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Review article

The Epidemiological Nexus: Age, Geography, and Infectious Disease in Egyptian Cattle

Age and Geography of Cattle Diseases in Egypt

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Abstract

Infectious diseases impose a severe constraint on cattle productivity, food security, and the national economy in Egypt. The susceptibility to, and manifestation of, these diseases are profoundly influenced by the age of the host animal, a factor often overlooked in broad control strategies. This review systematically synthesizes the scientific literature on Egypt's major bovine infectious diseases to elucidate the critical correlation between host age and disease epidemiology and to map the associated geographical distribution patterns. Our analysis reveals distinct age-specific syndromes: neonates (0-1 month) are dominated by enteric pathogens like *E. coli* and *Cryptosporidium*; growing calves (1-12 months) are most susceptible to severe outcomes from foot-and-mouth disease (FMD) and bovine viral diarrhea virus (BVDV) persistence; while adult cattle are most impacted by production diseases such as brucellosis, mastitis, and chronic fascioliasis. Geographically, the Nile Delta is identified as a multifactorial hotspot due to high animal density, intensive farming, and irrigation networks, whereas Upper Egypt and newly reclaimed areas exhibit distinct outbreak dynamics. The movement of specific age cohorts, such as pregnant heifers and weaned calves, is a key driver of disease spread. This synthesis underscores the imperative for a dual-targeting control strategy: implementing age-specific interventions within defined geographical risk zones. We conclude with evidence-based recommendations for age-stratified surveillance, vaccination, and management practices tailored to Egypt's diverse farming systems to enhance disease control and livestock productivity.

Keywords: Cattle diseases, Egypt, age susceptibility, geographical distribution, epidemiology, FMD, brucellosis, BVD.

Introduction

Cattle are a cornerstone of Egypt's agricultural economy, vital for dairy, meat, and draft power. However, the livestock sector faces persistent challenges from a range of infectious diseases that cause significant morbidity, mortality, and economic loss (Gamil et al., 2024). The epidemiological landscape of these diseases is complex, shaped by factors such as climate, husbandry practices, animal movement, and host immunity. Among these, the age of the host animal is a fundamental but often underutilized determinant of disease outcome.

Age influences disease susceptibility through immunological maturity, management-related exposure risks (e.g., colostrum intake, housing), and physiological status. A calf, a growing heifer, and a lactating cow represent vastly different epidemiological units within a herd. In Egypt, where farming systems range from traditional smallholder holdings to intensive commercial dairy operations, understanding the interaction between age, disease, and geography is critical for effective control.

This review aims to systematically compile and analyze the available scientific evidence on major infectious diseases of cattle in Egypt. Its specific objectives are to: 1) Establish clear correlations between host age and the occurrence, clinical presentation, and outcome of key diseases; 2) Map the geographical distribution of these diseases and identify high-risk zones; and 3) Synthesize this information to provide actionable, age- and geography-targeted recommendations for policymakers, veterinarians, and farmers.

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Methodology

A systematic approach was employed to identify, select, and analyze relevant literature. Electronic databases searched included PubMed, Scopus, Google Scholar, and the Egyptian Knowledge Bank (EKB). The search strategy combined keywords related to cattle ("bovine," "cattle," "Egypt"), specific diseases ("foot-and-mouth disease," "brucellosis," "mastitis," etc.), and epidemiological factors ("age," "susceptibility," "prevalence," "geographical distribution," "Egyptian governorate"). The search was limited to articles published between 2000 and 2024, with a focus on more recent studies where available. Inclusion criteria encompassed original research articles, surveillance reports, and reviews providing data on disease occurrence, age distribution, or geographical location within Egypt. Articles lacking specific age-related data or clear geographical referencing within Egypt were excluded. Data extracted from each study included: disease/pathogen, study location (governorate), sample characteristics (size, age groups), key findings on age association, and reported prevalence.

Selected Major Infectious Diseases

1. Viral Diseases

1.1. Foot-and-Mouth Disease (FMD)

• **Age Correlation:** The clinical and pathological impact of FMD is highly age-dependent. Neonatal and suckling calves (0-3 months) are particularly vulnerable, often suffering high mortality rates (exceeding 70% in outbreaks) due to viral myocarditis, which can occur without the classic signs of vesicular lesions (Soliman et al., 2022). Weaned calves and juveniles (3-12 months) exhibit high morbidity with severe oral and foot lesions, while adult cattle typically show the characteristic vesicles, with economic impact stemming primarily from milk drop and loss of condition.

• **Geographical Distribution & Interface:** FMD is endemic in Egypt with continuous circulation, particularly in the high-density livestock areas of the **Nile Delta** (e.g., Beheira, Gharbia, Dakahlia) (Abdelhakim et al., 2023). Here, the constant exposure pressure means calves are infected at a very young age, leading to endemic neonatal mortality. In contrast, in Upper Egypt governorates (e.g., Minya, Sohag) and newly reclaimed lands (e.g., New Valley, Toshka), outbreaks are often episodic. When the virus enters these areas with more naive populations, explosive outbreaks occur, affecting all age groups severely (Abdelhakim et al., 2023). Serotypes O (EA-3 topotype), A (African topotype), and SAT2 have been concurrently circulating, complicating control (Gamil et al., 2024; El-Nahas et al., 2025).

