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Knowledge, Attitude, and Practices of Poultry Farmers Regarding the Control of Chicken Coccidiosis in Lagos State, Nigeria

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ABSTRACT

Background: Coccidiosis, caused by coccidia of the genus *Eimeria*, accounts for significant production losses in the global poultry industry. This study evaluated commercial poultry farmers' knowledge, attitude, and practices (KAPs) on chicken coccidiosis and its control in Lagos State, Nigeria.

Methods: Semi-structured questionnaires assessing KAPs relating to chicken coccidiosis and its control were administered to 157 poultry farmers. Summary statistics were performed on the collated data using the Statistical Package for the Social Sciences (SPSS) software. The relationship between respondents' knowledge and demographic features was analysed using the Chi-square test of independence on SPSS. Results were considered significant at $p < 0.05$.

Results: The majority of the respondents were males (91, 58%), married (108, 68.7%), and between 31 and 50 years old (106, 67.5%). Most have had tertiary education (84, 53.5%) and farming experience between 1 and 5 years (97, 61.8%). All the respondents have heard about coccidiosis previously, and of these, 57 (36.3%), 45 (28.7%), and 37 (23.6%) sourced this information from veterinarians, fellow farmers, and during training/workshops, respectively. Ingestion of faecally contaminated feed and water by chickens was opined as the cause of coccidiosis by 48 (30.6%) respondents, followed by bacteria (30, 19.1%) and poor hygiene and sanitation (27, 17.2%). Most mentioned that ingesting faecally contaminated feed and water (126, 80.2%) is the mode of coccidiosis transmission, and 76 (48.4%) identified bloody and watery diarrhea as the major clinical sign. The gender of the farmers and their educational status were significantly associated with the level of coccidiosis knowledge. Of the study participants, 150 (95.5%) have experienced an outbreak of coccidiosis on their farms before, and the majority observed bloody diarrhea (90, 60.0%) as the major clinical sign. None of the farmers used ionophore drugs. Embazin-forte® (Sulphaquinoxaline) was the drug most reportedly used to prevent and treat coccidiosis. Few farmers (11, 7%) adopted anticoccidial vaccines for coccidiosis prevention using either Immucox®, Livacox®, or both.

Conclusion: This study showed that poultry farmers in Lagos State have adequate knowledge of chicken coccidiosis. Chemical anticoccidials were the only drugs used for prevention and treatment, and vaccines were not adopted. There is a need for veterinarians and poultry extension workers to enlighten farmers in the study area about the proper, safe, and effective use of anticoccidial drugs and vaccines.

Keywords: Chicken, Coccidiosis, *Eimeria* parasites, Knowledge, Attitude, and Practices, Poultry farmers

1.0 INTRODUCTION

Coccidiosis, caused by apicomplexan parasites of the genus *Eimeria*, is the most widespread and economically important parasitic disease of poultry worldwide. It is an enteric disease characterized by enteritis, malabsorption, and reduced feed conversion efficiency, significantly affecting poultry health, welfare, and productivity [1]. Although morbidity and mortality resulting from the disease are notable, the sub-clinical form is responsible for most production losses. Globally, more than UK£10 billion is lost yearly to coccidiosis and the cost of its control [1, 2]. Epizootiological studies have also demonstrated the importance of coccidiosis in the poultry sector in Nigeria [3], with *Eimeria* prevalence rates ranging from 12% to 69% in chickens [4, 5].

Eimeria parasites are transmitted when susceptible birds ingest feed and water contaminated with faeces containing infective oocysts. These environmentally resistant oocysts can survive in poultry litter for several months. Certain husbandry and management practices, such as deep litter rearing, favor oocyst survival and sporulation, facilitating *Eimeria* transmission. Seven species of Eimeria are widely recognized to cause coccidiosis in chickens, namely, *E. acervulina, E. brunetti, E. maxima, E. mitis, E. necatrix, E. praecox,* and *E. tenella*. All these species have been reported in Nigeria, with *E. tenella* and *E. maxima* being the most dominant [5, 6]. Although these species differ markedly in pathogenicity, they all contribute to considerable economic losses.

Control relies on chemoprophylaxis, vaccination, and proper biosecurity [7]. While these measures have proven effective in preventing clinical outbreaks [8], the highly resistant nature of oocysts, poor hygiene and biosecurity, drug resistance, and high cost of vaccines are contributing to the persistence of *Eimeria* parasites in poultry establishments in developing countries [9].

