European Journal of Science, Innovation and Technology
ISSN: 2786-4936
www.ejsit-journal.com
Volume 4 | Number 4 | 2024

Seroprevalence and Associated Risk Factor Studies of Newcastle Disease (NCD) in Small-Scale Poultry Farms of North Shewa, East Shewa, Arsi and W/Arsi Zones of Oromia Regional State

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ABSTRACT

A cross-sectional study on seroprevalence of Newcastle disease virus (NDV) antibodies in backyard and small-scale chicken producer farms in Lume, G/Jarso, Tiyo and Shashamane districts was conducted using I-ELISA from June, 2019 to August, 2019. A total of 488 chicken sera were randomly collected from kebele of selected districts. I-ELISA test was used to analyze 488 chicken sera for NDV antibodies and the overall seroprevalence rate of 69.05% was found. A higher seroprevalence of 23.16% was observed in Lume district when compared to Tiyo (29.05%), Shashamane (13.93%) and G/Jarso (12.91%) districts. Chi-square computed statistical analysis indicated that origin ($\chi2=62.0944$; $p<0.05$) was the major risk factors for NCD infection in the studied areas. The difference, however, was not statistically significant ($p>0.05$) for sex (female/male), breed (exotic/cross/indigenous (local)) and type of chicken. Multivariable logistic regression statistical analysis revealed that origin and type (layers/broilers) were significantly associated with NCD seropositivity ($p<0.05$). Consequently, origin was statistically identified to be the major risk factor for NCD to occur in relation to other factors. The study showed that majority of the chicken population in the studied area was susceptible to the pathogenic NDV infection. Therefore, more proactive measures should be taken to protect the chicken population from ND infection to reduce its economic impact to the poultry industry and it is good to take correct diagnosis like seroconversion test for further investigation.

Key words: chicken, districts, Newcastle disease, risk factors, seroprevalence

INTRODUCTION

Poultry production plays a major role in the economy particularly of developing countries (Mazengia, 2012). The larger proportion of rural poultry in the national flock population of developing countries makes them worth paying attention to improved management and breeding. At national level in Ethiopia, 99% of the total, 56.5 million, estimated chickens are contributed by village poultry production while only 1% is from intensive exotic breed maintained under intensive management system (Dinka *et al.*, 2010). In village systems, farmers keep poultry for diverse objectives. They are raised for purposes of hatching, sale, home consumption, sacrifices (healing ceremonies) and gifts (Mazengia, 2012). In Ethiopia, village chickens have been reared for a long time for similar purposes. Constraints which restrict the potential of village chickens in Ethiopia include; low inputs of feeding, poor management, the presence of diseases of various natures and lack of appropriate selection and breeding practices (Tadelle & Ogle, 2001).

Among the constraints, poultry diseases are considered to be the most important factor responsible for reducing both the number and productivity of chickens (Tadesse *et al.*, 2005). A growing concern reveals that as there is introduction of diseases of various etiologies into several poultry farms concurrent with importation of exotic breeds to backyard chickens. Furthermore, intensification is aggravating the rapid spread of the prevailing infectious diseases between and within poultry farms. And the distribution of these exotic breeds to farmers is creating a great threat to the indigenous backyard chickens (Zeleke *et al*., 2005a). Among these threats, viral diseases like Newcastle disease (ND) are the major health constraints inflicting heavy losses (Tadelle & Ogle, 2001; Zeleke *et al*., 2005a, b).

Newcastle disease (ND) is one of the most important viral diseases (Orsi *et al*., 2010). It is an acute infectious viral disease of domestic poultry and other species of birds regardless of variation in sex and age (Haque *et al*, 2010). The disease is characterized by respiratory, nervous system impairment, gastrointestinal and reproductive problems (Tiwari *et al*., 2004). Sources of infection for NDV are exhaled air from infected birds and contaminated feed and water and transmission is mostly via aerosol. Feces, eggs lay during clinical diseases, and all parts of the carcass during acute infection and at death can also act as sources of infection. Chickens infected with virulent NDV may die without showing any clinical sign of illness though young chickens are more susceptible and show sign sooner than older ones. Much of the spread of ND in village is probably via human agents (Ashraf & Shah, 2014). An outbreak of ND is unpredictable and discourage villager from paying proper attention to the husbandry and welfare of their chickens (Spradbrow, 2001).

