Brucella Prevalence in Goats and Farmers’ Awareness and Practices towards Brucella Infection in Giwa Area of Kaduna State Nigeria

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Authors’ contributions

This work was carried out in collaboration between all authors. Author RD designed the study, performed the statistical analysis, wrote the protocol, wrote the first draft of the manuscript and managed literature searches. Authors BVM, JAM and JQT managed the analyses of the study and literature searches. All authors read and approved the final manuscript.

ABSTRACT

Aims: To detect and determine the prevalence of Brucella antibodies in goats and farmers’ awareness and practices towards Brucella infection in Kaduna State, Nigeria.

Experimental Design: A cross sectional study was used in this research.

Place and Duration of Study: Giwa area in Kaduna State, Nigeria. The study was conducted from July, 2014 to June, 2015.

Methodology: Two hundred and eighty serum and 113 milk samples (from lactating Does) were collected from goats in Giwa area of Kaduna State. Of the six districts in the area, 52 samples were collected from 10 households in Kakangi, 45 from 9 households in Giwa, 43 from 8 households in...
Tsibiri, 43 from 8 households in Gangara, 56 from 10 households in Yakawada, 41 from 9 households in Danmahawayi. Open and close ended questionnaires were administered to the farmers in form of interview using local dialect, to obtain information on their goats, such as age, sex, management practices, pregnancy, abortion history, and other reproductive problems such as retention of placenta in goats. Rose Bengal Plate Test (RBPT), Competitive Enzyme Linked-Immunosorbent Assay (cELISA) and Milk Ring Test (MRT) were used to detect *Brucella* antibodies. Open and close ended questions were administered to the farmers in form of interview to obtain information on their goats and to determine their knowledge and practices with respect to *Brucella* infection. Chi-square ($\chi^2$), Fisher’s exact tests and Odds ratio were used to test for association between categorical variables. P-value less than 0.05 (P<0.05) was considered statistically significant.

**Results:** A prevalence of 8.2%, 2.5% and 38.1% were obtained using RBPT, cELISA and MRT respectively. There was a significant association (P<0.037) between the districts and prevalence of *Brucella* antibodies in milk. The prevalence of *Brucella* antibodies was higher (10.9%) in goats from households where the farmers had no knowledge of the disease than those who had knowledge of the disease (5.9%). Those flocks with history of abortion had a lower prevalence (6.3%) as compared to those without abortion (12.5%). Detection of *Brucella* antibodies were higher (13.8%) in flocks that recorded abortion during the late gestation period than the early (5.0%) and mid (12.3%) gestation periods. Thirty-nine percent of these farmers used polythene bags on their hands as protective covering when handling aborted fetuses and other vaginal discharges, while 56.1% discard aborted materials freely into the environment. There was no statistical association between the prevalence of *Brucella* antibodies and farmers’ knowledge of the disease, abortion history and gestation period at the time of abortion.

**Conclusion:** This study has demonstrated that goats in Kaduna State harbour antibodies to *Brucella* and the farmers’ awareness and practices towards *Brucella* infection is insufficient. There is a need to further enlighten the farmers on the zoonotic implication of brucellosis, *Brucella* infection prevention and control.

**Keywords:** Antibodies; *Brucella*; cELISA; farmers; goats; prevalence; awareness; practices; Nigeria.

### 1. INTRODUCTION

Brucellosis is a bacterial disease caused by the members of the Genus *Brucella* that can infect humans but primarily livestock. *Brucella* organisms are facultative, small, Gram negative, non-motile, non-spore forming, coccobacilli bacteria [1,2]. *Brucella* has several species but the most important ones and their preferred natural host include: *B. abortus* (cattle), *B. melitensis* (goats and sheep), *B. suis* (pigs), *B. canis* (dogs), *B. ovis* (sheep), *B. neotomae* (desert wood rat), *B. ceti* and *B. pinnipedialis* (isolated from cetaceans and pinnipeds respectively) [3,4].