Farmers' positive attitude and compliance with disease control measures are a function of correct perception and accurate knowledge of the disease [10]. To achieve control success, efforts must be made to assess and improve what is known and done about chicken coccidiosis among poultry farmers. Previous studies have evaluated the Knowledge, Attitude, and Practices (KAPs) of chicken coccidiosis in commercial poultry farms in Nigeria [11]. Other authors have assessed the adoption and usage of anticoccidial drugs and vaccines [12 - 14], revealing varying levels of practices and identifying areas that should be improved for effective control of chicken coccidiosis in different parts of the country. There is, however, a dearth of information available for commercial chicken production in Lagos State. If made available, such data will assist veterinarians, poultry extension agents, and other relevant stakeholders in identifying areas where farmers in Lagos State need to improve their knowledge of and attitude toward chicken coccidiosis for more effective disease management. This study, therefore, evaluated the KAPs of chicken coccidiosis and its control among commercial poultry farmers in Lagos State, Nigeria.

2.0 METHODOLOGY

2.1 Study Area

This study was conducted in Lagos State, Southwest Nigeria. It is a wetland region dominated by freshwater and mangrove swamp vegetation. It has a humid tropical climate marked by two distinct seasons. The wet season begins in April and ends in October, while the dry season spans from November to March. Lagos State is a metropolitan area with a 90% urban population. The rural minorities are mainly involved in agriculture and agro-related activities such as farming and fishing. Poultry production is a profitable enterprise in Lagos State. The State boasts of many small to large-scale poultry farms, about 30 live bird markets, an estimated broiler population of 2.3 million, and an annual production of 133 million eggs [15, 16].

2.2 Study Design

This study was part of a cross-sectional survey designed to determine the prevalence of *Eimeria* parasites and identify associated risk factors in Lagos State. It involved a total of 157 commercial chicken farms initially selected at random and subsequently by snowballing in Lagos-East (n = 84) and Lagos-West (n = 73) senatorial districts. Most poultry farms in the study area (about 90%) are concentrated in the selected senatorial districts. The selection of farms was based on the records obtained from the Poultry Association of Nigeria (PAN), Lagos Chapter. One poultry farmer per visited farm was interviewed to assess Knowledge, Attitude, and Practices (KAPs) about chicken coccidiosis and its control.

2.3 Questionnaire Administration

Semi-structured questionnaires adapted from Adeyemi *et al.,* [11] were designed to assess the socio-demography of the study participants, their knowledge of the cause, transmission, signs/symptoms of coccidiosis, and their

attitude and practices in relation to the control of the disease.

2.4 Data Analyses

Data generated were compiled on a Microsoft Excel spreadsheet, and summary statistics of all categorical variables were performed on Statistical Package for Social Sciences (SPSS) (IBM SPSS Statistics 20). One point each was awarded to respondents' accurate knowledge of the cause, transmission, major signs, whether coccidiosis can be prevented/treated, and the available methods of coccidiosis prevention, making an overall score of 6 points. A percentage score was calculated for each respondent, and a grading system was adopted as follows: >70% = very good; 50 – 69% = good; 40 – 49% = poor; and <40% = very poor. The relationship between respondents' knowledge and demographic features was analysed using the Chi-square test of independence on SPSS. Results were considered significant at $p < 0.05$.

3.0 RESULTS

The socio-demographic profile of respondents is shown in Table 1. Findings revealed that 106 (67.5%) of the 157 interviewed subjects were aged between 31 and 50 years, 91 (58.0%) were males, and 108 (68.7%) were married. Eighty-four (53.5%) and 70 (44.6%) have had tertiary and secondary education, respectively, and the majority reported farming experience between 1 to 5 years (61.8%, n = 97).

