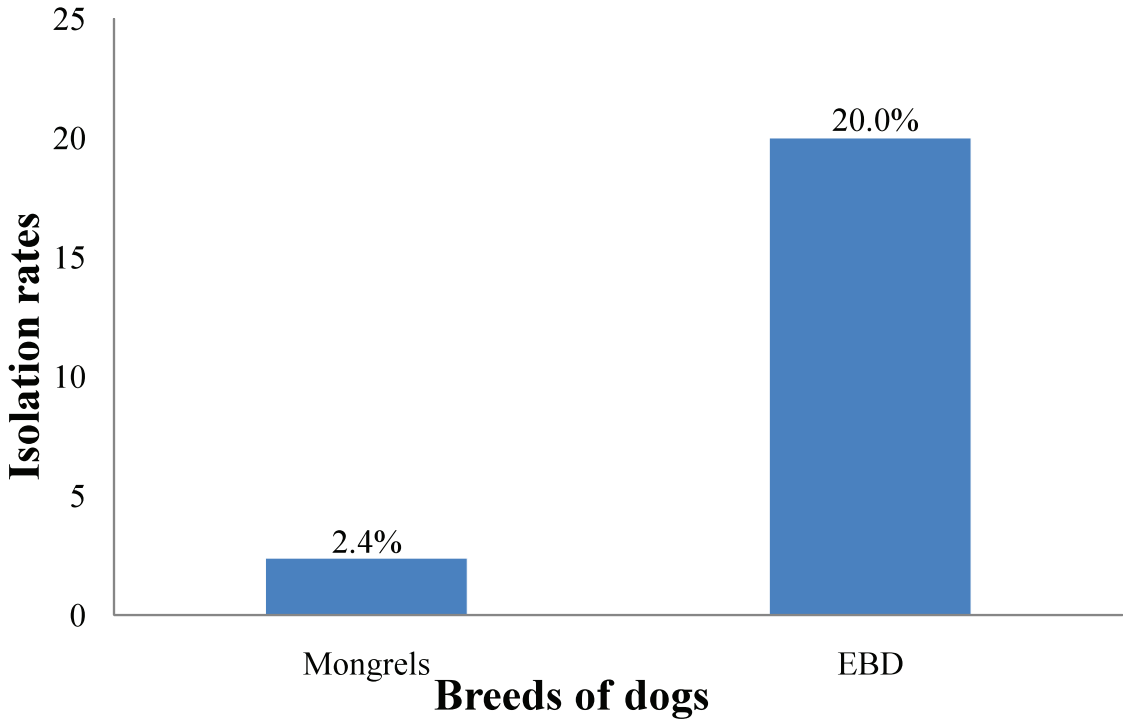

Figure 1. Percentage occurrence of *Salmonella* infection in breeds of dogs. EBD = exotic breeds of dogs.

identified as *Salmonella* organisms. The Oxoid *Salmonella* Test Kit detects the majority of common *Salmonella* serotypes, including *Salmonella typhimurium* and *Salmonella enteritidis*.

Statistical analysis

The significance of the association between dog breeds, age, sex, and clinical signs and the prevalence of *Salmonella* infection was determined using chi-squared analysis. Significance was accepted at 5% probability level.

Results

Salmonella serotypes were isolated from 11 (5.5%) rectal swabs of the 200 dogs examined in the study area (Table 1). Salmonellae were isolated from 1 (4.5%) of the 22 clinically sick dogs and 10 (5.6%) of the 178 apparently healthy dogs; *Salmonella* isolation was not significantly ($p > 0.05$) associated with clinically sick dogs (Table 1).

Six (4.1%) of the 145 male dogs and 5 (9.1%) of the 55 female dogs examined were positive for *Salmonella* isolation (Table 2). There was no significant ($p > 0.05$) association between the prevalence of *Salmonella* infection and sex of dogs.

Salmonella infection rates among breeds of dogs are shown in Table 3. Infection rates ranged from 0% to 100%. Isolation rate of salmonellae, as shown in Figure 1, was significantly ($p < 0.05$) higher in exotic breeds of dogs (EBD) (15.6%) than in Nigerian local dogs (2.6%). Only one Chihuahua breed was sampled and it was positive for *Salmonella*. Rottweiler and Alsatian breeds recorded significantly ($p < 0.05$) high isolation rates of *Salmonella,* respectively.