Statement of the Problem

Various studies have been conducted to determine the epidemiology of ND in various countries in Africa. In study conducted in Ethiopia by Tadesse *et al*. (2005) and Ashenafi (2000), the seroprevalence rates of 28.57, 29.69, 38.33 and 43.68% were found in Debre Berhan, Sebeta, Adama and Central Ethiopia (among local scavenging chickens kept under a traditional management system), respectively. Another study conducted in two districts of Eastern Shewa Zone, Ethiopia by Chaka *et al*. (2012) to estimate the seroprevalence of ND (and other poultry diseases being not considered in this study) in the wet and dry seasons and they reported the overall seroprevalence of ND was 5.9% during the dry season and 6.0% during the wet season.

In general, the epidemiology of ND in village poultry in Ethiopia is poorly understood and there is no appropriate investigation and control strategy designed against the disease. This is due to lack of disease monitoring capacity in the Veterinary Services Department of the Ministry of Agriculture and Rural Development (Tadelle & Jobre, 2004). Farmers start to consider, therefore, losses due to diseases as normal and natural (Tadelle, 1996; Nasser, 1998) and they fail to report outbreaks to the veterinary authorities. Though all the above study reveals that as ND seriously devastating poultry industry in Ethiopia, there is scarcity published data (information) about the seroprevalence of this disease in poultry industry threat in E/Shoa, N/Shoa, Arai and W/Arsi Zone in general in selected districts in particular.

MATERIALS AND METHODS

Study Area

Administratively, Ethiopia is subdivided into regions that are again subdivided into zones and then woredas (districts). The study was conducted in Lume, Girar Jarso, Tiyo and Shashamane districts.

Lume is located in the East Shewa Zone of the Oromia Region, Ethiopia. It is located at 66 Km South-east of Addis Ababa and lies at latitude 8°35’N and longitude 39°7’E at an altitude of 1790 meters above sea level. The area gain rainfall twice a year those known as long and short rainy season. The main rainy season extends from June to September. The average annual rainfall, temperature, and mean relative humidity are: 776mm, 19.4 ºC and 59.9% respectively (CSA, 2005).

Girar Jarso is located in North Shewa Zone, Oromia Regional State. It is located at a latitude and longitude of 9.50°N 36.3°E/ 9.08°N 36.6°E and 114 Km North west of Addis

Ababa, capital city of the country. It has 24 rural villages (community) which have a total household population of 334,124 (CSA 2007). The climate condition is conducive for both crop and livestock production. The annual average rainfall is 1800 mm and an elevation of 2,088 meters above sea level. The annual average temperature is 21°C (NMSA 2011). There are four seasons and two rainy seasons namely the Kiremt and Belg. Out of the four seasons, Kermit is cooler and Bega is hotter (EPLA, 2005).

Shashemene is located 250 km south of the capital Addis Ababa, and 25 km north of Awassa. The area lies within the Rift Valley, with altitudes ranging from 1700 to 2600 meters above sea level (m.a.s.l) and located at 7° 05'N to 7° 19'N and 38° 23'E to 38° 41'E. It receives an annual rainfall of 700–950 mm, and has an annual temperature range of 12–27oC.Out of the total area of 76,888 hectares, crop land accounts for 48,975 hectares, and the rest 7440, 5160, and 1320 hectares are forest land, grazing land and land for other purposes, respectively. The urban settlement accounts for 1733 hectares. The cattle population in the districts is 184,549 (SDARDO, 2010).

Tiyo district located in South Eastern Ethiopia. Asalla town, the capital of Arsi zone, is located at about 175 km Southeast of Addis Ababa at 6^{0}59' to 8 49' N latitudes and 38 41' to 40 44' E with an altitude of the area ranges from 2500 to 3000metreabove sea level and the temperature, between, 10-25c. The rain fall is 1147mm on average and agricultural production system of the area is of mixed crop and livestock production (TDAO, 2006). It is one of the highly populated areas in Ethiopia with estimated population of bovine-82,190, ovine-51,292; caprine-8, 11479; poultry-5, 62915 and equine-22,055 (Geresu *et al*., 2016). Dairy farming using improved cross breeds is a common practice and farming system exists in the study area were intensive, semi-intensive and extensive.