As shown in Figure 1, all the respondents have heard about coccidiosis previously (Figure 1). They obtained this knowledge from various sources, including veterinarians or veterinary clinics (36.3%, n = 57), fellow farmers

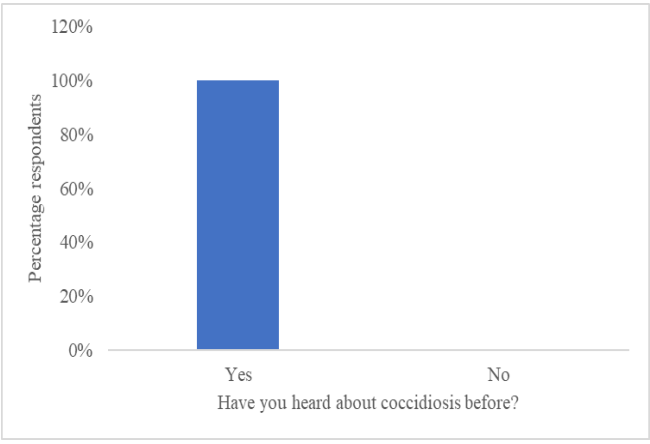

Figure 1. Prior Knowledge about Coccidiosis among Chicken Farmers in Lagos State

Table 1. Socio-demographic Profile of Commercial Poultry Farmers in Lagos State

Variables	Frequency (N = 157)	Percentage (%)
Age group (yrs)		
10 – 30	27	17.2
31 – 50	106	67.5
51 and above	24	15.3
Gender		
Male	91	58.0
Female	66	42.0
Marital status		
Single	47	29.9
Married	108	68.7
Divorced or widowed	2	1.3
Level of education		
Primary	0	0.0
Secondary	70	44.6
Tertiary	84	53.5
None	3	1.9
Religion		
Christianity	114	72.6
Islam	43	27.4
Farming experience (yrs)		
<1	8	5.1
1 - 5	97	61.8
6 - 10	31	19.7
>10	21	13.4

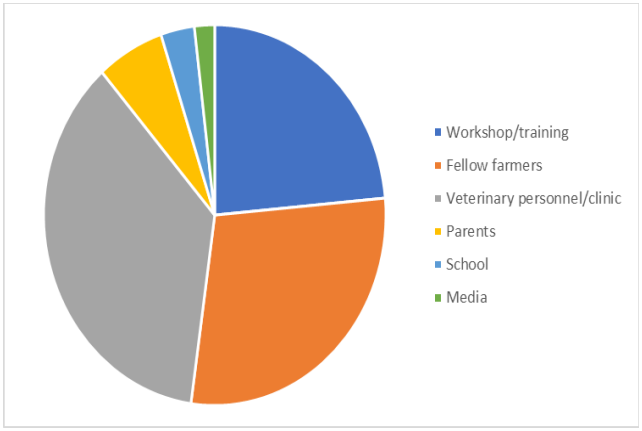

Figure 2. Source of Information about Coccidiosis among Poultry Farmers in Lagos State

(28.7%, n = 45), and during training (23.6%, n = 37), amongst others (Figure 2).

The knowledge of the cause, transmission, and clinical signs of chicken coccidiosis among the study participants is summarised in Table 2. Over 30% (n = 48) of the stud-

Table 2. Knowledge of Chicken Coccidiosis among Commercial Poultry Farmers in Lagos State

Response	Frequency (N = 157)	Percentage (%)
What is/are the cause(s) of coccidiosis?		
Ingesting feed/water contaminated with faeces	48	30.6
Poor hygiene and sanitation	27	17.2
Wet litter	22	14.0
Bacteria	30	19.1
Eimeria parasite	3	1.9
Poor air quality, bad weather, overcrowding, stress, change in pens, change of feed, heat from faeces	12	7.6
Virus, unspecified pathogens, rodents	9	5.7
Contact with sick birds, contact with other farms	3	1.9
Don't know	3	1.9
How is coccidiosis transmitted?		
Ingesting feed/water contaminated with faeces	126	80.2
Inhalation	17	10.8
Contact with sick birds	8	5.1
Human Traffic	3	1.9
Overcrowding	3	1.9
What are the major signs of coccidiosis?		
Bloody or watery diarrhea	76	48.4
Weight loss	36	22.9
Weakness	23	14.6
Loss of appetite	4	2.5
Paleness	5	3.2
Feather loss, Ruffled feathers	5	3.2
Don't know	8	5.1
Is coccidiosis of economic importance in Nigeria?		
Yes	145	92.4
No	4	2.5
Don't know	8	5.1
Can coccidiosis be prevented?		
Yes	150	95.5
No	1	0.6
Don't know	6	3.8
Is coccidiosis treatable?		
Yes	151	96.2
No	6	3.8

