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UDC 619 **Review article**

A comprehensive review of lameness in broilers: infectious and non-infectious factors in the context of Kazakhstan's poultry industry

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Abstract

In recent years, Kazakhstan has experienced steady growth in poultry production and increased poultry meat production, but the prevalence of lameness in broilers remains high. Lameness in broilers is one of the most urgent problems in the modern poultry industry, having a significant impact on the health and welfare of birds, as well as on the economic performance of production. The aim of this review article is to systematize data on causes, diagnosis, prevention and strategies to reduce lameness in broilers. Special attention is given to bacterial chondronecrosis with osteomyelitis (BCO), one of the major infectious causes of lameness caused by pathogens such as *Staphylococcus aureus* and *Escherichia coli*. Both infectious and non-infectious factors are discussed: genetic predisposition, rapid growth, vitamin and mineral deficiencies, poor housing conditions, poor litter quality and high planting density. Modern diagnostic techniques, including bacteriological tests, histology, polymerase chain reaction (PCR), and imaging technologies such as infrared thermography and computer vision are covered. Preventive measures including probiotics, vitamin and mineral supplements, vaccinations, genetic selection, and improved housing and biosecurity have also been analyzed. The prospect for future research aimed at the use of digital technologies, genomic analysis of pathogens and the development of disease-resistant broiler lines are considered. The review provides an up-to-date scientific and practical basis for specialists working in the field of veterinary medicine, zootechnics and industrial poultry production.

Keywords: bacterial chondronecrosis; diagnosis; genetics; lameness broilers; osteomyelitis; prevention.

Introduction

Poultry farming in Kazakhstan in recent years demonstrates stable growth, which is accompanied by an increase in the number of poultry and poultry meat production. Compared to last year (2024), the number of birds as of February 1 (2025) increased by 1.8% and amounted to 45.990.901 heads. Broiler production plays a key role in ensuring food security of Kazakhstan, for this purpose it is necessary to provide the population with quality products. The increase in domestic production of poultry meat, helps to reduce dependence on imports, as well as the creation of new jobs and the development of agriculture. Over the past year, the output of meat in the country shows positive dynamics. Thus, poultry meat production in 2024 amounted to 445.4 thousand tons, which is 7.7% higher than in 2023 (413.6 thousand tons) [1]. In 2023, Kazakhstan imported 118 thousand tons of poultry meat, which is a significant part of the country's total meat imports. However, in the first 11 months of 2024, the volume of poultry meat imports decreased by 10.7% year-on-year to 121 thousand tons. Thus, despite the significant volume of poultry meat imports at present, Kazakhstan is taking active measures to increase its own production in order to achieve food independence in this sector.

Based on observations by *Dr. Adnan Alrubaye* from the University of Arkansas (USA) during visits to broiler farms in Kazakhstan, lameness has been identified as a significant contributor to economic losses in broiler production [2]. Lameness in broiler chickens is a serious problem causing significant economic losses and deterioration of animal welfare. Lameness in broiler chickens has a serious impact on welfare, meat quality, production, food safety and economic losses [3]. Lameness in broilers results in reduced weight gain, increased feed costs, increased culling and additional veterinary costs, causing significant financial losses to producers [4]. Lameness causes significant economic losses in the poultry industry due to decreased meat quality and increased treatment and prevention costs [5]. Foot disease in birds has a negative impact on both their welfare and productivity. Poultry farms should strive to improve housing conditions, optimize diets and regularly monitor poultry health to minimize the risk of lameness. Ultimately, taking care of broiler health not only promotes broiler welfare, but also provides a higher economic return for poultry farms.

The aim of this review article is to conduct a multifactorial analysis of the causes of lameness in broilers, taking into account genetic, infectious, feed and management factors, which will allow the development of effective measures for prevention and improvement of poultry productivity. Bacterial chondronecrosis with osteomyelitis (BCO) is a major cause of lameness, causing significant welfare and health problems in birds. Bacterial pathogens such as Escherichia coli and Staphylococcus aureus can play a significant role in the development of lameness in broilers. These bacteria are easily transmitted from one bird to another, which can make transmission control difficult [3, 6]. The main causes of lameness in broilers include both bacterial infections and a mismatch between muscle growth and skeletal development. The rapid rate of weight gain places excessive mechanical stress on immature bone and cartilage, resulting in the formation of osteochondral fissures, which are then colonized by bacteria, causing abscesses and necrosis. Bacterial chondronecrosis with osteomyelitis is also associated with immunodeficiency caused by stress or inflammation, which allows bacteria to enter the bloodstream and colonize bone growth zones [3, 7]. The next major factor contributing to a significantly increased risk of lameness is housing conditions, such as floor type (wire or litter). Wire floors can create instability and physiological stress in birds. Poor ventilation, litter quality and boarding density affect the incidence of lameness, as poor housing conditions can contribute to deteriorating feet and other skin conditions associated with lameness [8].

