



ISSN Print: 2664-844X
 ISSN Online: 2664-8458
 NAAS Rating (2026): 4.97
 IJAFA 2026; 8(4): 28-32
www.agriculturaljournals.com
 Received: 03-02-2026
 Accepted: 06-03-2026

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Epidemiology and economic significance of infectious bursal disease in Ethiopia: A Review

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DOI: <https://www.doi.org/10.33545/2664844X.2026.v8.i4a.1291>

Abstract

Infectious bursal disease is among the most highly contagious immunosuppressive diseases of poultry. Its causal agent is a double-stranded Ribonucleic Acid virus known as infectious bursal disease virus. Infectious bursal disease virus has two serotypes. Serotype1 is host-specific affects chicken. Young chickens that are 21-45 days are highly susceptible. Serotype2 is non-pathogenic. The main mode of transmission is primarily via the fecal-oral route. Risk factors for the occurrence of disease is feed, water and litter from infected chicken houses since this virus remain infective for significant time periods. This virus mainly affects bursa fabricus. Initially, affected bursa fabricus shows sign of swelling from edema hemorrhage during the early stages of disease and then atrophy one week following infection. The virus is resistant and can survive in various environmental conditions and commonly used disinfectants. The virus is exposed to genetic changes and via forming mutations and reassortment, which leads to formation of new variants and change in epidemiological situation in a field. Poultry farm biosecurity is the primary focus area to prevent and control of this disease. Appropriate cleaning and disinfection before introducing new flocks are essential for limiting the spread of disease to other area. Infectious bursal disease causes significant economic losses either directly or indirectly. The direct losses associated with mortality of infected chickens and reduced production.

Keywords: Epidemiology, Infectious Bursal Disease, Economic impact, Ethiopia

Introduction

Livestock provides a paramount opportunity in Ethiopian agribusiness, and the poultry sub-sector is among the promising ones ^[1]. Currently, poultry industry is critical sub-sector in agriculture and a key driver of economic growth in Ethiopia. The poultry farming is serving as significant source of livelihood, food security, income generation, job creation, poverty reduction and contributing to national economy at large ^[2, 3]. The poultry industry is confronted with a variety of problems of infectious diseases in general and, particularly the diseases of viral origin ^[4]. The introduction and outbreak of viral diseases in chicken populations have hampered the growth of poultry producer economies ^[5]. The Ethiopian government has prioritized poultry production as a key driver to improve food security and job creation. The government also set initiative guided by national poultry development strategy (2022-2031) and development of goodness initiative targeting increase in poultry meat and eggs ^[6]. Infectious bursal disease is a major viral disease threat to poultry production ^[7].

IBD is a disease of worldwide importance due to the huge losses as a result of opportunistic infections encountered by poultry farmers ^[8]. Infections with serotype 1 IBDV are of worldwide distribution, occurring in all major poultry producing areas. IBD or Gumboro disease is an acute, extremely contagious infection of young chickens which is the most important threat to poultry production ^[9]. Infectious bursal disease virus is hard, resistant and very stable, so that difficult to eradicate from premises since this pathogen can thrive in a range of environmental conditions and withstand even potent disinfectants ^[10].

The prevalence of IBD in Ethiopia has fluctuated over time. During the period from 2007 to 2014, the prevalence peaked at 77%, followed by 70% from 2000 to 2007 and 58% from 2015 to 2023 ^[9]. Infectious Bursal Disease is one of the major significant economic importance poultry diseases both in the family poultry production and intensive poultry production systems in Ethiopia ^[11, 12]. The high monetary loss attributed to crude chicken

mortalities shows that poultry producers bear significant losses which lead to less profitability and termination of poultry business as well ^[13]. Improvement in poultry production and strict biosecurity implementation are the most promising options to prevent infectious bursal disease in a country ^[1]. The aim of this review was to update the IBDV epidemiological situation and economic impact in the poultry production in Ethiopia.

