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PAMJ One Health

Short communication

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Received: 20 Jul 2024 - **Accepted:** 22 Aug 2024 - **Published:** 29 Nov 2024

Keywords: Seroprevalence, avian influenza, Newcastle, co-infection, guinea fowl

Cite this article: Albert Agyapong Tweneboah et al. Seroprevalence and associated risk factors of co-infection with avian influenza and Newcastle disease in guinea fowls from the Upper East Region of Ghana. PAMJ-One Health. 2024;15(16). 10.11604/pamj-oh.2024.15.16.44716

Available online at: https://www.one-health.panafrican-med-journal.com/content/article/15/16/full

Seroprevalence and associated risk factors of co-infection with avian influenza and Newcastle disease in guinea fowls from the Upper East Region of Ghana

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Abstract

The Upper East Region of Ghana, with its diverse poultry farming practices, is particularly vulnerable to outbreaks of infectious diseases such as Avian Influenza (AI) and Newcastle Disease (ND). This study investigated the seroprevalence and risk factors of co-infection with AI and ND in guinea fowls from this region. A total of 397 guinea fowls were sampled, revealing a seroprevalence rate of 24.9% for avian influenza, 50.9% for Newcastle disease, and 12.1% for AI and ND co-infection. No significant associations were found between co-infection rates and variables such as sex, age group, and sampling site. These findings underscore the need for enhanced biosecurity measures, regular surveillance, and further research to manage and prevent AI and ND outbreaks in poultry populations. Enhanced biosecurity, regular monitoring, farmer education, and investigation into additional risk factors are recommended to ensure poultry health and productivity.

Introduction

In recent years, the poultry industry in Ghana has been increasingly impacted by respiratory diseases, notably Avian Influenza (AI) and Newcastle Disease (ND) [1,2]. These viral infections are significant not only for their economic implications but also for their potential public health risks. AI, caused by the influenza A virus, manifests in two primary forms: highly pathogenic avian influenza (HPAI) and low pathogenic avian influenza (LPAI), with HPAI causing severe illness and high mortality rates in poultry [1]. Newcastle disease, caused by the Newcastle Disease Virus (NDV), is another critical viral infection that affects a wide range of avian species and often leads to severe respiratory distress and high mortality in infected birds [3,4].

The Upper East Region of Ghana, bordering Burkina Faso and Togo, is a significant area for poultry farming, which includes both commercial and backyard poultry systems. This region, due to its geographical location and cross-border trade activities, presents a unique environment for the spread of infectious diseases among poultry [1,5]. The region with its diverse poultry farming practices and high density of poultry populations, is particularly vulnerable to outbreaks of AI and ND. The introduction of enhanced surveillance and diagnostic measures is crucial in this context to manage and mitigate the impacts of these diseases. Recent outbreaks of HPAI H5N1 in Ghana have underscored the need for vigilant monitoring and rapid response to infectious diseases in poultry to prevent widespread economic losses and safeguard public health [1,6].

The co-infection of AI and ND poses a complex challenge, as these infections can exacerbate each other's effects, leading to more severe clinical outcomes and increased mortality rates in affected flocks [7]. Studies have shown that co-infections of AI and ND are not uncommon and have been reported in various regions globally. For instance, a study in Iran highlighted the co-existence of AI and ND in backyard chickens, emphasizing the role of such mixed infections in worsening the health status of poultry [7]. Similarly, research conducted in Nigeria and other parts of Africa has documented the seroprevalence of both AI and ND, indicating that these co-infections can lead to significant economic losses due to increased mortality and decreased productivity in poultry farms [8]. Nevertheless, this has not been properly elucidated in the Ghanaian context. This study aimed to determine the seroprevalence and identify the risk factors associated with the co-infection of AI and ND in guinea fowls in the Upper East Region of Ghana. By doing so, it sought to provide a comprehensive understanding of the epidemiology of the co-infection of these diseases in the region and inform strategies for effective disease control and prevention.