Prevention of lameness in broilers, is an important objective to improve animal welfare and economic efficiency in poultry production. Various strategies are used to reduce the incidence of lameness, which include the use of probiotics and vitamins in the diet as well as the use of antibiotics. This promotes bone health and reduces the risk of lameness in broilers [5, 7]. Lameness in broilers is and remains a multifactorial problem associated with bacterial, genetic and environmental factors Management of these factors, including improved housing conditions and the use of various supplements, can significantly reduce the incidence of lameness and improve the overall health of the birds as well as the economic viability of production. Research highlights the importance of early detection and management of this problem through genomic analysis, experimental lameness models and behavioral monitoring.

In the study of lameness in broilers we analyzed scientific publications in peer-reviewed foreign and domestic journals, data from the Bureau of National Statistics of the Republic of Kazakhstan, studies considering infectious and non-infectious causes of pathology, as well as the works of leading researchers in the field of veterinary medicine and poultry farming. Special attention is paid to bacterial chondronecrosis with osteomyelitis (BCHO), works devoted to the influence of housing conditions, feeding, genetics on the development of lameness. Modern diagnostic methods, including histologic, microbiologic, and molecular analysis, are studied.

1. Etiology and classification of lameness in broiler chickens

1.2 Infectious and non-infectious causes

Lameness in broiler chickens is a serious problem in the poultry industry that affects the welfare of the birds and economic performance. Studies show that lameness in broilers can be caused by infectious factors such as bacterial chondronecrosis with osteomyelitis, and non-infectious factors such as genetic parameters and housing and nutritional conditions of birds [9]. As described by *B. Kierończyk* lameness of birds can arise from both infectious factors and non-infectious factors that affect broiler leg health.

Infectious factors play a significant role in the development of lameness in broilers [7]. The main bone and joint infection leading to lameness is bacterial chondronecrosis with osteomyelitis, which is caused by various pathogenic bacteria (Table 1).

Table 1 – Bacterial, viral and fungal pathogens associated with lameness in broilers

Pathogen	Disease / Condition	Clinical manifestations	Diagnostic methods	Sources
Staphylococcus aureus	Infectious arthritis	Swollen joints, lameness, pain.	Bacterial culture, PCR	*Anthney* et al, 2024; *Assumpcao* et al, 2024; *Wideman*, 2016; *Alrubaye* et al, 2015; *Alrubaye* et al, 2020; *Choppa & Kim*, 2023.
Escherichia coli	Colibacillosis	Systemic infection, joint involvement.	Bacterial culture, serology	*Ekesi* et al, 2021; *McNamee & Smyth*, 2000;
Enterococcus spp.	Infectious tendovaginitis	Joint swelling, limited mobility.	PCR, histology	*Do* et al, 2024.
Reovirus	Viral arthritis	Joint deformities, inflammation of tendons	Serology, PCR	*Kierończyk* et al, 2017

The most important pathogens causing BCHO are *Staphylococcus spp.* and *Escherichia coli*, penetrating through the bloodstream, cause necrosis and inflammation leading to bone lesions especially femur and tarsal [3, 10]. In addition to *Staphylococcus spp*. and *Escherichia coli*, other types of pathogenic bacteria are often isolated as well as those associated with bone and joint disease leading to lameness in broiler chickens. Studies indicate that BHO can be caused by different strains of bacteria, making it difficult to diagnose, treat and prevent the disease [11]. Research by *R. Wideman* indicates that BCD is the primary infectious cause of lameness in broilers, often resulting from bacterial infections such as *Staphylococcus aureus* and *Escherichia coli*, these bacteria can spread hematogenously, leading to bone lesions. The pathogenesis of BCO begins with microfractures in the rapidly growing bones due to mechanical overload, which create a favorable microenvironment for bacterial colonization. Once pathogens such as *Staphylococcus aureus* or *Escherichia coli* enter the bloodstream – either through damaged mucosa or skin – they localize in these weakened areas. There, they trigger an inflammatory response, osteolysis, and necrosis. The virulence factors of these bacteria, including adhesins and toxins, exacerbate bone degradation and impair the host's immune response [6, 10, 14]. This complex pathophysiological mechanism makes both diagnosis and prevention challenging.