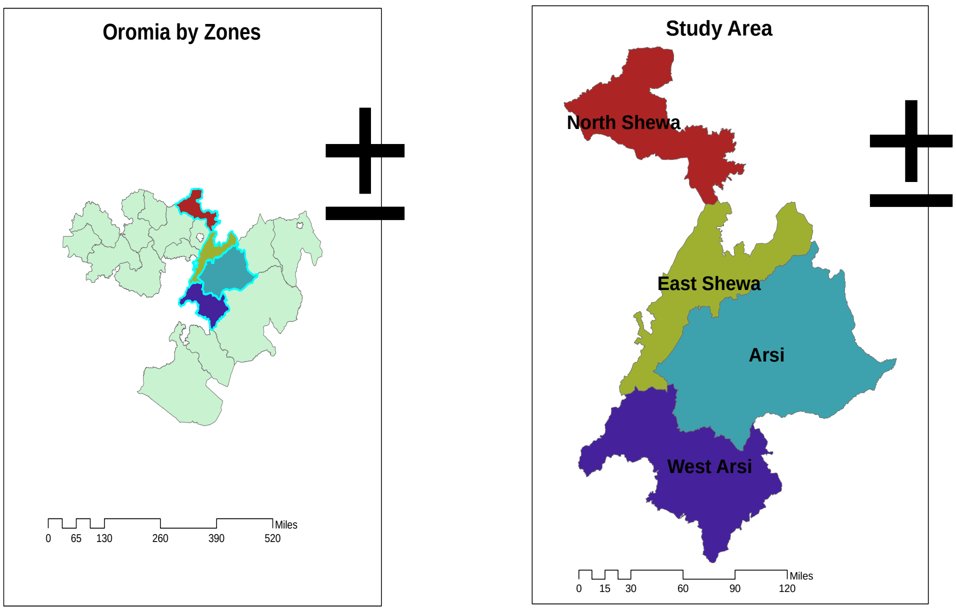

Figure 1: Study area

Study Design and Sampling Size

The cross-sectional study was conducted from June to August, 2019 to determine the seroprevalence of Newcastle disease in unvaccinated backyard chickens. The sample size was calculated using 95% confidence interval, 5% desired absolute precision and with the assumption of 19.78% (Chaka *et al.*, 2012) expected seroprevalence of Newcastle disease; the sample size was determined according to the formula given by Thrusfield (2005).

$$n = \frac{1.96^2 P_{exp}(1-P_{exp})}{d^2}$$

Where, P_{exp}= expected prevalence;
d= absolute precision;
n = sample size.

Where n is the required sample size, P is the expected prevalence and d is the desired absolute precision, for n=244. The total sample size was proportionally allocated between randomly selected peasant associations of study area. To avoid loss of sample units and increase precision we make it two fold. Thus, total samples of 488 chickens were selected for this study.

Sample Collection and Procedure

A total of blood samples was collected from wing vein of chickens with 3 ml disposable syringe. The sera samples were left horizontally for some hours and then held vertically to allow clotting for serum separation. The collected sera were transferred into cryogenic vials and stored at –20°C until testing. The collected sera samples will be tested by using commercial I-ELISA kits for the presence of antibodies against NCD. The OD values will be calculated according to the instructions of the kit (ID.Vet innovative Diagnostics, ID Screen ND indirect, IDvet, 310 rue Louis Pasteur – Grabels- France).

Questionnaire Survey

The questionnaire interview contained 25 questions; the questionnaire was developed in English and translated by the involved local language Afan Oromo. Poultry farms or households rearing village/town poultry were randomly selected and all interviewed using structured questionnaire. Accordingly, data on major constraints (health problems, marketing and others), health managements, opportunities and challenges of village poultry production in randomly selected districts of North Shoa, Arsi, West Arsi and East Shoa zones was collected.