Brucellosis in goats is caused by *B. melitensis* and *B. abortus* with clinical signs such as abortion, infertility, birth of weaklings, retention of the placenta and dead offsprings [5,6]. This infection may vary in duration from acute to chronic infection, which may be persistent for years, where excretion of the organism in vaginal discharges and milk may continue for at least two lactation periods and perhaps many more.

Occupational groups such as farmers, shepherds, butchers, laboratory workers, veterinarians and slaughterhouse workers have a greater risk of contracting the disease through inhalation of contaminated aerosols or entry of the bacteria through cuts and abrasions in the skin as a result of contact with infected animals or their products [7,8]. The non-occupational sources of exposure include ingestion of infected meat, unpasteurized milk and milk products [7]. Although human-to-human transmission of the disease is rare, the possible transmission of this organism through bone marrow transplantation, blood transfusion, trans-mammary route, and sexual intercourse have been documented [9,10].

Globally, most cases of human brucellosis are caused by *B. melitensis* which is considered the most invasive and pathogenic species of the genus [11]. In the livestock industry, *Brucella* has caused economic wastage resulting from loss of young, replacement of animals, and reduction of milk yield [12]. Although the disease has been eradicated in most industrialized nations, its occurrence is still on the increase especially in...
developing countries such as Nigeria, where it remains a serious zoonotic disease [13,14].

Livestock form key components of the livelihood strategies of many of the world's poorest people, with different species fulfilling different functions in the household economy [15]. In Nigeria, small ruminant production plays an important role in the economic improvement of poor farmers and contributes to poverty alleviation [16]. However, one of the major constraints to a successful development of goat industry is the menace of abortion and stillbirth caused by diseases such as brucellosis [17,18]. This study was designed to determine the prevalence of Brucella antibodies in goats and farmers' knowledge and practices towards Brucella infection in Giwa area of Kaduna State, Nigeria with the aim of understanding the epidemiology of this infection in the study area.

2. MATERIALS AND METHODS

2.1 Study Location/Design

A cross sectional study was conducted in six districts namely; Giwa, Yakawada, Tsibiri, Dan Mahawyai, Kakangi and Gangara within Kaduna State from July, 2014 to June, 2015. The study area has a landmass of about 3,350 square kilometres with a human population of about 280,427 (National Bureau of Statistics, 2007) and located 30 km north-west of Zaria. It lies on latitude 11° 30′ N and longitude 7° 45′ E [19].

2.2 Sampling Procedure

A multistage cluster sampling method was used to select the districts, households and goats in the study area. A total number of 280 goats were sampled from households in each of the Districts by employing the systematic random sampling method, whereby a maximum of 3 and 5 goats were sampled from households having ≤15 goats and >15 goats in a flock respectively, while all lactating does seen at the time of sampling were included in the study for collection of both blood and milk samples. An organogram showing the different sampling techniques used in the selection of districts households and goats in Giwa area of Kaduna State are shown in (Fig. 1).

2.3 Sample Collection

2.3.1 Collection of milk

A total of 113 lactating does were sampled from among the 280 goats. Before each lactating doe was milked, the teats were disinfected using 70% alcohol. The fore milk was stripped to reduce contamination and five ml of milk was collected into a clean sterile sample bottle, labelled, kept on ice packs (4°C) in a Cole-man® box and transported within 2 hours to the laboratory for analysis.

2.3.2 Collection of blood for sera

A total of two hundred and eighty blood samples were collected from all the six Districts. Five ml of blood was aseptically obtained from jugular vein of each selected goat using a ten ml sterile syringe into a plain ten ml sample bottle containing no anticoagulant. Each sample was labelled accordingly and these samples were then transported on ice packs (4°C) in a Cole-man® box within 2 hours to the Laboratory. The blood samples were centrifuged at 3,000 x g/5 minutes to obtain clear sera for analysis.

2.4 Questionnaire Administration

Open and close ended questions were administered to the farmers in form of interview using local dialect, to obtain information on their goats, such as age, sex, management practices, pregnancy, abortion history, and other reproductive problems such as retention of placenta in goats. The questionnaires were also used to determine farmers’ knowledge and practices with respect to Brucella infection. A total of 54 households were sampled for the study but only 41 farmers agreed to be interviewed. Therefore, the household head or his representative in each of the 41 houses where the samples were collected was interviewed.