ied population affirmed that ingesting faecally contaminated feed/water by chickens causes coccidiosis. In comparison, others mentioned bacteria (19.1%, n = 30), poor hygiene and sanitation (17.2%, n = 27), and the presence of wet litter (14.0%, n = 22). Most respondents (80.2%, n = 126) reported that ingesting faecal matter/litter was the mode of transmission, while 17 (10.8%) and 8 (5.1%) mentioned inhalation and contact with sick birds, respectively. Bloody diarrhea (48.4%, n = 76) and weight loss (22.9%, n = 36) were identified as the major signs of chicken coccidiosis among the farmers interviewed. A good percentage of respondents (92.4%, n = 145) agreed that chicken coccidiosis is of economic importance in Nigeria and are aware that the disease can be prevented (95.5%, n = 150) and treated (96.2%, n = 151) (Table 2). As presented in Figure 3, most of the respondents mentioned that coccidiosis could be prevented with the use of anticoccidial drugs (47.8%, n = 75), followed by anticoccidial drugs and vaccines (15.9%, n = 25), good litter management (12.7%, n = 20) amongst others.

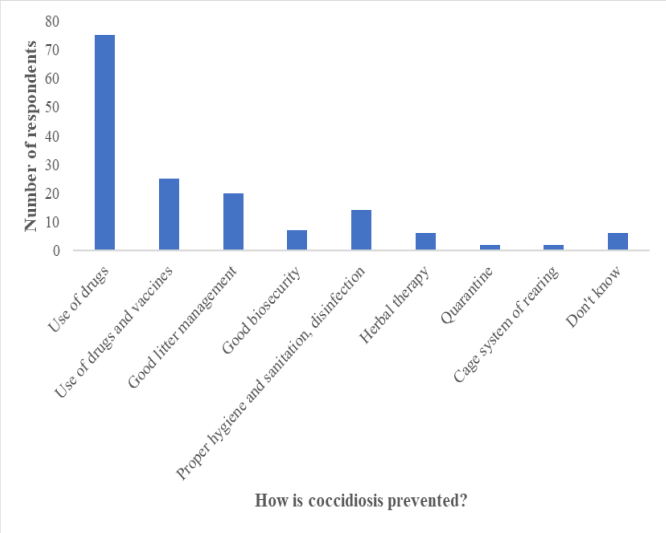

Figure 3. Study Participants' Opinions on Possible ways of Preventing Chicken Coccidiosis

The relationship between the level of knowledge and the demographic characteristics of the study participants is shown in Table 3. The proportion of male farmers with excellent (66.0%, n = 64) knowledge of coccidiosis was significantly higher than females at the same level of knowledge ($P < 0.05$). Similarly, a significantly higher proportion of the respondents who have had tertiary education showed very good (58.8%, n = 57) knowledge of coccidiosis when compared to those with secondary or no education ($P < 0.05$). There was no statistical difference in the knowledge score of respondents based on age group, marital status, religion, and farming experience.

According to Table 4, 150 (95.5%) of the study population have previously experienced an outbreak of coccidi

Table 3. Demographic Factors Associated with Knowledge of Coccidiosis among Poultry Farmers in Lagos State

Variables	N	Knowledge score n (%)				P value
		Very good	Good	Poor	Very poor	
Age group (yrs)						
10 – 30	27	15 (15.5)	9 (19.1)	0 (0.0)	3 (37.5)	0.576
31 – 50	106	69 (71.1)	29 (61.7)	4 (80.0)	4 (50.0)	
51 and above	24	13 (13.4)	9 (19.1)	1 (20.0)	1 (12.5)	
Gender						
Male	91	64 (66.0)	22 (46.8)	1 (20.0)	4 (50.0)	0.044
Female	66	33 (34.0)	25 (53.2)	4 (80.0)	4 (50.0)	
Marital status						
Single	47	34 (35.1)	10 (21.3)	2 (40.0)	1 (12.5)	0.583
Married	108	62 (63.9)	36 (76.6)	3 (60.0)	7 (87.5)	
Divorced or Widowed	2	1 (1.0)	1 (2.1)	0 (0.0)	0 (0.0)	
Level of education						
Primary	0	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0.042
Secondary	70	38 (39.2)	25 (53.2)	2 (40.0)	5 (62.5)	
Tertiary	84	57 (58.8)	22 (46.8)	2 (40.0)	3 (37.5)	
None	3	2 (2.1)	0 (0.0)	1 (20.0)	0 (0.0)	
Religion						
Christianity	114	66 (68.0)	37 (78.7)	4 (80.0)	7 (87.5)	0.402
Islam	43	31 (32.0)	10 (21.3)	1 (20.0)	1 (12.5)	
Farming experience (yrs)						
<1	8	2 (2.1)	4 (8.5)	1 (20.0)	1 (12.5)	0.409
1 - 5	97	60 (61.9)	28 (59.6)	3 (60.0)	6 (75.0)	
6 - 10	31	22 (22.7)	9 (19.1)	0 (0.0)	0 (0.0)	
>10	21	13 (13.4)	6 (12.8)	1 (20.0)	1 (12.5)	