Data Analysis

The collected data from the laboratory analyses was stored in Microsoft spread sheet and OD values will be computed. The seroprevalence of the disease in each district will be calculated with based on 95% confidence intervals. Seroprevalence will be compared between districts by using Chi-square test. Analyses will be done using STATA 11 (Stata Corp., College Station, TX).

RESULTS

Overall Seroprevalence of Newcastle Disease in the Studied Districts

In the present study, an overall seroprevalence of NCD, 69.05% was estimated by I-ELISA test. A higher seroprevalence of 23.16% was observed in Lume district when compared to Tiyo (19.05%), Shashamane (13.93%) and G/Jarso (12.91%) districts as depicted in Table 1.

Table 1: Overall seroprevalence of I-ELISA test result of NCD in small-scale poultry production system of the study districts

I-ELISA Test results	Selected districts				Total	Overall prevalence
	Lume N(%)	G/Jarso N(%)	Tiyo N(%)	Shashamane N(%)		
Positive	113(23.16)	63(12.91)	93(19.05)	68(13.93)	337	**69.05**
Negative	9(1.84)	59(12.09)	29(5.94)	54(11.07)	151	**30.95**
Total	**122(25)**	**122(25)**	**122(25)**	**122(25)**	**488**	**100**

Chi-square Analysis of Association of the Relative Risk Factors with ND Seropositivity

A Chi-square analysis revealed that origin was significantly associated (P<0.05) with NCD Seropositivity among other factors considered during the study. However, sex, type of chickens and Breeds were insignificantly associated (p>0.05) with NCD Seropositivity (Table 2).

Table 2: Chi-square analysis of association of the relative risk factors with NCD seropositivity

Variables	Category	No. of examined	No of positive (%)	X^{2-}P-value
Origin	Lume	122	113(23.16)	62.0944(0.000)
	G/Jarso	122	63(12.91)	
	Tiyo	122	93(19.06)	
	Shashamane	122	68(13.93)	
Sex	Female	481	331(67.82)	0.9221(0.337)
	Male	7	6(1.23)	
Breed	Layers	344	243(49.79)	1.3657(0.243)
	Broilers	144	94(19.26)	
Age	Exotic	474	326(66.80)	1.1120(0.574)
	Cross	2	2(0.41)	
	Local	12	9(1.84)	

Breed and sex were not entered to the final model as they were collinear with each other's and or P-value ≥ 0.25. The final multivariable logistic regression model of risk factors analysis revealed that type of chicken and origin had a significant (P<0.05) association with NCD and hence are independent predictors (P ≤ 0.05) (Table 4).

Table 3: Multivariable logistic regression model analysis of predictors of NCD in backyard and small-scale poultry farm

Variables	Category	OR	95%CI	P-value
Origin	Lume	1.0		
	G/Jarso	0.072	0.033-0.158	<0.001
	Tiyo	0.223	0.099-0.500	<0.001
	Shashamane	0.077	0.035=0.171	<0.001
Type of chicken	Pullet	1.0		
	Layers	2.03	1.258-3.269	0.004

DISCUSSION

The present serological study revealed that the presence of circulating antibodies of ND among chickens sampled from backyard and small-scale poultry farms of Lume, G/Jarso, Tiyo and Shashamane districts of E/Shoa, N/Shoa, Arsi and W/Arsi.

The study revealed that the prevalence of NCD antibodies in backyard chickens was generally high, around 69.05%. This is considerably higher than previous reports 19.8% by Zeleke *et al*. (2005b), 27.86% by Geresu *et al*. (2016), 31.2% by Salihu *et al*. (2012), 32.2% by Tadesse *et al*. (2005) and 43.68% by Ashenafi (2000) reported. The result of the present study is considerably lower than previous report 79.6 by Birhan *et al*. (2019) in Gondor zone, but our results were not close to those reported 6% by Chaka *et al*. (2012) and 11% by Regasa *et al*. (2007) in Eastern Shoa zone and rift valley districts respectively. Our results are also some consistent with seroprevalence in backyard poultry of 76.19% in Mauritania.