Etiology of Infectious Bursal Disease

Infectious bursal disease also known as Gumboro is an acute, extremely contagious infection of young chickens (*Gallus gallus domesticus*) caused by infectious bursal disease virus (IBDV) ^[14]. The causal agent was first isolated in Gumboro, Delaware in the Bunting farm, United States of America in the year 1962, and the disease was originally known as Gumboro disease. Infectious bursal disease (IBD) virus is a member of the genus Avibirnavirus of family Birnaviridae ^[15]. Birnaviridae are about 60nm in diameter, non-enveloped icosahedrons and contain two segments of double stranded RNA, each with covalently linked protein at the 5' end. ^[16]. The virus is resistant to pH 2, 50 °C heat and commonly used chemicals like quaternary ammonium compounds and survives in poultry house for long time ^[17]. Based on virus neutralization assay, IBD virus strains are classified into serotype 1 and serotype 2, While serotype 1 viruses are pathogenic and are classified as attenuated (atIBDV), classical virulent (cvIBDV), antigenic variant (avIBDV) and very virulent (vvIBDV) subtypes ^[18].

IBDVs are believed to emerge via homologous recombination and re-assortant phenomena, besides mutations, that occur naturally among different IBDV strains including vaccine strains ^[39].

Clinical manifestation of disease has been associated only with serotype 1, against which all commercial vaccines are prepared ^[18]. The IBDV infections mostly affect the cloacal bursa, although it can also replicate in other lymphoid organs such as the spleen, thymus, Harderian gland, and caecal tonsils ^[3]. The viruses affect lymphoid tissue causing destruction of B lymphocytes of Bursa of Fabricius and are actively dividing in young chickens ^[15]. Four to five hours after oral infection virus replicates first in macrophages and lymphoid cells in cecum, duodenum, jejunum and kupffer cells of liver ^[22]. In some birds the virus also spread to kidney and muscle tissue ^[20]. The most interesting characteristic of this virus is its ability to remain infectious for a very long period of time and resistance to commonly used disinfectants. The virus has no envelope and is very resistant, surviving more than 50 days in contaminated feed, water, manure and insects and beyond 4 months in the poultry house after removal of an infected flock. IBDV is susceptible to robust disinfection with formaldehyde and iodophors have shown effective improvement ^[17].

Prevalence

Despite its emergency more than 50 years ago, the IBDV continues to pose great challenges to the poultry industry worldwide and ranks among the top five disease in poultry industries ^[42]. The World Organization for Animal Health (OIE) listed IBD as notifiable disease ^[19]. There is a major difference in the distribution of vvIBDV strains ^[18]. The disease is highly contagious to growing chickens and causes high mortality and morbidity ^[20]. Globally, IBDV genotype that has been causing a disease is categorized as

classic, variant, very virulent IBDV (vvIBDV), antigenic variants, and reassortant strains. Ongoing mutation, recombination, and genome segment reassortment drive antigenic drift and shifts that undermine the vaccine protection ^[21]. The terms 'variant', 'classical' and 'very virulent' have been used to describe IBDV strains that exhibit differences in pathogenicity ^[19]. The prevalence of IBD was greater in exotic breeds than in local chickens in Ethiopia ^[8]. The variation among susceptibility to IBD results from their faster growth rates and increased productivity in exotic breeds which may lead to compromise their immune responses and increase their vulnerability ^[22].

To improve prophylactic measures, the understanding of the immunosuppressive mechanisms of the virus and possible host associated factors influencing the outcome of infectious IBD is an important requirement ^[43]. Overcrowding of chickens, irregular cleaning, poor ventilation systems, and poor litter conditions are the main risk factors for the cause and rapid spread of the disease in poultry farms ^[5, 23]. Amino acid mutation located in the hyper variable region of VP2 have crucial impact on the responsiveness of the neutralizing antibodies and lead to infection in chickens by mutant strain ^[19]. Very virulent strain typically causes high morbidity and mortality rates in young chickens ^[20]. The variability of infectious bursal virus may affect its infectivity and virulence for host cells, as well as ability for immune escape. High mortality of susceptible chickens in summer season is expected due to high temperature stress and immediately after rains; there is high humidity in the environment which may also substantially increase mortality ^[24]. Being resistant to most of the disinfectants and environmental factors, the poultry house remains contaminated with IBDV that persists on the premises and tends to reappear in subsequent flocks ^[18]. The presence of the disease in many parts of the country and is despite the fact that IBD incidences are increasing at an alarming rate all over the country where commercial poultry production is intensified and even in the backyard chickens, and also a serious problem for the poultry industry of Ethiopia ^[4]. Poor vaccination practices, non-maintenance of cold chains during transport and at farm, use of chlorinated water for vaccine, exposing vaccine virus to outside environment for a longer duration, improper handling of vaccine, health status of flock, concurrent disease and low maternal antibody are risk factors for the occurrence of IBD even in vaccinated chickens.