2.5 Laboratory Analysis

2.5.1 Milk ring test (MRT) for milk

The Milk ring test antigen was obtained from Veterinary Laboratory Agency (VLA), Surrey, United Kingdom. The test was performed by adding 0.03 ml of MRT antigen to 1 ml of whole milk. The milk and antigen mixtures were incubated at 37°C for at least an hour. Formation of a dark blue ring above a white milk column was considered positive. The test was interpreted as negative if the colour of the underlying milk remains homogeneously dispersed in the milk column.
Fig. 1. An organogram showing the multistage sampling techniques used in the selection of districts households and goats in Giwa area of Kaduna State.

2.5.2 Rose bengal plate test (RBPT) for sera

The Rose Bengal Plate Test (RBPT) antigen was obtained from Veterinary Laboratory Agency (VLA), Surrey, United Kingdom, and the test was carried out as described [20].

2.5.3 Competitive enzyme-linked immunosorbent assay (cELISA) for sera

The cELISA kit coated with Brucella melitensis antigen was obtained from Veterinary Laboratory Agency, Weybridge, United Kingdom. The test procedure was performed according to the manufacturer’s instruction.

Briefly, the conjugate concentrate (BM40) was mixed in a diluting buffer. The microplate was prepared by adding 20 µl of each test serum per well, while two columns D11, D12 and E11, E12 were used as control wells and had no sera. Twenty microlitre (20 µl) of the negative control was added to wells A11, A12, B11, B12, C11 and C12, while 20 µl of the positive control was added to wells F11, F12, G11, G12, H11 and H12. The prepared conjugate solution (100µl) was immediately dispensed into all wells, giving a final serum dilution of 1:6. The plates were rinsed 5 times with a washing solution and dried by tapping on absorbent paper towel. 100 µl of stopper solution was added to all wells to slow the reaction and the plate was read using the microplate reader at 450 nm. The resulting colouration was interpreted by visual reading whereby the appearance of white colouration indicates the presence of Brucella antibodies whereas yellowish colouration indicates that there are no Brucella antibodies in the test sample.

2.6 Statistical Analysis

The data obtained as well as the questionnaire survey were statistically analyzed using descriptive analysis to express Brucella positive samples as percentages. Statistical Package for Social Sciences (SPSS) was used to determine the Chi-square (χ²), Fisher’s exact tests and Odds ratio where appropriate to test association between categorical variables. P-value less than 0.05 (P<0.05) was considered statistically significant.

3. RESULTS AND DISCUSSION

3.1 Sero-prevalence of Brucella Antibodies in Goats by RBPT and cELISA Based on Districts in Giwa Area of Kaduna State

Out of the 280 serum samples evaluated for Brucella antibodies, 23 (8.2%) and 7 (2.5%)
tested positive respectively. Giwa district recorded the highest prevalence using the RBPT, while Gangara and Tsibiri districts had higher antibodies to Brucella using the cELISA as compared to the other districts. There was no statistical association (P>0.05) between the prevalence of Brucella antibodies and the districts sampled (Table 1). This study has shown that antibodies to Brucella were detected in goats in six districts of Giwa, Kaduna State.

The relatively high prevalence of Brucella antibodies in goats from Giwa area could be attributed to the fact that these goats were housed together and were allowed to graze freely, thereby coming in contact with other infected animals and environmental contaminants that could be harbouring Brucella organisms [21,22]. These farmers also introduced new goats into the flock without quarantining or vaccinating them and these animals could be carriers of Brucella and may possibly introduce them into the animal population [23].