Methods

Study area: the study was conducted in three districts in the Upper East Region of Ghana namely Bongo, Bolgatanga, and Bolgatanga East. The region shares borders with the Republic of Burkina Faso to the north, the Republic of Togo to the east, the Northeast Region of Ghana to the south, and the Upper West Region of Ghana to the west. The region occupies a land mass of 8,842 square kilometers (2.7% of the total landmass of Ghana).

Study population:a total of three hundred and ninety-seven (397) guinea fowls were purposively recruited for the study. These were from live bird markets, households, and slaughter facilities. The households kept a mixture of guinea fowls and indigenous chicken. The inclusion criteria were all guinea fowls of both sexes, growers, adults apparently healthy, and those showing signs of ill health.

Blood sample collection: blood samples were collected from guinea fowls that were over 4 weeks of age. A 21-gauge 5 ml syringe was used to collect blood from the brachial vein into appropriately labeled gel and clot activator tubes. The samples were transported on ice at 4°C to the laboratory. Once blood samples were fully clotted, it was centrifuged at 3000 rpm for 5 minutes. The serum was aliquoted into plain labeled cryotubes and stored at -20°C till serology was performed.

Serological technique

Antibodies against influenza A: sera samples were screened for the presence of antibodies to influenza A using ID Screen® Influenza A Antibody Competition Multi-species obtained from ID-vet Innovative Diagnostics, Grabels, France. The test is a competitive ELISA for the detection of influenza A antibodies in the serum of avian species.

Antibodies against Newcastle disease: sera samples were tested for Newcastle disease virus-specific antibodies using the Haemagglutination inhibition (HI) test as described in the manual of diagnostic tests and vaccines for terrestrial animals.

Data analysis: an Excel spreadsheet from Microsoft Office 365 was used to enter and organize the data. The data was analyzed using STATA 15 (STATA Corporation, 4905, Lakeway River, College Station, Texas 77845, USA). Chi-square analysis was performed to ascertain the association between sex, age group, and location of guinea fowl (sampling site) to the co-infection of avian influenza (AI) and Newcastle disease (ND).

Results

Out of the 397 guinea fowl sera samples examined, a total of 99 (24.9%) tested positive for avian influenza (AI), 202 (50.9%) tested positive for Newcastle disease (ND), while 48 (12.1%) tested positive for coinfection of avian influenza (AI) and Newcastle disease (ND) as shown in Figure 1.

Association between risk factors and co-infection of avian influenza (AI) and Newcastle disease (ND): the analysis of the association between sex, age group, and sampling site of guinea fowl with the co-infection of avian influenza (AI) and Newcastle disease (ND) is revealed in Table 1. For sex, the co-infection rates were 5.3% in females and 6.8% in males (χ^2= 0.356, p = 0.551). Age group analysis showed co-infection rates of 11.3% in adults and 0.8% in growers ((χ^2= 0.257, p = 0.612). Regarding sampling sites, co-infection rates were 2.3% for households, 4.0% for live bird markets, and 5.8% for slaughter points ((χ^2= 1.686, p = 0.430). These findings indicate that there were no significant associations between these variables and the co-infection of AI and ND in guinea fowl (Table 1).

Discussion

This present study reports for the first time the seroprevalence and associated risk factors of co-infection with avian influenza and Newcastle disease in guinea fowls from the Upper East

Region of Ghana. The study found a 12.1% seroprevalence of avian influenza and Newcastle coinfection in guinea fowl. This finding is significant as it highlights for the first time the co-circulation of these two important avian respiratory pathogens within the same poultry population, which can have serious implications for poultry health and productivity. The seroprevalence of AI and ND co-infection observed in this study aligns with similar findings from other regions, where co-infections have also been reported. Studies in Nigeria, have documented the seroprevalence of AI and ND, indicating that co-infections can lead to significant economic losses due to increased mortality and decreased productivity in poultry farms [8]. Musa *et al.* [9] reported a 0.2% prevalence of AI and ND co-infection in a local chicken from a live bird market.