Transmission

The virus primarily transmitted via feces, air and contaminated equipments constitutes the natural means by which IBDV infection occurs in chickens ^[14, 20, 25]. Rodents like mice and darkling beetles can carry the organism for a very long time and might transport the virus and act as mechanical vectors ^[28]. In an infected chicken IBDV is excreted in the faeces and then contaminates water, feed and litter, where it persists and from where it commonly spreads ^[4]. Virus excretion can begin as early as 24 hours after infection ^[25]. In intensive farming systems, the chicks were fed on commercially purchased feed and trucks transporting feed to the farm could be a source of virus introduction if adequate biosecurity measures were not in place ^[26]. Houses from which infected birds were removed can be infective for other birds at 54 and 122 days later and also water, feed, and

droppings taken from infected pens were infectious after 52 days [27]. The amount of virus posing a challenge to the poultry is indicated by the virus pressure, also known as challenge pressure. The management system used at the farm (all-in, all-out, accumulated litter, multiage and cages) the standard of cleanliness and disinfection, and the farm's location in relation to other nearby farms are all related to virus pressure [3].

Host range

Clinical disease occurs solely in chickens but turkeys, ducks, and ostriches can be naturally and experimentally infected with IBDV serotypes I and II as evidenced by serological response and isolation but no clinical sign [23]. Only chickens younger than 10 weeks are usually clinically affected [15]. Older chickens usually show no clinical signs [19]. Layer chickens more susceptible to vvIBDV than broiler chickens and higher mortality are recorded in light than heavy breeds [3, 20]. Local breeds are less susceptible than exotic chickens due to the innate resistance of the indigenous breeds resulting from long-term exposure and co-evolution with the virus as there are no biosecurity measures under backyard production systems [6, 29].

Lack of knowledge about the epidemiology of the IBD disease by the farmers, which ultimately results in the continual transmission of the virus [6]. Maintaining large herds and overcrowding in intensive production systems contribute to disease spread due to the close contact between infected and uninfected animals. In contrast, chickens in a backyard system roam freely and forage for feed, which can also increase their susceptibility to disease [22].

Clinical Findings

The high pathogenicity and fatality of vvIBD have made it the major threat to the healthy development of the poultry industry [44]. The clinical course of IBD is determined by the pathogenicity of IBDV and the age, breed, and immune status of chickens [30]. The incubation period is very short 2-3 days. Virus excretion can begin as early as 24 hours after infection. After an incubation period of 2-3 days, young chickens show symptoms of ruffled feathers, watery diarrhea, trembling, severe prostration, severe depression, vent picking, presence of urate stains on the vent, dehydration, loss of appetite and elevated water consumption, and also death may follow 1-3 days later [4]. Bursa of Fabricius is the main organ affected by the virus and causes lymphoid depletion of this organ [19]. On acute phase of the disease, clinical signs and death may result from the (7-10 days) and death is due to the necrotizing effect of these viruses on the host tissues [31]. The disease when not fatal leads to immunosuppression with reduced antibody response. Finally, the chickens fail to produce antibodies against other viral and bacterial infections [18].

Morbidity and Mortality rate

The mortality rate is fluctuating broadly with virulence strains and types of breeds that range from 30% to 60% in chickens infected with classical strains. The fatality rates of vvIBDV strains range from 70% to 100% [20]. Classical strains of virus can cause 10-50% mortality rates in infected flocks, whereas vvIBDV strains can cause 50-100% mortality [11]. Classical strains of virus can cause 10-50% mortality rates in infected flocks, whereas vvIBDV strains can cause 50-100% mortality [18]. Recovery occurs in less

than 1 week, and broiler weight gain is delayed by 3-5 days. High morbidity and mortality of chickens have caused production losses, discouraging poultry farming investment [22]. Flock morbidity is typically 100%, and mortality can range from 5% to greater than 60% depending on the strain of virus and breed of chicken [28].

Economic impact

Due to high resistance to most disinfectants and environmental factors, IBDV continues to present in poultry houses and tends to reappear in subsequent chicken flocks. Consequently, acute or chronic IBD in the flock reduces the efficiency of broiler production and net profitability [40]. Immunosuppression caused by infectious bursal disease virus has a significant economic impact due to the widespread nature of the disease in commercial chickens [3, 14, 18]. The disease causes either direct or indirect economical loss to the poultry sector [32]. The direct losses are associated with death of young chickens and the reduction of egg production in pullets. The indirect economical loss of the disease is resulting from the potential interaction of IBDV with other viruses, bacteria, and parasites since it causes virus-induced immunosuppression [20, 23].