3.2 Sero-prevalence of Brucella Antibodies in Goats by RBPT and cELISA Based on Breed, Age and Sex Distribution

Of the 256 Red Sokoto breed sampled, 20 (7.8%) were positive to Brucella antibodies on RBPT, whereas 6 (2.3%) were positive on cELISA. One (12.5%) out of the 8 breed representing the West African Dwarf was positive on RBPT, while none (0%) was positive on cELISA. Sixteen Kano Brown breed were tested, of which 2 (12.5%) and 1 (6.3%) were positive by RBPT and cELISA respectively. Twenty-four goats aged less than 12 months showed no positive reaction when tested using both RBPT and cELISA. Six (5.4%) and 2 (1.8%) out of 111 goats within the age range of 12-36 months were positive on RBPT and cELISA. Out of 145 goats aged above 36 months tested, seventeen (11.7%) and 5 (3.4%) were found to be positive on RBPT and cELISA respectively. Four (8.0%) out of the 50 male goats tested were positive to Brucella antibodies while 19 (8.3%) out of 230 females tested had antibodies to Brucella as tested on RBPT. Two males (4.0%) and 5 (2.2%) females were positive on cELISA. There was no statistical association between the different breeds, age and sex and the prevalence of Brucella antibodies (P>0.05) (Table 2). The sero-prevalence of Brucella antibodies in goats on Rose Bengal Plate Test (RBPT) was low when compared to previous studies [24,25] in Plateau and Sokoto States respectively, but higher than those reported by [18,23,26] in the arid zone of Nigeria, Ibadan and Bauchi States respectively. The disparity with respect to other studies may be attributed to the variation in the sensitivity and specificity of the type of test used to detect Brucella antibodies and the management system employed by farmers in the flock.

The prevalence of Brucella antibodies varied among the male and female goats in this study. With RBPT, the female goats had a slightly higher prevalence than their male counterparts. However, the males had a higher prevalence of Brucella antibodies than the females as detected by cELISA. The presence of erythritol, a sugar which favours the growth of Brucella in the reproductive organs of susceptible animals could be a factor making these goats prone to Brucella infection. This sugar is secreted in large quantity in goats of reproductive age especially females during pregnancy, leading to rapid multiplication of Brucella in the placenta and uterus, thus causing placentitis and metritis, which could result in abortion. Interestingly, earlier studies have shown that females are more susceptible to Brucella infection than the males [27,28].

The result showed a higher prevalence of Brucella antibodies in the West African Dwarf and Kano Brown breeds, as compared to Red Sokoto breed by RBPT, while there were more Kano brown breeds with higher rate of antibodies to Brucella as detected by cELISA. This result is in contrast with the findings of [25] who reported a higher prevalence in the Red Sokoto as compared to the Sahelians and cross breed of goats in Sokoto metropolis. However, previous reports have shown that Brucella infection is not breed specific [29,30].

Goats above 36 months of age showed higher prevalence of Brucella antibodies than the younger ones as demonstrated by both the RBPT and cELISA. This could be attributed to the fact that younger goats (kids) are conferred with maternal immunity and therefore, are protected against infectious agents at the early stage of their lives. Studies have shown that Brucella infection is usually high in sexually matured animals than the younger ones because animals within this age range are actively involved in breeding and this could predispose them to Brucella infection which may have serious economic implications in terms of loss through reproductive wastages [31-33].
Table 1. Sero-prevalence of Brucella antibodies in goats by RBPT and cELISA based on districts in Giwa area of Kaduna State

| Sampling location (districts) | No. of sera tested | RBPT | cELISA | *F-test | P-value |
|------------------------------|--------------------|------|--------|---------|---------|
|                              |                    | No. positive (%) | No. positive (%) |         |         |
| Giwa                         | 45                 | 6 (2.1) | 1 (0.4) |         |         |
| Gangara                      | 43                 | 4 (1.4) | 2 (0.7) | **5.535 | **0.337 |
| Yakawada                     | 56                 | 5 (1.8) | 1 (0.4) | ***2.893 | ***0.754 |
| Dan Mahawayi                 | 41                 | 1 (0.4) | 0       | df=5    |         |
| Kakangi                      | 52                 | 2 (0.7) | 1 (0.4) |         |         |
| Tsibiri                      | 43                 | 5 (1.8) | 2 (0.7) |         |         |
| Total                        | 280                | 23 (8.2) | 7 (2.5) |         |         |