Additionally, Costa-Hurtado *et al.* [10] reported co-infections of AI and ND in commercial poultry farms, emphasizing the complicated clinical picture and increased severity of disease outcomes associated with these co-infections. Several factors could contribute to the high seroprevalence of AI and ND co-infection observed in this study. Poor biosecurity measures and management practices in poultry farms, such as inadequate quarantine procedures for new birds and lack of proper vaccination, can facilitate the spread of AI and ND viruses.

In this study, the co-infection rates for AI and ND were 5.3% in females and 6.8% in males, with no significant association ($p = 0.551$). This indicates that both male and female guinea fowls are equally susceptible to co-infection with AI and ND. This study further showed high co-infection rates of 11.3% in adult guinea fowls and 0.8% in growers, with no significant association between the co-infection rate and the age of guinea fowls. This suggests that age does not significantly influence co-infection rates, even though adults showed higher rates numerically. In addition, this study found AI and ND co-infection rates of 2.3% in guinea fowls from households, 4.0% in live bird markets, and 5.8% in slaughter points, with no significant association ($p>0.05$). The higher prevalence rates in live bird markets may be due to the high density and turnover of birds, which can facilitate viral transmission. The current study´s lack of significant association suggests that factors other than sampling site location may be more critical in determining co-infection rates.

The findings of this study contribute to the understanding that sex, age group, and sampling site may not be the primary determinants of co-infection with AI and ND in guinea fowls. This highlights the necessity for future research to explore other potential risk factors, including environmental conditions, management practices, genetic predispositions, and biosecurity measures. Furthermore, the study underscores the importance of comprehensive surveillance and control strategies that encompass a broader range of potential risk factors. This approach is essential for effectively managing and preventing the spread of AI and ND in guinea fowls, ensuring the health and productivity of poultry populations.

Conclusion

This study identified a significant overall seroprevalence of 12.1% for co-infection with Avian Influenza (AI) and Newcastle Disease (ND) in guinea fowls in the Upper East Region of Ghana. The findings revealed that there were no significant associations between co-infection rates and variables such as sex, age group, and sampling site. This suggests that other factors, potentially including environmental conditions and management practices, may play a more critical role in the prevalence of these infections. The presence of these co-infections within the guinea fowl population underscores the importance of implementing effective control measures. It is recommended that enhancing biosecurity measures at poultry farms and live bird markets, conducting regular serological surveillance to monitor and detect outbreaks early, and educating farmers on biosecurity and vaccination would be beneficial. Further research should investigate

additional risk factors such as environmental conditions and management practices. These strategies are crucial for managing and preventing AI and ND outbreaks, ensuring poultry health and productivity.

What is known about this topic

- *The Upper East Region of Ghana, with its diverse poultry farming practices, is particularly vulnerable to outbreaks of Avian Influenza (AI) and Newcastle Disease (ND);*
- *Previous studies have documented the presence of AI and ND as singly occurring diseases with speculations of possible co-infections in Ghana;*
- *Avian influenza and Newcastle disease are critical avian diseases with major economic and public health implications, caused by highly pathogenic viruses that can lead to severe illness and high mortality in poultry.*

What this study adds

- *This study provides the first report on the seroprevalence and associated risk factors of co-infection with AI and ND in guinea fowls from the Upper East Region of Ghana;*
- *The study found no significant associations between co-infection rates and variables such as sex, age group, and sampling site, suggesting that other factors may be more influential in the prevalence of these infections;*
- *The findings underscore the necessity for enhanced biosecurity measures, regular surveillance, and further research to manage and prevent AI and ND outbreaks in poultry populations in Ghana.*

Competing interests

The authors declare no competing interests.

Funding

This research was funded by the Pan African University Life and Earth Sciences Institute (Including Health and Agriculture), Ibadan, Nigeria.

Authors' contributions

Albert Agyapong Tweneboah, Sherry Ama Mawuko Johnson and Benjamin Obukowho Emikpe were responsible for conceptualizing the study and designing the methodology; Albert Agyapong Tweneboah was responsible for data collection, analyzing the data, and drafting the original manuscript; Patrick Amponsah Mensah was responsible for laboratory analysis; Albert Agyapong Tweneboah, Sherry Ama Mawuko Johnson, Benjamin Obukowho Emikpe, and Derrick Adu Asare all contributed to data analysis, as well as reviewing and editing the manuscript; Benjamin Obukowho Emikpe, Derrick Adu Asare, and Edmond Onidje reviewed and edited the manuscript. All the authors read and approved the final version of this manuscript.

