EVALUATING THE RISK, KNOWLEDGE AND PRACTICES OF POULTRY MARKETERS ON *SALMONELLA* INFECTION IN VILLAGE CHICKENS SOLD AT LIVE BIRD MARKETS IN MAIDUGURI METROPOLIS, NIGERIA

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ABSTRACT

This study was conducted to evaluate the risk, knowledge and practices of village chicken (live bird) sellers on Salmonella infection in village chickens sold at live bird markets in Maiduguri Metropolis. One hundred questionnaires were administered to 100 village chicken sellers to generate information on sources and types of birds sold, types of housing used in keeping the birds before sale as well as knowledge and awareness of salmonellosis and its associated clinical signs in chickens by the sellers. Practices such as the removal of deceased birds, mixing of old and newly purchased birds in the same cages, sources of drinking water for the birds, cleaning of feeding and watering troughs, and other biosecurity protocols were among the risk factors evaluated. Data generated were analyzed using the SPSS software. Majority (75.8%) of the village chicken sellers had no knowledge of Salmonella infections. A few (12%) of the respondents washed the feeding and watering troughs daily while the majority (85.5%) washed the watering and feeding troughs weekly. Most of the village chicken sellers (93.5%) disposed dead birds in refuse dumps around the markets. However, few (3.2%) of them burry or sell the dead birds to butchers. The practices of the village chicken sellers in the live bird markets in Maiduguri metropolis on the prevention and spread of Salmonella infections among village chickens were very poor. Salmonella occurrence in the live bird markets may be influenced by several risk factors such as sources of water, type of chicken sold and the mixing of new and old stock.

Keywords: Risk, Knowledge, Practices, *Salmonella* infection, Village chicken, Sellers, Maiduguri, Nigeria.

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INTRODUCTION

Live bird sellers (LBS) are primarily traders that are involved in the buying and selling of live birds on which they rely for a living. They acquire experience in the trade by working as apprentices in the business (working

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under particular LBS) for a period of time. Live bird sellers mostly sell chickens, but they also buy and sell ducks, geese, guinea fowl, ostriches, and pigeons. They may also include the slaughter and dressing of the birds in their services, and operate in many open markets around Nigeria, with the number of LBS at each market varying based on the markets' capacity. Most (about 73%) of live bird markets are owned and operated by the government [1] but cages, baskets, tables, slaughter apparatus, and other items required for their vocation are provided by the LBS.

Live bird sellers handle a major percentage (75%) of poultry sales in Nigeria and they operate through live bird markets (LBM) [1]. They trade predominantly in local, village, indigenous or traditionally reared, non-speciated, chickens. Despite the fact that large commercial farmers usually slaughter and sell about 90% of their birds as packaged chilled products without involving the LBS [2], their sales account for only 13.83% of the total bird population sold, compared to 86.17% for traditionally managed birds handled by LBS [3].

Without the use of biosecurity or poultry disease screening, LBS buy stock directly from farmers or wholesalers and retail to individual consumers, thus serving as a link between farmers or poultry whole sellers and customers. Consequently, they play a significant role in the poultry food supply chain as well as in the spread of poultry diseases [3]. Because the nature of the LBS trade requires close contact with live birds, they may be easily exposed to avian zoonotic diseases such as salmonellosis. Furthermore, people who frequent live bird markets (LBM) are at danger of contracting zoonotic diseases through human-to-human transmission or directly from live birds that can act as carriers or sources of zoonotic disease transmission to humans through handling [4].

Salmonellosis is a well-known water/food-borne faecal-oral zoonotic disease that affects millions around the world [5,6]. *Salmonella* is a rod-shaped *Enterobacterium* [7,8] that is linked to *Escherichia* and *Shigella* [9]. The genus *Salmonella* is divided into two species, *Salmonella bongori* and *Salmonella enterica*, each of which has six subspecies and multiple serovars [10]. *Salmonellae* can be found in both cold-blooded and warm-blooded animals as well as the environment where they cause diseases such as typhoid fever, paratyphoid fever, and food poisoning [10].

The intake of contaminated or undercooked foods such as poultry, beef, pork, eggs, milk, shellfish, and other fresh produce may be common sources of *Salmonella* infection to people [11]. Although *Salmonella* usually contaminates meat surfaces through faeces during slaughter and processing, it can also be found internally in diseased animal meat tissues [12]. *Salmonella* contamination of poultry meat occurs largely through the excrement of sick or asymptomatic birds, contaminated equipment, floors, and employees in slaughterhouses where pathogens can thrive [12].