Table 4. Attitude and Practices of Commercial Poultry Farmers Regarding Chicken Coccidiosis Control in Lagos State

Response	Frequency (N = 157)	Percentage (%)
Have you experienced an outbreak of coccidiosis on your farm before?		
Yes	150	95.5
No	7	4.5
What were the major signs you observed?	*N* = 150	
Bloody or watery diarrhea	90	60.0
Weight loss	31	20.7
Weakness	18	12.0
Paleness	5	3.3
Appetite loss	3	2.0
Dead birds	3	2.0
How do you prevent coccidiosis?		
Anticoccidial drugs only	137	87.3
Anticoccidial drugs and vaccines in alternation	11	7.0
Don't know	9	5.7
How long have you been using this method?	n = 148	
One	58	39.2
Two	57	38.5
Three	21	14.2
Four	12	8.1
How effective has this preventive method been?	n = 148	
Very effective	137	92.6
Barely effective	1	0.6
Ineffective	2	1.4
Not known	8	5.4
Have you ever contemplated changing this method?	n = 148	
Yes	11	7.4
No	127	85.8
Not known	10	6.8

Table 5. Chemoprophylactic Drugs Adopted by Commercial Poultry Farmers for the Control of Chicken Coccidiosis in Lagos State

Preventive drugs	Frequency (N=157)	Percentage (%)	Active ingredient	Drug type	Mode of administration
Embazin-forte®	69	43.9	Sulphaquinoxaline	Sulphonamides	In water
Adacox®	30	19.1	Sulphadimidine	Sulphonamides	In water
Coccicox WS®	20	12.7	Sulphacloxine	Sulphonamides	In water
Kepcox®	25	15.9	Toltrazuril	Symmetric triazines	In water
Coccinol®	3	1.9	Fusidium coccineum	Botanical	In water
Amprolium®	2	1.3	Amprolium	Methylpyridines	In water
Vitamins	8	5.1	-	-	In water

Table 6. Drugs used for the Treatment of Chicken Coccidiosis among Commercial Poultry Farmers in Lagos State

Trade names	Frequency (N=157)	Percentage (%)	Generic name	Drug type	Mode of administration
Embazin-forte®	60	38.2	Sulphaquinoxaline	Sulphonamides	In water
Adacox®	25	15.9	Sulphadimidine	Sulphonamides	In water
Coccicox WS®	17	10.8	Sulfacloxine	Sulphonamides	In water
Kepcox (2.5%)®	13	8.3	Toltrazuril	Symmetric triazines	In water
Amprolium	3	1.9	Amprolium	Methylpyridines	In water
Centre-dicox®	2	1.3	Diclazuril	Symmetric triazines	In water
Ivermectin	1	0.6	Ivermectin	Avermectin	In water
Doxygen®	1	0.6	Tetracycline	Tetracycline antibiotics	In water
Tylo-dox®	1	0.6	Tylosin tartate Tetracycline antibiotics	Macrolide antibiotics Doxycycline hyclate	In water
Vitamins	3	1.9	-	-	In water
Herbs	1	0.6	-	-	In water
Don't know	30	19.1	-	-	-

Table 7. Anticoccidial Vaccines Adopted by Commercial Poultry Farmers for the Control of Chicken Coccidiosis in Lagos State