*Fisher’s exact test; **RBPT; ***cELISA

Table 2. Sero-prevalence of Brucella antibodies in goats by RBPT and cELISA based on breed, age and sex distribution

| Variables | No. of sera tested | RBPT | cELISA | *F-test | P-value |
|-----------|--------------------|------|--------|---------|---------|
|           |                    | No. positive | Specific rate (%) | No. positive | Specific rate (%) |         |         |
| Breed     |                    |                |                   |                |                   |         |         |
| Red Sokoto| 256                | 20             | 7.8               | 6               | 2.3               | **2.047 | 0.285  |
| West African | 8            | 1             | 12.5              | 0               | -                 | ***2.051 | 0.440  |
| Dwarf     |                    |                |                   |                |                   |         |         |
| Kano Brown| 16                 | 2              | 12.5              | 1               | 6.3               | df=2    |         |
| Age       |                    |                |                   |                |                   |         |         |
| <12 months| 24                 | 0              | -                 | 0               | -                 | **5.066 | 0.66   |
| 12-36 months | 111         | 6              | 5.4               | 2               | 1.8               | ***0.722 | 0.842  |
| >36 months| 145                | 17             | 11.7              | 5               | 3.4               | df=2    |         |
| Sex       |                    |                |                   |                |                   |         |         |
| Male      | 50                 | 4              | 8.0               | 2               | 4.0               | **1.0   |         |
| Female    | 230                | 19             | 8.3               | 5               | 2.2               | df=1    | ***0.612 |

*Fisher’s exact test; **RBPT; ***cELISA

3.3 Prevalence of Brucella Antibodies in Goats’ Milk by MRT in Giwa Area of Kaduna State

The overall prevalence of Brucella antibodies in milk detected by the milk ring test was 38.1% with Yakawada district recording the highest detection rate 10.6% of Brucella antibodies. There was a statistical association between the districts sampled and the presence of Brucella antibodies ($\chi^2=19.291; P=0.037; df=5$) (Table 3). The prevalence of Brucella antibodies recorded in milk in this study using the milk ring test (MRT) is presumably attributed to Brucella usually present in milk and other seminal and vaginal fluids where the organism is being shed by an infected animal for several years. False positive reactors could have contributed to the high prevalence observed in this study due to the low specificity attributed to the test and certain factors such as: mastitis, presence of colostrum, collection of milk at the end of the lactation period and/or hormonal disorder [34]. This result is in consonance with the findings of [35] who recorded a prevalence of 34.75% in goats in northern Nigeria, but higher than 17% reported in Kaduna [33].

3.4 Prevalence of Brucella Antibodies in Goats and Knowledge of Farmers on Brucella Infection

The prevalence of Brucella antibodies was higher in flocks where the farmers had no knowledge of the disease (10.9%) than those with knowledge of the disease (5.9%). Those who knew that the disease could be transmitted amongst animals recorded a higher (8.9%) detection rate than those (7.6%) who said it cannot be transmitted among animals. However, 8.5% prevalence was obtained in flocks where the respondents said the disease is not zoonotic in nature, while 5.9% of them said it is a zoonotic disease. There was no association between prevalence of Brucella
antibodies and knowledge of farmers on the disease (P > 0.05) (Table 4).

The response from the questionnaires administered revealed that farmers who had knowledge of the disease had lower prevalence of Brucella antibodies in their flock as compared to those without knowledge of the disease. Despite the fact that these farmers were aware of the disease, only a few of them knew that it is a zoonotic disease. The low level of knowledge on this zoonosis could predispose these farmers to Brucella infection as they hardly employed hygiene practices when handling the animals, aborted fetuses and other vaginal discharges that may be contaminated with Brucella organisms. These organisms are also shed in the milk of infected does and from this study; farmers consume goat milk without pasteurizing it. This is because demand for goat milk as a substitute for cow milk is on the increase, especially in the northern part of the country, where these farmers believe it has higher nutritional and medicinal importance, especially in its raw form [24,33]. The consumption of this unpasteurized goat milk is of public health concern, since goats harbour the most pathogenic strain of Brucella (B. melitensis) that may cause infection in humans. The high prevalence of Brucella antibodies detected in this study is an indication that individuals consuming unpasteurized milk are at risk of contracting brucellosis.