This study is necessitated by the dearth of information relating to the importance of Live bird sellers (LBS) and, by extension, live bird markets in the spread of *Salmonella* infections in Maiduguri. Therefore, this study is aimed at evaluating the risk, knowledge, and practices of LBS towards *Salmonella* infections in village chickens sold at LBM in Maiduguri metropolis, Nigeria.

MATERIALS AND METHODS
Study Area
The study was carried out in Maiduguri Metropolis, the capital city of Borno State and the largest urban centre in North-eastern Nigeria. Maiduguri Metropolis has an area of about $69,436 \, km^2$ and lies within latitude $10^° - 13^°N$ and longitude $12^° - 15^°E$. Maiduguri metropolis is located between the Sudan savannah and Sahel savannah vegetation zones of Nigeria [13]. It has an estimated population of about 1.1 million people [14] and is comprise of three Local Government Areas (LGAs): Maiduguri Metropolitan Council (MMC) and Jere and Konduga LGAs.

Selection of Live Bird Markets/Live Bird Sellers
Five live bird markets (LBM) located within major markets in Maiduguri Metropolis were randomly selected for the study. These are the Monday market, Baga Road market, Ngomari market, Gamboru market and Budum market. In each market, LBS were randomly selected for inclusion in this study.

Data Collection
Data collected during the study included information on the sources and types of birds sold, the types of housing used to keep the birds before selling, knowledge and awareness of salmonellosis and its associated clinical signs in chickens by the traders as well as records of previous and recent suspected outbreaks of the disease and their management in the markets. Other data include, whether they vaccinate the chickens or use antibiotics to treat salmonellosis in the LBM. The use of antibiotics for the treatment of salmonellosis was also investigated. The removal of deceased birds, mixing of old and newly purchased birds in the same pens, sources of drinking water for the birds, cleaning of feeding and watering troughs, and other biosecurity protocols were among the risk factors identified.

Questionnaire Administration
A total of 100 live bird sellers in the 5 LBM within Maiduguri Metropolis were randomly selected for inclusion in the study but only 62 of them consented to questionnaire administration. Prior to the administration of the questionnaire in each market, permission to conduct the one-on-one interviews was obtained from the Market Head and individual LBS during which the objectives of the study were duly explained to all participants. Thereafter, a pilot study was done to validate and standardize the approach and techniques. As majority of the respondents understood and spoke the Hausa language, the common language of communication in the study area, the questionnaire was translated to Hausa for each participant.

Data Analysis
Data obtained during the study were expressed as percentages and presented in a tabular form. Chi square test was used to determine association between variables and p-values ≤ 0.05 were considered significant. All statistical analyses were performed using the IBM SPSS Statistics (IBM, Armonk, NY: IBM Corp.). Initially, all the raw data collected were imported and managed in Microsoft® Office Excel version 23.0, Excel spread sheet, Chi-square or Fisher's exact test as the case may be were used for univariable exploratory analysis in order to identify epidemiological risk factors strongly associated with the *Salmonella* positivity (outcome variable), determine strength and significance of associations.

RESULTS
The demographic analysis of the LBS showed that out of the 62 respondents involved in the study significantly ($p<0.05$) more males (82.3%) than females (17.7%) were involved in the live bird sales business in Maiduguri metropolis. Also, most LBS (45.1%) had no formal education, while 35.4% and 19.3% of them had only primary and secondary education, respectively. On the other hand, none of the sellers had tertiary education. Majority (80.6%) of the LBS were married, 4.8% of them were divorced while 14.6% were never married (Table 1).

Knowledge of Live Bird Sellers about *Salmonellosis*.
Only 15 (24.2%) of the respondents had any knowledge of salmonellosis as a disease of village chickens while the majority (75.8%) had no knowledge of the disease. Most (85.5%) of those who have knowledge of salmonellosis got the information about the disease from other village chicken farmers while the others got their information from either veterinarians (11.3%) or the social media (3.2%). The LBS believed that salmonellosis is a seasonal disease of poultry and that it occurs mostly during the rainy season (51.6%). Majority of the LBS reported diarrhea (56.6%) as the most common clinical manifestation observed during salmonellosis while other manifestations mentioned included moist eyes (11.32%), ruffled feathers (24.1%) and sunken eyes (8.1%) (Table 2).