Anticoccidial vaccine	Frequency (N=157)	Percentage (%)	Vaccine type	Targeted species
Immucox®	8	5.1	Live, non-attenuated	Ea, Eb, Em, En, Et
Livacox®	1	0.6	Live, attenuated	Ea, Em, En, Et
Immucox® and Livacox®	2	1.3	-	-
Not used	138	87.9	-	-
Don't know	8	5.1	-	-

Ea: *E. acervulina*, Eb: *E. brunetti*, Ema: *E. maxima*, Emi: *E. mitis*, En: *E. necatrix*, Ep*: E. praecox*, Et: *E. tenella*

osis on their farm, with a good number reporting bloody/watery diarrhea (60.0%, n = 90) and weight loss (20.7%, n = 31) as the major signs observed. A majority affirmed that they only prevent coccidiosis with anticoccidial drugs (87.3%, n = 137), while others alternate between drugs and vaccines (7%, n = 11). Exactly 137 (92.6%) claimed their preventive method was effective.

Anticoccidial drugs used by the study participants to prevent chicken coccidiosis are summarized in Table 5. Embazin-forte® (43.9%, n = 69), Adacox® (19.1%, n = 30), Kepcox® (15.9%, n = 25), Coccicox WS® (12.7%, n = 20), and Amprolium® (1.3%, n = 2) among other chemical, synthetic drugs were reported. None of the respondents reported the use of ionophore-based drugs. A small proportion of respondents also affirmed using a botanical, Coccinol® (1.9%, n = 3). As presented in Table 6, most of the drugs used for prevention were also employed for treatment, in addition to Centre-dicox (1.3%, n = 2), Ivermectin (0.6%, n = 1), Doxygen (0.6%, n = 1) and Tylodox (0.6%, n = 1).

About 90% (n = 138) of the respondents in this study do not employ vaccines to control chicken coccidiosis (Table 7). Only a few reported that they used Immucox (5.1%, n = 8), Livacox (0.6%, n = 1), or a combination of both (1.3%, n = 2) vaccines.

4.0 DISCUSSION

Improper biosecurity, poor farm management practices, and uninformed managerial decisions will continue to undermine the success of chemoprophylaxis and vaccination against coccidiosis [2]. Thus, assessing what farmers know about coccidiosis and the control measures they adopt is essential to designing effective control strategies. In this current study, a panel of 157 commercial poultry farmers domiciled in Lagos State had adequate knowledge of coccidiosis and its control.

Most of the respondents in this study were aged between 31 and 50 years. This means that most of the poultry farmers were engaged in poultry farming in their active years and should be able to cope with the strenuous, labour-intensive activities required to ensure proper biosecurity on their farms. Oladoja and Olusanya [12] reported similar findings in the Ijebu-Area of Ogun State, Southwest Nigeria.

This study showed that most poultry farmers in the study area were men. This aligns with the findings from previous KAPs surveys conducted among commercial poultry farmers in Nigeria [12,17 - 20], unlike backyard poultry production systems where women play important roles [21]. The involvement of women in poultry farming in developing countries decreases with increasing intensification because women often have restricted access to and control over land resources, credit facilities, labour, and technology [22]. Moreso, men are often the breadwinners in their families and engage in the poultry business to cater for their family's needs. This study also showed a significant relationship between gender and knowledge of coccidiosis. A higher proportion of males had good knowledge of coccidiosis compared to females. This finding reflects the increased interest of males in commercial poultry production and efficient disease management.

The majority of the study participants were married. Poultry farming may be common among this group because they are usually saddled with the responsibility of catering for family needs and can do so from the profit made. Furthermore, married individuals are mature and responsible enough to protect their birds from infectious diseases. This is in line with the reports of Oladoja and Olusanya [12], Arowolo *et al.,* [13], Akintunde *et al.,* [17], Eze *et al.,* [18], and Akintunde and Adeoti [23].

A larger percentage of the study participants have had secondary and tertiary levels of education. Similar findings have been reported previously [11, 19, 20]. This high level of education implies that most respondents know about proper farm management and husbandry practices. Studies have established a link between the level of education and access to information and technology required to improve biosecurity practices and enhance poultry production [12, 24]. Akintunde and Adeoti [23] have also revealed that farmers with formal education had a higher probability of attaining a moderate level of disease management. The fact that a significant proportion of those with tertiary education in this study showed good knowledge of coccidiosis also supports these claims.