Salmonellae were not isolated from Caucasian, Bullmastiff, and Alsatian-Rottweiler cross sampled. There was a significant ($p < 0.05$) association between the prevalence of *Salmonella* infection and breed of dogs in this study.

Salmonellae were isolated from all the age-groups identified in this study with the prevalence rates ranging from 2% to 20% (Table 4). There was a significant ($p < 0.05$) association between the prevalence of *Salmonella* infection and age. *Salmonella* infection rates were lower in dogs below 4 years and much higher in dogs that were 4 years and above.

Discussion

Out of the 200 dogs screened, 11 (5.5%) were confirmed by the serological method to be colonized by *Salmonella* serotypes. This finding reveals that dogs in Makurdi, Benue State, North-central Nigeria can harbor Salmonellae. This prevalence rate of salmonellae recorded in this study falls within 0.0% and 43.0% range of the prevalence of *Salmonella* isolated from clinically healthy dogs reported by Sanchez et al. [19] and Carter and Quinn [23] cited by Jajere et al. [10]. Since salmonellosis can be transmitted from dogs to human, as cases of dog to human transmission of *Salmonella* resulting in severe infection in human have been reported by Morse et al. [13], the presence of *Salmonella* in dogs makes them a potential source of infection to their human companions in Makurdi, Benue State. Households that keep dogs and those who make frequent contacts with dogs should be aware of this fact to take precautionary measures. Ojo and Adetosoye [14] pointed out that infection in dogs might be acquired from their food sources and they subsequently pass the infection on to their human companions. Thus, humans can acquire *Salmonella* from dogs following contaminations of the immediate, shared-environment, and household utensils.

The isolation rate of salmonellae recorded in this present study is at variance with the results obtained from other

Table 1. Distribution of *Salmonella* infection in Makurdi based health status.

Health status	No. sampled	No. (%)* positive
Clinically healthy	178	10 (5.6)
Clinically sick	22	1 (4.5)
Total	200	11 (5.5)

* = % of total number sampled for each row.

Table 2. Sex distribution of *Salmonella* infection in dogs in Makurdi.

Sex	No. sampled	No. (%)* positive
Male	145	6 (4.1)
Female	55	5 (9.1)
Total	200	11 (5.5)

* = % of total number sampled for each row.

Table 3. Breed distribution of *Salmonella* infection in dogs in Makurdi.

Breed	No. sampled	No. (%)* positive
Nigerian local breed (Mongrel)	165	4 (2.4)
Caucasian	4	0 (0.0)
Alsatian	18	4 (22.2)
Rottweiler	7	2 (28.6)
Bullmastiff	2	0 (0.0)
Alsatian-Rottweiler cross	3	0 (0.0)
Chihuahua	1	1 (100.0)
Total	200	11 (5.5)

* = % of total number sampled for each row.

Table 4. Age distribution of *Salmonella* infection in dogs in Makurdi.

Age group (year)	No. sampled	No. (%)* positive
0–2	126	5 (4.0)
>2 ≤ 4	47	1 (2.0)
>4 ≤ 6	15	3 (20.0)
>6	12	2 (17.0)
Total	200	11 (5.5)

* = % of total number sampled for each row.

parts of Nigeria and other countries in the world. Kwaga et al. [16] and Ojo and Adetosoye [14] reported lower isolation rates of 1% and 3.7% of salmonellae in dogs in Zaria (North-eastern Nigeria) and Ibadan (South-western Nigeria), respectively. Seepersadsingh et al. [15], in a similar study in Trinidad, reported a lower prevalence rate (3.6%) of *Salmonella* spp. in non-diarrheic dogs. On the other hand, in similar studies by Britt et al. [24] in Vom (North-central Nigeria) and Jajere et al. [10] in Maiduguri (North-eastern Nigeria), higher prevalence rates of 18% and 43.7% were respectively reported. A higher prevalence of 23.5% for *Salmonella* was also recorded in dogs in Sudan in an earlier study by Khan [12] cited by Jajere et al. [10]. The differences in the prevalence rates in the various studies mentioned above could lie, as pointed out by Seepersadsingh et al. [15] and Jajere et al. [10], in the differences in the sample sizes, period of study, type of fecal samples, geographical areas, and isolation methods employed.