Table 1. Socio demographic characteristics of poultry sellers in live bird markets in Maiduguri metropolis, Nigeria.

Variable	Description	No. (%) of Respondents	chi square	P- value
Gender	Male	51 (82.3)	49.065	< 0.0001
	Female	11 (17.7)		
Educational qualification	Not Educated	28 (45.1)	38.796	< 0.0001
	Primary	22 (35.4)		
	Secondary	12 (19.3)		
	Tertiary	0 (0.0)		
Marital status	Married	50 (80.6)	94.984	< 0.0001
	Divorced	3 (4.8)		
	Never married	9 (14.6)		

Table 2. Knowledge of village chicken sellers on Salmonellosis in live bird markets in Maiduguri Metropolis.

Variables	Description	No. of respondents	X2	P-value
Awareness of *Salmonella* infection	Yes	15 (24.2)	31.000	< 0.0001
	No	47 (75.8)		
Disease Seasonality	Rainy season	32 (51.6)	0.03226	0.8575
	Dry season	30 (48.4)		
Symptoms observed	Ruffled feathers	15 (24.1)		
	Diarrhoea	35 (56.5)	48.430	< 0.0001
	Moist eyes	7 (11.3)		
	Sunken eyes	5 (8.1)		
Source of information	Social media	2 (3.2)		
	Veterinarians	7 (11.3)	114.73	< 0.0001
	Other poultry sellers	53 (85.5)		

Practices of Poultry Sellers on salmonellosis in Live Bird Markets in Maiduguri, Borno State, Nigeria

A significant ($p<0.05$) majority (85.5%) of the respondents engaged in the sale of only village or indigenous chickens compared to those selling only exotic (3.2%) or both (11.3%). Most of the LBS (79%) sourced their stock from other markets, while a few others received their stock as gifts (13%) or from both sources (8.1%). Majority of the LBS (69.4%) stocked more than 50 chickens every week. On the average, stocks of chicken are usually sold off within a minimum of 2 weeks to 2 months (Table 3).

Although most sellers usually mixed newly acquired stock with unsold old stock (83.8%), majority of them also mixed local chicken with other species of birds (67.7%).When birds become sick most of the sellers sell them off (64.5%) while a few will either slaughter (19.3%) or treat them (16.1%). Among those that treat their sick birds, most frequently use antimicrobials (56.5%. Only 14.5% of the sellers vaccinate their birds against salmonellosis while majority do not vaccinate their stock against the disease. Water for the business of live

bird selling is mostly sourced through water vendors (56.5%) although a few of the sellers sourced their water from well (24.1%) or bore hole (16.1%) but rarely from streams (3.2%).

Most of the respondents washed the feeding and watering troughs weekly while a few did that daily. However, very few of the sellers washed the feeding and watering troughs monthly (Table 3). Dead birds were usually disposed of primarily by dumping them in refuse bins (93.5%) but some of the respondents will either sell such birds to butchers (3.2%) or bury (3.2%) them.

Association of the knowledge and the educational level of poultry sellers and *Salmonella* infection
The association between level of education of poultry sellers and their knowledge of *Salmonella infection* is presented Table 4. There was no significant association between level of education of the respondents and their knowledge of *Salmonella* infection including awareness of the infection, seasonality, clinical manifestations, sources of infection and information regarding the disease in poultry (Table 4).

Risk Factors Associated with the occurrence of *Salmonella*
The findings from this study showed that *Salmonella* occurrence in poultry markets was influenced by several risk factors including sources of water, type of chickens sold, mixing of new and old stock, washing/cleaning of feeding and watering troughs and the use of antimicrobials. None of the factors had significant ($p>0.05$) association with the occurrence of salmonellosis in the logistic regression analyses (Table 5).

DISCUSSION
Live Bird sellers (LBS) constitute important stakeholders in the poultry industry in Nigeria, and therefore, should be incorporated into any activity that is aimed at preventing or controlling poultry diseases. The results of this study that in Maiduguri metropolis the trade in indigenous chicken is predominantly carried out by male individuals contrasts with the situation in South-western Nigeria where the female gender dominates (82.5%) the business [1,15]. The dominance of the trade by the male gender in Maiduguri metropolis could be associated with cultural practices/religious belief/background of people in the study area. This low level of involvement of women in the live bird sales business may negatively impact the family income as family poultry plays an important role in the livelihood of the family in which women are more likely to manage well [16].