Table and figure

Table 1: association between sex, age group, and location of guinea fowl (sampling site) and the co-infection of avian influenza and Newcastle disease

Figure 1: seroprevalence of avian influenza and Newcastle disease in guinea fowls

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Table 1: association between sex, age group, and location of guinea fowl (sampling site) and the co-infection of avian influenza and Newcastle disease

Variable	Categories	Coinfection of AI and ND		χ2 -value	P-value
		Negative	Positive		
Sex	Female	137 (34.5%)	21 (5.3%)	0.356	0.551 ns
	Male	212 (53.4%)	27 (6.8%)		
Age group	Adult	333 (83.9%)	45 (11.3%)	0.257	0.612 ns
	Grower	16 (4.0%)	3 (0.8%)		
Sampling site	Household	71 (17.9%)	9 (2.3%)	1.686	0.430 ns
	Live bird market	86 (21.7%)	16 (4.0%)		
	Slaughter point	192 (48.4%)	23 (5.8%)		

ns: non-significant differences at a 5% significance level; AI: Avian Influenza; ND: Newcastle Disease

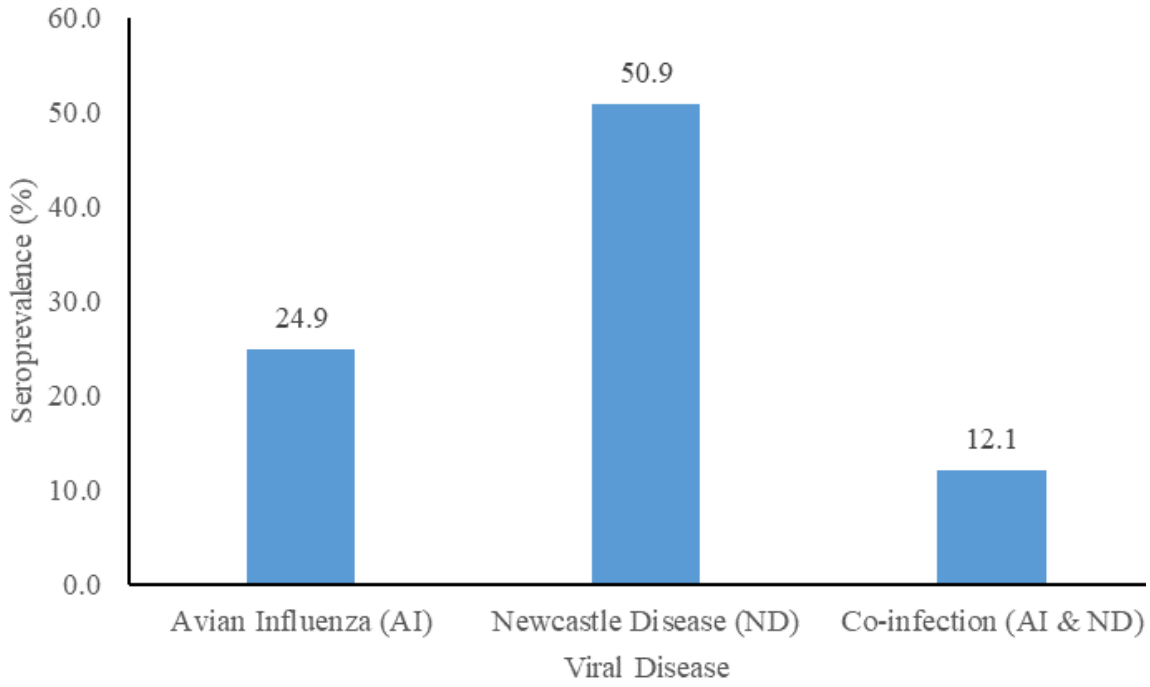

Figure 1: seroprevalence of avian influenza and Newcastle disease in guinea fowls