3.5 Prevalence of Brucella Antibodies in Goats and how it Relates to Information on Goats in the Flock

The respondents who source their goats from the Giwa central market had more (11.8%) antibodies to Brucella than those (6.2%) who bought their goats from their immediate community. Farmers who reported cases of abortion recorded a lower prevalence (6.3%) than those (12.5%) with no history of abortion in their flock. Respondents who noticed the occurrence of abortion at the late gestation period had a higher prevalence (13.8%) than those who noticed abortion at the early (5.0%) and mid (12.3%) gestation periods. The reduced prevalence among those reporting abortion in Table 3. Prevalence of Brucella antibodies in goats’ milk by MRT in Giwa area of Kaduna State

| Sampling location (Districts) | No. of milk samples tested | MRT | Chi square value | P-value |
|------------------------------|---------------------------|-----|-----------------|---------|
| Giwa                         | 19                        | 8 (7.1) |                 |         |
| Gangara                      | 19                        | 3 (2.7) |                 |         |
| Yakawada                     | 28                        | 12 (10.6) | 19.291 | 0.037   |
| Dan Mahawayi                 | 10                        | 2 (1.8) | df=5            |         |
| Kakangi                      | 22                        | 7 (6.2) |                 |         |
| Tsibiri                      | 15                        | 11 (9.7) |                 |         |
| Total                        | 113                       | 43 (38.1) |                 |         |

Table 4. Prevalence of Brucella antibodies in goats in and knowledge of farmers on Brucella

| Factors                                      | No. of sera examined | No. positive | Specific rate (%) | χ²       | Odds ratio (OR) | 95% CI on OR | P-value |
|----------------------------------------------|----------------------|--------------|------------------|----------|-----------------|--------------|---------|
| Have you heard of brucellosis?              |                      |              |                  |          |                 |              |         |
| Yes                                          | 151                  | 9            | 5.9              | 2.209    | 0.521           | 0.218-1.246 | 0.190   |
| No                                           | 129                  | 14           | 10.9             |          |                 |              |         |
| Do you think it can spread from one animal to another? |          |              |                  |          |                 |              |         |
| Yes                                          | 123                  | 11           | 8.9              | 0.155    | 1.187           | 0.505-2.789 | 0.827   |
| No                                           | 157                  | 12           | 7.6              |          |                 |              |         |
| Do you think it can spread from animals to humans? |          |              |                  |          |                 |              |         |
| Yes                                          | 34                   | 2            | 5.9              | 0.670    |                 | 0.150-2.992 | *1.0    |
| No                                           | 246                  | 21           | 8.5              |          |                 |              |         |

*P-value on fisher's exact test
Table 5. Prevalence of *Brucella* antibodies in goats and how it relates to information on goats in the flock

| Factors                                | No. of sera examined | No. positive | Specific rate (%) | \( \chi^2 \) | Odds ratio (OR) | 95% CI on OR | P-value |
|----------------------------------------|----------------------|--------------|-------------------|-------------|----------------|--------------|---------|
| Source of goats                        |                      |              |                   |             |                |              |         |
| Within the community                   | 178                  | 11           | 6.2               | 2.683       | 0.494          | 0.210-1.164  | 0.116   |
| Giwa market                            | 102                  | 12           | 11.8              |             |                |              |         |
| Abortion status in the flock           |                      |              |                   |             |                |              |         |
| Abortion cases                         | 192                  | 12           | 6.3               | 3.126       | 0.467          | 0.197-1.103  | 0.10    |
| No abortion                            | 88                   | 11           | 12.5              |             |                |              |         |
| Gestation period at abortion           |                      |              |                   |             |                |              |         |
| Early                                  | 20                   | 1            | 5.0               | *2.054      | 0.316          |              |         |
| Mid                                    | 114                  | 14           | 12.3              |             |                |              |         |
| Late                                   | 58                   | 8            | 13.8              |             |                |              |         |
| Cases of retained placenta             |                      |              |                   |             |                |              |         |
| Retained placenta occurred             | 184                  | 12           | 6.5               | 2.039       | 0.539          | 0.228-1.272  | 0.172   |
| No retained placenta                   | 96                   | 11           | 11.5              |             |                |              |         |