Non-infectious factors are also an acute problem in the development of lameness in broilers (Table 2).

Table 2 – Risk factors for lameness in broiler chickens

Factor Category	Specific reason	Effect on lameness	Sources
Genetics	Rapid growth	Skeletal deformities, bone fragility	*Wideman*, 2016; *Guo* et al., 2019.
Management	High planting density	Increased stress, trauma to the extremities	*Gocsik* et al., 2017; *Granquist* et al., 2019.
Nutrition	Calcium and phosphorus deficiency	Rakhitis, bone weakness	*Waldenstedt*, 2006; *Alharbi et al*., 2025.
Mechanical factor	Poor quality of bedding	Dermatitis of the paw pads, infections	*De Jong* et al., 2014; *Kierończyk* et al., 2017; *Alrubaye* et al., 2020.

Rapid growth and increased body weight in modern broilers place mechanical stress on immature bones, which can lead to microfractures and lameness [7, 9]. Genetic predisposition also plays a role in the development of BHO. Nutrient deficiencies, especially calcium and phosphorus in the diet, affect bone development and increase the risk of developing lameness. Proper nutrition is critical to keeping birds' feet healthy [9]. Likewise, poor housing conditions, including litter quality and ventilation, can exacerbate skeletal diseases leading to lameness [3, 12]. Non-communicable factors also have their own specific mechanisms of action. Calcium and phosphorus deficiency in the diet disrupts bone mineralization, leading to osteopenia and deformities. Vitamin D3 deficiency reduces calcium absorption and disrupts bone remodeling, making them more brittle. Environmental stresses, such as high planting density and wet litter, cause chronic stress and immunosuppression, which indirectly increases susceptibility to infections. In addition, wet bedding contributes to the appearance of dermatitis and skin damage, through which bacteria can enter the bloodstream [9, 12, 21]. To reduce these risks, management strategies that include improving housing and nutritional conditions are recommended.

Lameness in broilers is a complex problem caused by many factors. Infectious and non-infectious factors play a key role in the development of lameness in broilers. A comprehensive approach to the treatment of lameness, including measures to improve housing and nutritional conditions, can reduce the risk of disease prevalence and economic losses.

1.2 Main types of limb pathologies in broilers

Limb abnormalities in broilers represent a major problem in the poultry industry, affecting the health and welfare of the birds as well as the economic performance of production. They can be related to genetic factors, rapid growth, nutrition and housing conditions.

The main types of limb pathology in broilers include tibial dyschondroplasia (TD), femoral head necrosis (FHN) and valgus-varus deformity (VVD). Dyschondroplasia of the tibia is characterized by abnormal cartilage growth and is common in fast growing broiler breeds. Necrosis of the femoral head This condition is associated with destruction of bone tissue in the femoral head region and often results in lameness. Valgus-varus deformity is a condition in which the limbs are deviated inward or outward, resulting in impaired gait and reduced growth [13].

Bacterial chondrosclerosis with osteomyelitis (BCO) is one of the leading causes of lameness and health problems in modern broilers. The disease results from bacterial bone infections, which leads to bone destruction and is one of the leading causes of lameness [14]. Lameness results in limited mobility and reduced activity of the birds, leading to poor quality of life. It is manifested by an increase in the time spent lying down and a decrease in the time birds spend walking. This condition is also associated with the pain and discomfort that lameness causes, which impairs the overall well-being of the birds [15]. Lameness leads to difficulty in accessing food and water, which can cause dehydration and death. It is also associated with increased culling of birds for slaughter due to pathological changes in carcasses [3]. Lameness causes significant economic losses in the poultry industry due to decreased meat quality and increased treatment and prevention costs [5]. Limb pathologies in broilers include a variety of conditions that have a significant impact on the health and welfare of the birds as well as the economic performance of production.

2 Pathogens causing lameness

Lameness of broiler chickens, is a serious health and welfare problem in the poultry industry, often associated with bacterial infections. Various bacterial species have been identified as causative agents, including known pathogens including *Staphylococcus aureus, Escherichia coli, Enterococcus spp.* The diversity of genome, virulence factors, and transmission routes of these pathogens is critical for the development of effective prevention and treatment strategies. *Staphylococcus spp., Enterococcus spp.* and *Escherichia coli* are the predominant bacterial pathogens isolated from lameness-affected broiler chickens [5].