1.2. Bovine Viral Diarrhea Virus (BVDV)

• **Age Correlation:** BVDV epidemiology is intrinsically linked to age via the mechanism of persistent infection (PI). If a pregnant cow is infected between approximately 45-125 days of gestation, the virus can be transmitted to the fetus, resulting in the birth of a PI calf that sheds large amounts of virus for life (Dubovi, 2013). These PI animals are the main reservoir and often succumb to fatal mucosal disease between 6-24 months of age. Acute infection in immunocompetent animals of any age can cause mild enteric or respiratory signs and transient immunosuppression.

• **Geographical Distribution & Interface:** PI animals are disproportionately found in large, intensive dairy herds in the Nile Delta (e.g., Menofia, Qalyubia) due to frequent animal introductions and high population density (Mahmoud et al., 2020). A recent study identified a PI prevalence of 2.5%, with all detected animals being young calves aged 1-6 months, highlighting the age-specific risk window (Ibrahim et al., 2022). The emergence of the HoBi-like pestivirus (BVDV-3) in Egypt further underscores the risk posed by international and regional livestock trade (Ibrahim et al., 2022; El-Damaty et al., 2018).

1.3. Infectious Bovine Rhinotracheitis (IBR) and Lumpy Skin Disease (LSD)

• **IBR** causes severe respiratory disease in weaned calves and feedlot cattle, while in adults it is associated with reproductive failure (abortion, infertility). It is endemic nationwide, with higher seroprevalence in intensive Delta farms.

• **LSD**, which became epidemic in Egypt in 2020, affects all ages. However, high-yielding dairy cows and young calves may experience more severe generalized lesions. Its spread has been nationwide, with cases

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reported from Alexandria to Aswan, demonstrating rapid geographical dissemination.

2. Bacterial Diseases

2.1. Brucellosis (*Brucella abortus* & *B. melitensis*)

• **Age Correlation:** Clinical disease is tightly coupled to reproductive maturity. The hallmark sign—late-term abortion—is most common in primiparous heifers and adult cows during their first infected pregnancy (Godfroid et al., 2011). Young calves can be infected and may harbor the bacteria for extended periods without showing clinical signs, acting as asymptomatic carriers that disseminate the disease upon reaching breeding age (El-Diasty et al., 2025).

• **Geographical Distribution & Interface:** Brucellosis is endemic, with high seroprevalence reported in both the Nile Delta (Kafr El-Sheikh, Dakahlia) and several Upper Egypt governorates (Assiut, El-Minya) (Khalifa et al., 2018). The risk is amplified in traditional mixed farming systems where cattle, buffalo, and small ruminants share space, facilitating cross-species transmission primarily of *B. melitensis* (El-Diasty et al., 2025). The movement of untested, sub-adult replacement animals from these endemic zones is a primary route of geographic spread to lower-prevalence areas.

2.2. Mastitis and Calf Diarrhea Complex

• **Mastitis:** Primarily a disease of the lactating adult dairy cow, with the peri-parturient period being highest risk. Environmental pathogens (e.g., *E. coli*, *Streptococcus uberis*) can affect all lactating animals, while contagious pathogens like *Staphylococcus aureus* spread within milking herds. It is ubiquitous, with higher prevalence and pathogen diversity in intensive dairy farms of Lower Egypt.

• **Calf Diarrhea:** A neonatal syndrome (0-3 weeks) where age dictates the likely pathogen: enterotoxigenic *E. coli* (K99) in the first week, *Rotavirus*, *Cryptosporidium parvum*, and *Coronavirus* in weeks 1-3, and *Salmonella* spp. potentially later. It is a major cause of pre-weaning mortality across all farming systems, with incidence often linked to failures in colostrum management and hygiene in calf pens.

2.3. Tuberculosis (*Mycobacterium bovis*)

• **Age Correlation:** A chronic, slowly progressive disease. Detection rates are typically higher in older, culled dairy cows due to longer exposure time and the disease's insidious nature. Younger animals may be infected but less frequently show advanced, detectable lesions.

• **Geographical Distribution:** Reported in scattered foci, including Delta governorates (Menofia) and Upper Egypt (Sohag), often linked to intensive farming or areas with historical prevalence. Its zoonotic nature makes it a significant public health concern at the human-animal interface.

3. Parasitic Diseases

3.1. Fascioliasis (*Fasciola gigantica* & *F. hepatica*)

• **Age Correlation:** Infection shows a clear age-prevalence gradient due to cumulative exposure. A 2025 study in the New Valley found prevalence was lowest in animals <1 year old (12.7%) and highest in those >3 years old (30.4%) (Khedr et al., 2025). Young cattle (6-18 months) experiencing first major exposures often develop the most severe chronic, debilitating disease (weight loss, anemia, "bottle jaw").