The widespread impact of IBD on the health and productivity of chickens, both globally and in specific regions, such as Ethiopia, underscores the significant economic importance of this disease [22]. The presence of disease may also limit opportunities in the market place, either locally or internationally [4]. The acute or chronic IBD in the flock reduces the efficiency of production and net profitability in terms of feed conversion ratio [18].

Control and Prevention Measure

Decontamination of housing will not ensure that flock will be free of IBD, removal of litter and disinfection of equipments and concrete are recommended [25]. Integrated strategies, enhanced molecular surveillance, vaccine matching and proper vaccination practices, improved biosecurity, and monitoring for immunosuppression are needed to reduce the threat to poultry production [21]. Passive antibodies have a half-life of 3-5 days, usually depending on breeds, for broiler chicks three days, and for laying hens five days [35]. IBDV is resistant to different environmental conditions and capable of surviving in the environment for long period of time [9].

The nature of IBDV complicates control efforts due to its bi-segmented dsRNA genome, which undergoes frequent genetic mutations and reassortment of genome segments [41]. By closely studying the evolution of IBDV, it is possible to find the cause of these outbreaks [18]. Following an infectious bursal disease outbreak, the farm should be depopulated and completely cleaned and disinfected. Effective disinfectants against IBDV are oxidizing agents, alkalis and aldehydes which includes sodium hypochlorite, sodium hydroxide, glutaraldehyde and formalin [28]. It is expensive to control IBDV in infected chickens and prevent the spread of the disease to other flocks. As a result, vaccination is still the preferred strategy for controlling IBD [36]. Vaccination with a booster dose would provide better protection than a single dose [37].

Current Status of IBD in Ethiopia

In Ethiopia, IBDV was spread to almost all the regions and agro-ecological zones [8]. Regional-level IBD prevalence

was highest in Addis Ababa and Amhara and lowest in Oromia where these regions hold the largest share of the country's chicken population ^[22]. The fatality rate of IBD in different poultry farming systems ranges 45 to 50% ^[20]. IBD became endemic in backyard chicken in many parts of Ethiopia warranting the need for attention by the veterinary and livestock authorities ^[6]. Small and large scale chicken farms were rapidly growing in Ethiopia. The chicken species imported were temperate breeds that are less adapted to the heat stress and disease challenges in the country and this exacerbate susceptibility in exotic than local chickens. Accompanying intensification of poultry farming, there is occurrence of epidemics of infectious bursal disease. Infectious bursal disease causes the major restraint to productivity and profitability in poultry industries of Ethiopia.

There is minimal variation in the prevalence of IBD between production systems, with a slight increase observed in intensive farming compared to backyard farming. Chickens in intensive and semi-intensive systems, confined in cages and pens, experience higher stress and vulnerability compared to those in backyard production systems. Encouragingly, the overall prevalence has shown a downward trend over the past 24 years. This decline may be linked to the recent expansion of poultry production in urban and peri-urban areas, where improved management and biosecurity practices are more common ^[22]. IBD can easily spread and persist in indigenous chickens since it is easy for hens from different places to come into contact with one another at open-air markets before being returned to their own localities ^[38].

Conclusion

Infectious bursal disease is highly contagious viral disease affecting chicken in between 3-6 weeks of age. In Ethiopia, IBD prevalence was highest in Addis Ababa and Amhara and lowest in Oromia. It has been a great challenge to the poultry industry world-wide for a long time and has a major setback to productivity and profitability in the poultry industries. IBD is widely distributed in almost all parts of Ethiopia. The most significant risk factors for the distribution and occurrence are overcrowding of chickens, irregular cleaning, poor ventilation systems, and poor litter conditions. (IBDV) is potent immunosuppressive pathogens. Chickens in intensive and semi-intensive systems, confined in cages and pens, experience higher stress and vulnerability compared to those in backyard production systems. The disease pose significant economic loss directly or indirectly.

Competing Interest

The author declared not any competing of interests

Funding

This research received no external funding

Authors Contributions

1. Addisu Bedashu Ararso: Conceptualization and writing
2. Yujie Ma: Writing, supervision, review and editing

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