Outbreaks of severe infectious diseases in birds caused by *Staphylococcus aureus* and *Escherichia coli* occur suddenly and cause serious health problems. These bacteria enter the body from the environment when the body's natural defenses are compromised, often through skin wounds or inflamed mucous membranes. In broilers with developing lameness, the bacteria enter the bloodstream through the skin, respiratory system, or gastrointestinal tract. The bacteria colonize the proximal growth zone of

the rapidly growing femoral and tibial bones, causing necrosis leading to lameness. *S. aureus* shows that the genome continues to evolve, while *E. coli* shows high genomic diversity, indicating frequent host changes and adaptation to different environments [10].

Studies suggest that the use of probiotics such as *Enterococcus faecium* on young chickens helps reduce the incidence of lameness and mitigates the negative effects [16]. The results of this research are valuable to the poultry industry, demonstrating significant benefits in maintaining normal avian health, and help elucidate the effects of preventive probiotic administration on lameness in broilers.

Bone disorders in broiler chickens are caused not only by pathogenic bacteria but also by viruses. Reovirus infection in broiler chickens can impair nutrient absorption, resulting in osteoporosis, bone fragility, femoral head necrosis and tendovaginitis, especially when combined with enteritis and digestive tract lesions [9]. Also in infectious bursitis, pathologic lesions include pitting type hemorrhages in the leg muscles.

Mycotoxins such as deoxynivalenol (DON) and fumonisin (FUM) are secondary metabolites of microfungi that are commonly found in corn and soybean cake-based feeds. These toxins reduce intestinal barrier function and cause immunosuppressive effects that predispose broilers to bacterial chondronecrosis with osteomyelitis. Studies have shown that the presence of DON and FUM in feed increases the incidence of BCHO, especially when kept on wire floors [17]. However, multiple studies indicate the need for further research on these problems.

3 Risk factors for lameness

There are many factors in growing broiler chickens that influence the development and function of the bones and skeletal system. Rapid growth rates in broilers are associated with an increased risk of lameness due to genetic factors and orthopedic disorders. Studies show fast-growing broiler breeds have a higher risk of lameness compared to slow-growing breeds due to their higher body weight and lower activity [18]. Rapid growth puts mechanical stress on immature cartilage, leading to microfractures in bone and subsequent bacterial infection, osteochondrosis and bacterial chondronecrosis with osteomyelitis [7, 9]. Lameness is closely associated with impaired avian health and welfare, including dermatitis of the pads of the feet and burning of the hock joints, which indicate ulcerative and necrotic lesions of the limbs in broilers [12]. Foot problems in broilers result in significant losses. High growth rates in broilers due to genetics significantly increase the risk of lameness and orthopedic disorders. These problems require attention to improve bird welfare and production development.

Housing and management conditions also influence lameness in broilers and is a significant indicator of broiler welfare. The main risk factors include housing density, litter quality and ventilation. High planting density compromises litter and air quality, leading to increased moisture and ammonia, which contributes to dermatitis and lameness. It also limits ventilation, which exacerbates heat stress and worsens the overall condition of the birds [9, 19]. Poor litter quality, especially wet litter, promotes microbial activity, worsening housing conditions. Most of the problems result in leg diseases that lead to reduced ability to walk, causing gait changes [12, 20]. Improving these aspects can greatly reduce the risk of lameness and improve the overall welfare of the birds.

Another major risk factor for lameness is related to nutrition and mineral metabolism, which Another major risk factor for lameness is related to nutrition and mineral metabolism, which include deficiencies in calcium (Ca), phosphorus (P), vitamin D3, and a lack of essential amino acids. These elements play a key role in maintaining bone health and preventing diseases such as chondronecrosis with osteomyelitis. Vitamin D3 deficiency is also critical, as it is necessary for the proper absorption of calcium and phosphorus. Without adequate vitamin D3, even with calcium and phosphorus, bone problems can occur. Ca and P deficiency significantly impairs bone development in broilers, reducing bone mineral density and bone strength, which increases the risk of lameness [21]. The addition of 25-OH vitamin D3 to broiler diets showed a reduction in the incidence of lameness caused by bacterial chondronecrosis with osteomyelitis, emphasizing its preventive efficacy [22, 23]. The use of organic micronutrients such as Availa-ZMC has shown a 20-25% reduction in lameness by improving the integrity of the intestinal barrier and stimulating the immune response [24]. These micronutrients and vitamins are critical for bone health and must be balanced in the diet of birds. Non-essential amino acids also play an important role in overall health, although their direct link to lameness requires further study.