Experience in poultry farming may influence disease management [23]. Most of the respondents in this study had between 1 and 5 years of farming experience. This indicates that most of the poultry farmers in the study area are new to poultry farming and may need the guidance of veterinarians and poultry extension officers to prevent disease effectively. However, the knowledge of coccidiosis was not associated with farmers' experience in this study.

Results show that coccidiosis is a well-known disease in the study area. This agrees with the reports of Adeyemi *et al.,*[11] and Oladoja and Olusanya [12] among poultry farmers in Southwest Nigeria. This finding is expected since most farms have experienced a coccidiosis outbreak before. Moreover, Eimeria, the causative agents of coccidiosis, are ubiquitous parasites of poultry that occur everywhere chickens are kept [25]. However, outbreaks of coccidiosis only occur when there is a breakdown in biosecurity or prophylaxis. Thus, this study's reported high occurrence of coccidiosis outbreaks suggests the need to strengthen control efforts in the study area.

Most respondents claimed they learned about coccidiosis from formal sources such as veterinary doctors, veterinary clinics, training and workshops. This shows the veterinary personnel's role in providing disease and disease management information. Farmers in contact with extension workers are expected to have better knowledge of disease prevention and modern husbandry practices. In a previous study, access to livestock extension services was found to increase the likelihood of attaining a moderate level of poultry disease management by about 11% compared to low disease management levels among poultry farmers in Osun and Oyo States, Nigeria [23]. The high level of education observed in the study popula-

tion is a likely reason for choosing formal sources as major sources of information.

The study population showed they had good knowledge of the cause of chicken coccidiosis. Although none of them mentioned the *Eimeria* parasite as the causative agent, they identified the ingestion of faecally contaminated feed and water as an important causal factor. To prevent misdiagnosis, farmers are encouraged to employ the services of veterinarians to confirm the occurrence of coccidiosis by checking for classical clinical signs, necropsy or laboratory diagnosis.

The majority of the respondents opined that coccidiosis is transmitted by faeco-oral means. This is accurate and has been established as the main route of coccidiosis transmission [26]. Susceptible birds become infected when they ingest feed and water contaminated with faeces containing sporulated oocysts of *Eimeria*, which another infected bird has passed out. This transmission mode is facilitated in deep litter systems where birds are reared on the ground and have free access to the faeces of other birds. Coccidiosis transmission is also possible in battery cage systems, as houseflies are implicated as critical mechanical vectors [27].

Bloody/watery diarrhea and weight loss were the major signs of coccidiosis identified by the respondents in this study. Diarrhea, whether bloody or mucoid, is recognized as the main sign of coccidiosis in poultry [26]. *E. tenella* and *E. necatrix*, which cause hemorrhagic coccidiosis, are usually suspected when blood is present in diarrheic stool, while mucoid diarrhea is more common in malabsorptive coccidiosis, caused mainly by *E. acervulina* and *E. maxima*. However, infected birds appear healthy at sub-clinical levels, except necroscopic or laboratory diagnoses are conducted. Sub-clinical coccidiosis has been implicated as the leading cause of production losses in the poultry industry [28].

Many study participants used only anticoccidial drugs to prevent coccidiosis on their farms, while few others either used only vaccines or alternated between drugs and vaccines. This is somewhat similar to the findings of Etuk *et al.,* [29] in Akwa-Ibom State, where 33% of poultry farmers relied on anticoccidial drugs as prophylaxis and none employed vaccines but contradicts the findings of Adeyemi *et al.,* [11], who found a higher percentage of farmers in Oyo and Ogun States employing vaccines for prophylactic treatment. This suggests that regional differences may exist in the accessibility of farmers to vaccines. Using anticoccidial drugs solely for coccidiosis prophylaxis can contribute to developing drug resistance in the study area. The most effective strategy for slowing down the emergence of drug resistance in the field is to alternate between chemoprophylactic drugs and anticoccidial vaccines in rotation programs [30, 31]. This method maintains the drug sensitivity of circulating parasites, thereby sustaining the effectiveness of currently available drugs.