• **Geographical Distribution & Interface:** The disease is hyperendemic in regions supporting the aquatic snail intermediate host. This includes the canal networks of the Nile Delta and the oasis systems of the New Valley and Fayoum (El-Shahawy & Metwally, 2018; Khedr et al., 2025). The high prevalence in cattle in these areas constitutes a significant zoonotic reservoir for human infection.

3.2. Theileriosis (*Theileria annulata*)

• Affects all ages, but exotic breeds and young calves are most susceptible to severe disease. It is endemic in areas where the *Hyalomma* tick vector is established, primarily the Nile Delta and the New Valley Oases.

4. Synthesis: The Interplay of Age, Geography, and Management

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Age-Susceptibility Landscape in Egypt:

• **The Neonatal Challenge Belt:** Ubiquitous, driven by enteric pathogens. Mortality is highest in smallholder systems with limited veterinary care.

• **The Growing Stock Risk Zone:** Geographically defined by FMD-endemic areas (Delta) and *Fasciola*-endemic wetlands (Delta, Fayoum, Oases). Economic loss from stunted growth and mortality in this age group is substantial.

• **The Adult Production Loss Zone:** Dominated by mastitis in high-yielding Delta dairy belts and reproductive/chronic diseases (brucellosis, tuberculosis) in older cattle nationwide.

A critical synthesizing factor is animal movement patterns (Fasanmi et al., 2021). The trade of weaned calves spreads BVDV and respiratory pathogens; the movement of pregnant heifers spreads brucellosis; and the importation of livestock introduces new strains of FMDV and BVDV. These movements directly link geographical disease hotspots with susceptible age cohorts in previously lower-risk areas.

Furthermore, farm management systems mediate the age-geography interaction (El Nahas & Hassanain, 2021). Intensive Delta dairies face high mastitis and BVDV challenges in adults and neonates, respectively. Traditional Upper Egyptian systems face higher risks from brucellosis and FMD outbreaks due to different husbandry and trade practices.

Conclusions and Strategic Recommendations

This review demonstrates that a cattle's age is a primary determinant of infectious disease risk in Egypt, and that this risk is spatially heterogeneous. Effective control requires moving beyond blanket strategies to precision interventions.

A. For Policy and National Programs:

1.**Implement Age-Stratified Surveillance:** Disease reporting systems should mandate recording of the age group affected (neonate, juvenile, adult). This data should be integrated into a geospatial platform to visualize and track age-specific disease hotspots in real-time.

2.**Enforce Age- and Risk-Based Movement Controls:** The highest-risk movements (e.g., pregnant heifers, calves from PI-positive herds) should require the most stringent testing and certification. Develop a "test-and-move" protocol based on age and destination risk.

3.**Refine Vaccine Campaigns:** For FMD in endemic Delta regions, prioritize strategies that ensure high maternal immunity to protect neonates (e.g., strategic vaccination of pregnant cows). For brucellosis, continue and strengthen the vaccination of female calves (RB51) before breeding age.

B. For Veterinary Practitioners and Farmers:

1.**Adopt Life-Stage Biosecurity:**

- **Neonatal Unit:** Ensure colostrum intake within 2 hours, use hygienic, separate calving pens, and implement targeted prophylaxis for calf diarrhea.
- **Weaner/Grower Unit:** In *Fasciola*-endemic areas, delay first grazing on wet pastures or use strategic pre-grazing anthelmintics. Avoid mixing age groups to reduce respiratory disease spread.
- **Adult/Lactating Unit:** Focus on mastitis control programs (milking hygiene, dry cow therapy) and regular reproductive health screening.

2.**Implement Targeted "Test-and-Cull":** In BVDV-endemic dairy herds (especially in the Delta), screen all young stock (6-12 months) for PI status and cull positive animals. Screen all breeding-age females for brucellosis before introduction to a clean herd.

C. For Research Priorities:

1.Conduct longitudinal cohort studies in contrasting agro-ecological zones (e.g., Delta village vs. New

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Valley settlement) to quantify precise age-incidence rates for key diseases.

2.Use phylogeographic studies combined with animal movement data to trace how different age cohorts contribute to the spread of pathogens like FMDV and *Brucella*.

3.Economically model the cost-benefit of age-targeted interventions (e.g., selective anthelmintic treatment for young heifers vs. whole-herd treatment) in different geographical settings to guide resource allocation.

Conclusion

The sustainable improvement of cattle health and productivity in Egypt depends on recognizing and acting upon the intricate link between an animal's age and its geographical context. By integrating age and spatial epidemiology into control programs, stakeholders can build more resilient, productive, and profitable livestock systems.

Conflicts of Interest

The authors declare no conflicts of interest.

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