Factors such as injuries during transportation and handling of poultry can arise from a variety of conditions and procedures. The condition of broilers prior to loading and unloading, including their health and fitness, significantly affects the risk of injury and mortality during transportation. External conditions such as temperature and humidity play an important role, they can lead to hyperthermia, while cold and wet conditions can cause hypothermia, which increases the risk of injury. To reduce these risks it is necessary to improve transport conditions, including temperature and humidity control, and to optimize handling procedures, this will help to reduce injuries [9, 25].

Limping in broilers is a multifactorial problem related to genetics, housing conditions, nutrition and mechanical damage. Rapid growth rates and deficiencies in important micronutrients can lead to poor leg health, and high planting density and poor litter quality exacerbate the situation. To reduce the risk of lameness, it is necessary to improve management, optimize nutrition and minimize stressors.

4 Diagnosis of lameness

Diagnosis of lameness in broilers is an important task and includes clinical evaluation of the severity of the abnormality, laboratory tests (bacteriological analysis, PCR, histology) and imaging techniques such as X-rays and ultrasound to detect bone and joint damage. The main cause of lameness in broilers is bacterial chondronecrosis with osteomyelitis (BCO), which causes significant problems in poultry [7].

Clinical studies have shown that the severity of lameness in broilers can range from mild to severe. Characteristic signs include changes in gait, such as decreased speed, step frequency and stride length, as well as lateral body sway. Lameness is also often associated with other health problems such as race joint burns and foot pad dermatitis [7, 12].

Laboratory diagnostic methods, including bacteriologic analysis, often reveal the presence of bacteria, such as *Escherichia coli* and *Staphylococcus aureus*, in the affected tissues. Histologic studies help to identify morphologic changes such as necrosis and osteomyelitis. Genomic analysis of bacterial pathogens allows a better understanding of disease mechanisms and identification of pathogenic elements [6, 10].

Modern imaging techniques such as infrared thermography (IRT) are used to non-invasively assess leg surface temperature, which can help in detecting subclinical signs of BHO. Computer vision and automated activity monitoring systems can be used for early detection of lameness by analyzing changes in bird activity and gait [26, 27]. A comprehensive approach to diagnosing lameness in broilers that includes clinical observations, laboratory tests and advanced imaging techniques can contribute to the timely detection of lameness and improve the leg health of broiler chickens.

5 Strategies for prevention of lameness

There are several strategies for preventing leg health in birds to reduce the incidence of lameness in broilers. These measures include biosecurity and sanitary measures, genetic selection and growth management, sound nutrition and optimization of broiler housing conditions (Table 3).

Table 3 – Strategy for prevention of lameness in broilers

Strategy	Target problem	Realization	Expected results	Sources
Biosafety	Infectious diseases	Strict sanitary measures, control of pathogen introduction	Reducing the incidence of infections	*Assumpcao* et al., 2024; *Alrubaye* et al., 2020; *Ekesi* et al., 2021.
Power management	Mineral deficiency	Balancing the diet for Ca, P, vitamin D, etc.	Bone strengthening	*Waldensted*, 2006; *Alharbi* et al., 2025; *Wideman* et al., 2015.
Control of planting density	Overpopulation	Optimal space per bird	Stress and injury reduction	*Gocsik* et al., 2017; *De Jong* et al, 2014; *Granquist* et al., 2019.

Continuation of table 3

Genetic selection	Skeletal disorders	Breeding for strong bones, stunted growth.	Less lameness	*Wideman*, 2016; *Guo* et al., 2019; *Kierończyk* et al., 2017.
Use of probiotics	Bacterial infections	Adding Enterococcus faecium and others to feed	Reduced incidence of osteomyelitis and lameness	*Alrubaye* et al., 2020; *Do* et al., 2024; *Alharbi* et al., 2024.
Vaccination	Staphylococcus aureus	Electronically processed vaccine	Reduction of arthritis caused by staphylococci	*Assumpcao* et al., 2024; *Choppa, Kim,* 2023.
Mycotoxin control	Weakening of the immune system and bones	Feed sorbent additives, feed quality control	Prevention of predisposition to lameness	*Alharbi* et al., 2024.
Maintaining bedding quality	Mechanical injuries and infections	Timely replacement and moisture control	Reduction of pododermatitis and secondary infections	*De Jong* et al., 2014; *Kierończyk* et al., 2017.