The finding in the present study that *Salmonella* infection rate was higher in clinically healthy dogs than in sick ones did not corroborate the results of Ojo and Adetosoye [14], who reported the prevalence rates of 4.0% and 3.6% in sick and healthy dogs, respectively, in Ibadan. The difference in the prevalence in the two studies could be attributed to the differences in the sample sizes. Ojo and Adetosoye [14] sampled 126 clinically sick and 332 healthy dogs as against 22 and 178 clinically sick and healthy dogs, respectively, sampled for the present study. However, both studies showed no significant difference ($p > 0.05$) in the incidence of *Salmonella* between clinically sick and healthy dogs. Isolation of *Salmonella* from feces of clinically sick dogs does not necessarily mean that the organism was the cause of the ill health. Other infectious and non-infectious agents can cause ill health in dogs.

In spite of sampling about three times more male than female dogs, female dogs showed a higher prevalence rate (9.1%). However, the strength of the association of infection with sex was not significant ($p > 0.05$). This finding contradicts an earlier report of significantly ($p < 0.05$) higher prevalence rate of *Salmonella* infection in male (50.0%) compared with female (34.7%) dogs in Maiduguri, North-western Nigeria [10]. Jajere et al. [10] recorded significantly higher prevalence rates in both sexes in spite of having smaller sample sizes when compared to the present study that recorded 4.1% and 9.1% prevalence rates in male and female dogs, respectively. The difference in isolation rates in both studies could be attributed primarily to the period of sampling and isolation methods employed. In the study by Jajere et al. [10], Carry-Blair transport medium, Selenite feces broth, brilliant green agar, McConkey agar, *Salmonella-Shigella* agar, and Xylose Lysine deoxycholate agar were used in the isolation of *Salmonella*.

Ironically, the present study revealed significantly ($p < 0.05$) higher isolation rate (20.0%) of *Salmonella* in EBD despite the fact that most owners of these dogs are rich and capable of keeping them under good hygienic conditions, which reduces their chances of exposure to contaminated materials. *Salmonella* infection in these EBD, as revealed in this study, may be due to the fact that the rich owners fed the dogs commercially prepared *Salmonella* contaminated diet and/or unprocessed or raw dog feed, especially meat that was contaminated. The lower prevalence rate (2.4%) of *Salmonella* infection in Nigerian local breed (Mongrels) recorded in this study is possibly an indication of a level of resistance to *Salmonella* in local breeds of dogs in the study area. Most mongrels are kept under poor management and compromised sanitary conditions because their owners are poor; thus mongrels are more exposed to *Salmonella* infection. Our findings completely contradict the reports of Jajere et al. [10], which revealed a very high prevalence rate (49.5%) of *Salmonella* infection in Nigerian local breed mongrel and low prevalence rate (18.2%) in exotic breeds in Maiduguri.

The low prevalence rates of *Salmonella* infection in dogs within age groups of 0–2 and >2 ≤ 4 years could result from the protection by the maternal antibodies and robust immune system in dogs within the respective age brackets. The high isolation rates of *Salmonella* in dogs above 4 years revealed in this study could be attributed to the compromised immune system. Greene [18] pointed out that older dogs are usually immunosuppressed and therefore, at high risk of infection [10]. The lower prevalence observed in younger dogs in this study agrees with the report of Jajere et al. [10] who also recorded lower prevalence in younger dogs in Maiduguri.

Conclusion

In conclusion, the isolation of salmonellae in apparently healthy and clinically sick dogs in this study could indicate a carrier status, which could have major epidemiological consequences in disease control programs as these infected dogs consequently contaminate the human environment, including food and water, which puts humans at risk. Thus, households that keep dogs (whether exotic or local breeds) and those who frequently come in contact with dogs should be aware of this fact in order to maintain adequate personal and environmental standard hygiene. Control of fecal contamination, both humans and animals, is of primary importance. Dogs must be prevented from eating feces and should be fed uncontaminated and properly cooked food. The low prevalence of *Salmonella* infection in mongrels in the present study should arouse interest in research in the pathogenicity and pathogenesis of *Salmonella* in local breeds of dogs.

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Conflict of Interests

None of the authors have any conflict of interest.

Authors' contribution

Akwuobu, Chinedu Adive and Agbo, Joseph Odeh: Carried out the field and laboratory work. Ofukwu, Agbo-Peters Raphael co-supervised the study with Akwuobu, Chinedu Adive.

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