Although, some of the respondents acquired western education (Primary or Secondary), majority of them never went to school. The low literacy level among the LBS may negatively impact the acquisition of knowledge and practices relevant for their trade [17]. Educated LBS will likely be more receptive to advice from veterinary and extension professionals and better able to deal with technical information as literacy level is known to be tied to the uptake of public health messages and risk perception [18].

The lack of the basic knowledge of *Salmonella* infection by the LBS as observed in this study may result in easy spread of infections among the birds in the market, since they were sourced from different locations. This was further corroborated by the fact that only a few of the LBS were aware of salmonellosis as a disease. The practice of mixing both new and old stock from different sources as well as mixing the village/indigenous chicken and the exotic ones by most of the LBS in the study area might facilitate the transmission of salmonellosis and other disease agents in such markets. Horizontal transmission has been reported as one of the potential ways of transmitting *Salmonella* infections especially through faecal droppings and residual presence of pathogens from previous flock [19]. There is, therefore, need for improved veterinary extension services among the LBS.

The observation of diarrhoea as a major clinical manifestation of salmonellosis in poultry by some of the LBS agrees with previous reports in Gombe [20] where the major signs observed by LBS were those of diarrhoea. *Salmonella* infection, especially in young poultry, frequently results in subclinical manifestations with the birds usually shedding bacteria in their faecal droppings without any noticeable signs of the disease [21]. It is

therefore important that poultry sellers and handlers be aware of these potential subclinical infections and thus institute risk-reducing practices [22].

Table 3. Practices of village chicken sellers on Salmonellosis in live bird markets in Maiduguri, Borno State, Nigeria.

Variables	Description	No. (%) of Respondents	($\chi 2$)	P-value
Type of chickens sold	Local chickens	53 (85.5)		
	Exotic chickens	2 (3.2)	114.73	< 0.0001
	Both	7 (11.3)		
Source of local chickens	Buying from markets	49 (79.0)		
	Gifts	8 (13.0)	87.726	< 0.0001
	Both	5 (8.1)		
Number of chickens purchased per week	> 50	43 (69.4)		
	30 – 50	10 (16.1)	54.339	< 0.0001
	< 30	9 (14.5)		
Minimum No. of days before complete selling-off of stock	2 weeks	30 (48.4)		
	4 weeks	19 (30.6)	23.330	< 0.0001
	2 months	13 (21.0)		
Mixing of new chickens with old stock	Yes	52 (83.8)		
	No	10 (16.2)	54.226	< 0.001
Mixing local chickens with other species	Yes	42 (67.7)		
	No	20 (32.3)	14.226	0.0002
Action taken when Chickens are sick	Slaughter	12 (19.3)		
	Sell-off	40 (64.5)	40.839	< 0.0001
	Treat (antimicrobials)	10 (16.1)		
Frequent use of antimicrobials	Yes	35 (56.5)	1.581	0.2087
	No	27 (43.6)		
Source of water supply	Stream	2 (3.2)		
	Bore hole	10 (16.1)	51.011	< 0.0001
	Well	15 (24.1)		
	Water vendors	35 (56.5)		
Washing of feeding and watering troughs	Daily	7 (12.0)		
	Weekly	53 (85.5)	114.73	< 0.0001
	Monthly	2 (3.2)		
Vaccination against Salmonellosis	Yes	9 (14.5)		
	No	53 (85.4)	59.645	< 0.0001
How do you dispose dead birds?	Burying	2 (3.2)		
	Dump in refuse	58 (93.5)	151.74	< 0.0001
	Sell to Butchers	2 (3.2)		

Table 4. Association of the knowledge of village chicken sellers and their educational level on *Salmonella* infection.