Studies show that the use of a vaccine based on electron beam-killed *Staphylococcus spp.* showed a 50% reduction in the incidence of lameness due to a more effective immune response [5]. The use of probiotics such as *Enterococcus faecium* and PoultryStar® Bro significantly reduces the incidence of lameness by improving gut integrity and barrier function [16, 19]. The use of organic micronutrients such as Availa-ZMC significantly reduces lameness by improving intestinal barrier integrity [8]. Addition of 25-hydroxyvitamin D3 to drinking water reduces the incidence of lameness by improving calcium metabolism and strengthening bone structure [23]. Using wire-floor models, high levels of lameness can be reproduced to evaluate the efficacy of various preventive measures [7]. These interventions improve immune response, gut integrity and bone health, which together reduce the risk of lameness.

6 Prospects and directions for future research

Current research is focused on developing new diagnostic and monitoring methods that can aid in the early detection and management of lameness in broilers. Systems have been developed that utilize computer vision for early detection of lameness in broilers. For example, automated systems such as eYeNamic™ can assess bird activity and predict lameness levels based on image analysis [26]. These systems may become part of animal welfare assessment schemes in the future.

Using machine learning techniques such as decision trees, broilers can be classified based on their walking ability [28]. These models can automatically estimate lameness based on the birds' walking speed. Accelerometers can be used to monitor activity and detect behavioral changes associated with lameness, which requires further research to improve continuous monitoring [18]. Future research should focus on integrating different technologies and methods to create comprehensive monitoring systems that will allow more accurate and timely detection of lameness in broilers.

Genome studies of bacterial isolates from lameness foci show that pathogens can vary significantly between farms, requiring further study to understand disease mechanisms [10]. Genetic studies show that there is an innate difference in the susceptibility of different broiler lines to BHO, opening up opportunities for breeding more disease-resistant lines [7]. One of the major contributors to lameness is bacterial chondronecrosis with osteomyelitis, which is caused by pathogenic bacteria such as *Staphylococcus* and *E. Coli* [10, 14].

Understanding the microbiological aspects of bacterial chondronecrosis with osteomyelitis, including the role of the gut microbiota and bacterial translocation pathways, is an important area of research. Improving microbial balance with probiotics and other supplements may reduce the risk of lameness in

broilers [14]. Probiotics and other supplements may support bone health and overall broiler resistance, which helps reduce the incidence of bacterial chondronecrosis with osteomyelitis.

Research shows that the physical environment, including litter and air quality, can significantly affect foot health in broilers. Lameness is often associated with race joint burns and paw pad dermatitis, indicating the need for improved housing conditions [12]. Future research should focus on developing new diagnostic methods, exploring new probiotic and phytobiotic supplements, integrating genetic, environmental approaches to develop comprehensive strategies for prevention and treatment of lameness in broilers.

Conclusion

This review work revealed that lameness in broilers is a complex multifactorial problem associated with infectious diseases, poor housing conditions, nutritional deficiencies, genetic predisposition and intensive growth of poultry. One of the most commonly diagnosed pathologic conditions associated with lameness is bacterial chondronecrosis with osteomyelitis (BCO). *Staphylococcus aureus* and *Escherichia coli* have been found to be the main bacterial agents in BCHO, causing inflammation and necrosis of bone tissue, especially in active growth areas in fast-growing broilers.

Infectious agents interact with predisposing non-infectious factors such as poor ventilation, poor litter quality, high planting density and micronutrient imbalances in the diet to exacerbate the risk of lameness. The rapid growth rate of modern broilers places mechanical overload on bones and joints, increasing the likelihood of microdamage and bacterial invasion.

Preventive strategies considered, including the use of probiotics (e.g. *Enterococcus faecium*), organic micronutrients, vitamin D3, and vaccination against *S. aureus*, have been shown to reduce the incidence of lameness in experimental conditions. Special attention is paid to the role of modern methods of visual and molecular diagnostics, such as infrared thermography, automated gait analysis and PCR, which allow to detect subclinical cases of lameness and monitor the health of the herd at an early stage.

Thus, effective control of lameness requires an integrated approach that includes both biological and management measures and the use of modern monitoring technologies. The integration of preventive strategies and early diagnosis will significantly improve broiler welfare and reduce economic losses in the poultry industry.

Authors' Contributions

GA: conducted a comprehensive literature search, analyzed the gathered data and drafted the manuscript. BB: conducted the final revision and proofreading of the manuscript. All authors have read, reviewed, and approved the final manuscript".

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