Anticoccidials are broadly classified into chemicals and ionophores. The former includes synthetic chemicals such as amprolium, sulphonamides, and diclazuril, while the latter (e.g. lasalocid, narasin, monensin) are fermentation products of fungi [32]. The anticoccidial drugs reportedly used by farmers to control coccidiosis in this study were all chemical drugs, and the most common was the sulphonamide, Sulphaquinoxaline (Trade name: Embazin-forte). None of the farmers reported the use of ionophores. Similar findings were reported among poultry farmers in Umuahia, Abia State [14]. Arowolo *et al.,* [13], who reported the use of ionophores among farmers in southwestern Nigeria, showed that the drugs were only used by a small proportion compared to the percentage that employed chemical drugs. Resistance has been shown to develop faster to chemical drugs because of their total killing action [33]. Ionophores, on the other hand, do not entirely kill their targets. Instead, they permit leakage of small viable oocysts that circulate within a poultry shed to allow birds to acquire immunity [31]. Therefore, the sole use of chemical drugs in this study suggests that *Eimeria* populations in the study area might be resistant to commonly used anticoccidials. Ojimelukwe *et al.,* [6] have shown reduced sensitivity to toltrazuril in *Eimeria tenella* populations in southern Nigeria. Caution must also be taken in using ionophores as there are speculations that this class of anticoccidials might contribute to antimicrobial resistance in humans [34]. The relatively high cost of ionophore anticoccidials is a plausible reason for its poor adoption in this study [14].

The predominant use of the anticoccidial chemical drug Sulphaquinoxaline by poultry farmers in the study area is similar to what was observed by Okonkwo and Uwalaka [14]. Sulphaquinoxaline is popular because of its effectiveness, affordability, and accessibility. It has, however, been associated with a marked decrease in weight gain in broilers, severe anaemia, and depression in egg production [35], making them counterproductive for treating *E. tenella* infections. Gout and retarded growth were reported among farmers who excessively used Embazin-forte in a survey conducted in Southwest Nigeria [13].

All the respondents declared that they administer their drugs only via drinking water. None of them practiced in-feed administration. This aligns with reports of other studies [13, 14]. Commercial medicated feeds are expensive and uncommon in developing countries [36]. This further explains why ionophore drugs usually incorporated into propriety feed are not commonly used in the study area [37]. Unfortunately, most anticoccidial drugs are partially soluble in water and may result in uneven dosing, increasing the risk of drug resistance [32]. Most of the drugs used for prevention in this study were also employed for curative purposes. Arowolo *et al.,* [13] also reported similar findings with an equal percentage of drugs used for curative and prophylactic purposes in Southwest Nigeria. This is a poor practice as ionophore-based drugs are preferred for chemoprophylaxis since they permit the development of acquired immunity in birds.

Poor adoption of vaccines was observed in the study area despite the level of interaction with veterinarians. According to Adeyemi *et al.,* [11], 54.8% of farmers in Southwest Nigeria used vaccines to control chicken coccidiosis. They also showed that respondents that consulted veterinarians were significantly more likely to adopt these vaccines when compared to those that sourced information from staff or fellow farmers. Oladoja and Olusanya [12] also showed that anticoccidial vaccines had gained widespread acceptance among poultry farmers in the Ijebu-Area of Ogun State. The high costs of anticoccidial vaccines might be a major factor limiting their adaption in this study. Immucox and livacox were the only vaccines reported in this study. This is similar to the findings of Oladoja and Olusanya [12], who reported 60% and 23% adoption of immucox and livacox in southwestern Nigeria, respectively.

This study showed that poultry farmers in Lagos State have a fair knowledge of the importance, cause, transmission, and clinical signs of chicken coccidiosis. Chemical drugs were the only anticoccidial drugs adopted for prevention and treatment, while only a few employed vaccines. It is recommended that veterinarians and poultry extension workers in the study area create forums where farmers are enlightened on the proper and effective use of the different types and classes of anticoccidial drugs and encourage the inclusion of anticoccidial vaccines in rotation programs. Government should provide credit facilities to encourage poultry farmers to acquire anticoccidial vaccines. Future studies should also be conducted to determine *Eimeria* populations' drug sensitivity to the commonly used anticoccidials in the study area.

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Conflicts of Interest

The authors declare that there is no conflict of interests.

Authors' Contributions

OOA conceived and designed the study, contributed to data collection, data analysis tools, performed analysis of data and prepared the original draft of the manuscript. **ETI, IDJ** contributed to study design, data analysis tools and manuscript writing. **BA** contributed to study design and manuscript writing. All authors approved the final copy of the manuscript.

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