*Fisher’s exact value*

Table 6. Practices of farmers with respect to *Brucella* infection in goats

| Practices                                      | No. of respondents | Percentage (%) |
|-----------------------------------------------|--------------------|----------------|
| Management system                             |                    |                |
| Intensive                                     | 0                  | -              |
| Semi-intensive                                | 41                 | 100            |
| Extensive                                     | 0                  | -              |
| Method of feeding goats in the flock          |                    |                |
| Separately                                    | 0                  | -              |
| Collectively                                  | 41                 | 100            |
| Action taken when there is retained placenta  |                    |                |
| Remove with bare hands                        | 4                  | 14.8           |
| Allow the placenta to drop on its own         | 23                 | 85.2           |
| Disposal of aborted fetuses and vaginal discharges |            |                |
| Bury                                          | 9                  | 22.0           |
| Burn                                          | 1                  | 2.4            |
| Throw into the bush for dogs                  | 23                 | 56.1           |

does is a rare finding when compared to previous reports. This reduced prevalence may be associated with other organisms causing abortion other than *Brucella*. However, this remained to be investigated. The farmers who reported cases of retained placenta had a prevalence of 6.5% while those without retained placenta had 11.5% (Table 5). All the farmers (100%) interviewed practiced the semi-intensive system of management and feed their goats collectively. When these farmers noticed cases of retained placenta in their flock, 23 (85.2%) of them allow the placenta to drop on its own while 4 (14.8%) of them assisted the animals by removing it with bare hands. Twenty-three (56.1%) of these farmers, dispose aborted fetuses and other vaginal discharges into the bush, while 9 (22.0%), 1 (2.4%) and 23 (56.1%) said they buried, burnt and threw to the bush for dogs respectively (Table 6).

Sixteen (39.0%) of the respondents handled aborted fetuses and other vaginal discharges using polythene bags as a protective covering while 12 (29.3%) used their bare hands and 13 (31.7%) used sticks (Fig. 2). After handling these animals, 28 (68.3%) of them washed their hands with detergent while 13 (31.7%) did not bother to wash their hands (Fig. 3). Thirty-five (58.5%) of them sought veterinary services through drug...
vendors when their goats fell sick, 12 (29.3%) sought self-medication, while 12 (34.3%) sought such services from animal health specialists (Fig. 4).

Inappropriate disposal of vaginal discharges could also serve as a risk factor for both the farmers and their livestock, as these animals, especially dogs could pick this organism and infect other animal population (mechanical carriers) and man. The history of abortion, especially at the late gestation period and retention of placenta reported by these respondents agreed with the high prevalence of *Brucella* antibodies in the study area. Similar findings have also been previously reported [13,18]. These farmers tend to patronize drug vendors more than consulting veterinary personnel for veterinary services and this could lead to misdiagnosis and wrong application of drugs. Additionally, this could result in losses in the livestock industry.

![Fig. 2. Protective covering worn by farmers when handling aborted fetuses](image1)

![Fig. 3. Hygiene practices employed by farmers for handling goats and aborted fetuses](image2)
4. CONCLUSION

In conclusion, this study has established the presence of *Brucella* antibodies in goats in Giwa area of Kaduna State. The prevalence of *Brucella* antibodies was higher in flocks where the farmers had no knowledge of the disease and also where little or no hygiene practices were employed in handling of these goats. This finding is of public health importance.

Therefore, public health education/campaign should be embarked upon to further enlighten the farmers on the zoonotic implication of brucellosis. The government should enact policies that can help to curb this disease from animal populations, through vaccination programmes and active surveillance system to monitor animal movements.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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