This could be explained by differences in study area or by exposure to mild virus strains that induced immunity but did not kill many chickens. The presence of lentogenic, or possibly mesogenic, NDV in backyard small-scale chicken producing farms in an area may result in a constant cycle of infection that periodically boosts the immunity of all exposed chickens, resulting in a higher proportion of chickens with antibodies (Martin, 1992; Chaka *et al*., 2012). Another reason for variation between studies could be subjectivity and variation in I-ELISA.

The present study revealed that the origin of the chickens was significantly associated with NCD seropositivity ($p<0.05$) and it was also statistically identified that origin was the major risk factor for ND seropositivity to occur in relation to other factors. The results showed higher individual chicken seroprevalence in Lume (23.16%) when compared to others. This might be due to veterinarian's best Vaccinating of poultry in each kebeles of district.

This study also revealed a higher seroprevalence rate among the female (67.82%) compared to male chickens (1.23%) with statistically insignificance difference ($p >0.05$). Our finding corroborates the findings of Geresu *et al*. (2016), who reported a slightly higher prevalence of 30.53% among female chickens when compared with a prevalence of 14.29% among male chickens in Ethiopia. In contrary to this finding, a study conducted by Zeleke *et al*. (2005b) in Rift Valley districts of Ethiopia, NCD shows a higher prevalence rate among males (21.74%) than among females (19.16%).

The highest seroprevalence was observed in exotic breed than in the indigenous (local) and cross-bred chicken in the present study. The difference, however, was not statistically significant. An insignificant difference ($p>0.05$) in the seroprevalence between the indigenous (local) and cross breeds of chickens (excluding exotic breed) was reported by Vui *et al*. (2002) which is consistent with the present findings. In contrast to this, the relatively higher overall seroprevalence rate of ND virus antibodies in local chickens reported by Tadesse *et al*. (2005) attributed to a number of factors. However, the exotic breed sampled in this study was lower than the indigenous (local) and cross-bred which results in difficulty of interpretation of our findings because the question of breed susceptibility to ND is still controversial (Awan *et al*., 1994). Hence, this area needs an indebt study to unveil the factors responsible for this difference There was statistically significant association ($p<0.05$) between type of the chickens (layers or broilers and seropositivity of ND in the present study. A higher prevalence recorded in layers than in broilers chicken can be attributed to more layers been sampled. Khan *et al*. (2011) reported that relatively high level of antibodies against ND in unvaccinated birds observed during the study, (33% in egglaying hens) indicated a high prevalence of NDV infections in village chickens. The birds showing detectable levels of antibodies were considered exposed, while those having undetectable level of antibody titer against ND were considered as non-vaccinated

CONCLUSION AND RECOMMENDATION

This study established that NCD is endemic in Lume, G/Jarso, Tiyo and Shashamane districts of E/Shoa, N/Shoa, Arsi and W/Arsi. Higher seroprevalence was observed in Lume when compared to others districts with significance difference. Origin was statistically identified as the major risk factor for NCD seropositivity, but sex, breed (exotic/cross/indigenous) and Type of chicken were insignificantly associated with NCD seropositivity. This finding, apart from being of economic significance, it is also of nutritional importance because of the high mortality of the birds, which calls for adoption of preventive measures to help curb the devastating effects of the NCDV. The prevailing NCD seropositivity in the chicken production system indicates the importance of NCD in poultry industry of the studied areas and therefore, to effectively control NCD, more attention should be given to those areas by adopting prophylaxis through the use of heat resistant NCD vaccines for the chickens.

Based on the above conclusion, the following recommendation are forwarded

- Improvement of back yard and semi-intensive poultry production management system could play a significant role on successful control of infectious diseases.
- Programmed vaccination at the household level could be considered to reduce the seasonal incidence and mortality of diseases,
- Further study is warranted to better understand and characterize the ND virus strains circulating in the study area.
- Further study is necessary to understand the interactions of these infectious poultry diseases and their impact production System
- Protection of day-old chickens after hatching is critical, as this is the time when they are most susceptible to disease.
- All poultry in both farms need to apply adequate bio-security principles.

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