		Total	Educational level			χ2	P value
			No Education	Primary Education	Secondary Education		
Awareness of *Salmonella* infection	Yes	15	3 (10.3)	7 (31.8)	5 (41.7)	5.469	0.065
	No	47	25 (89.3)	15 (68.20)	7 (58.3)		
Disease seasonality	Rainy	32	15 (53.6)	10 (45.5)	7 (58.3)	0.594	0.743
	Dry	30	13 (46.4)	12 (54.5)	5 (41.7)		
Clinical signs	Diarrhoea	36	15 (53.6)	14 (63.6)	7 (58.3)	7.918	0.224
	moist eyes	7	4 (14.3)	2 (9.1)	1 (8.3)		
	ruffled feathers	14	8 (28.6)	2 (9.1)	4 (33.3)		
	sunken eyes	5	1 (3.6)	4 (18.2)	0 (0.0)		
Source of information	Others	53	26 (92.9)	19 (86.4)	8 (66.7)	5.188	0.269*
	Social	2	0 (0.0)	1 (4.5)	1 (8.3)		
	Vets	7	2 (7.1)	2 (9.1)	3 (25.0)		

*Fisher's Exact Test

Table 5. Risk factors associated with *Salmonella* species isolated from village chickens in live bird markets in Maiduguri Metropolis.

Variable	Description	NO. of Respondents (%)	Odds Ratio (OR)	*p*-value	95 % C. I
Number of chickens purchased per week	> 50	43 (69.4)	1	1	1
	30 – 50	10 (16.1)	0.390	0.207	0.090-1.683
	< 30	9 (14.5)	1.034	0.963	0.244-4.382
Type of chickens sold	Exotic chickens	2(3.2)	1	1	1
	Local chickens	53 (85.5)	1.022	0.584	0.170-6.136
	Both	7 (11.3)	2.179	0.981	0.250-18.982
Mixing of new chickens with old stock	Yes	52 (83.8)	1	1	1
	No	10 (16.2)	2.403	0.148	0.733-7.883
Source of water	Bore hole	10 (16.2)	1	1	1
	Well	15 (16.1)	3.946	0.130	0.666-23.363
	Water vendors	35 (56.5)	3.476	0.192	0.535-22.588
	Stream	2 (3.2)	2.476	0.350	0.369-16.600
Washing of feeding and watering troughs	Frequently	7 (12.0)	1	1	1
	Often	53 (85.5)	0.936	0.932	0.207-4.234
	Seldom	2 (3.2)	1.201	0.794	0.304-4.738
Use of antimicrobials	Yes	35 (56.5)	1	1	1
	No	27 (43.6)	1.119	0.848	0.353-3.548

The practice of sourcing water from vendors as practiced by majority of the LBS may facilitate the transmission of microbial pathogens. Previous studies reported this as a potential source of *Salmonella* infection [23,24]. Natural/stream water may be a vehicle of transmission of *Salmonella* and other microbes since they have been shown to be present in surface water [25,26,27,28,29]. Poultry drinking water has been implicated as a risk factor for the infection of birds by pathogens, especially *Salmonella* due to the thick biofilm that can be formed on water systems thereby affecting the quality of the water [30].

Furthermore, the practice of frequently washing of feeding and watering troughs by the sellers is likely to assist in reducing the contamination of equipment. Feeders and waterers may also serve as sources of infection with *Salmonella* if they are not properly and frequently cleaned. Contamination of feeders and waterers with pathogens could be through dust, dirty litter, regurgitation of feed and water by infected bird [31,32].

The indiscriminate use of antimicrobials by the LBS may be associated with their lack of awareness of the global threat for human, animal and environmental health. Indiscriminate use of antimicrobials in poultry may pose a great risk for the development and spread of antimicrobial pathogens [33,34,35]. The prudent use of antimicrobials and the observance of withdrawal periods associated with their use are the major means of preventing the development and spread of resistance by microbes [36].

Furthermore, the sale of sick or dead birds by most of the LBS poses a great risk to public health. *Salmonella* infections in humans originating from poultry meat accounted for more than 94,000 human cases reported in the European Union countries in 2016 [37]. Besides the spread of *Salmonella* infections, other zoonotic diseases such as avian influenza may also be spread by such practices [38,39].

The lack of association between the level of awareness of *Salmonella* infection by the respondents and their level of education suggest the need to educate the live bird marketers on the dangers of *Salmonella* infections and the health hazards their practices may pose to public health.

CONCLUSION

In conclusion, the results of this study have shown that the LBM in Maiduguri metropolis is dominated by males with limited literacy level and information about *Salmonella* infections while some of their business practices may pose danger to public health through a possible spread of *Salmonella* infection among village chickens. The results also suggested that several risk factors including sources of water, type of chickens sold, mixing of new and old stock, washing of feeding and watering troughs and the use of antimicrobials are associated with the live birds marketing in the study area.

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