Mortality in chickens raised for meat

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Photo: Animal Equality

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Introduction

In the United States, over nine billion chickens are raised to be slaughtered for meat annually. Millions of these chickens, referred to as "broilers," die every year before they reach the slaughterhouse. According to the United States Department of Agriculture (USDA), deaths in chickens prior to slaughter exceeded 556 million in 2021[1]. These deaths occur at every stage of their growth cycle. While there are many causes of pre-slaughter mortality, deaths can be overwhelmingly attributed to poor animal welfare leading to compromised health. Management practices and genetic selection for rapid growth and increased body weight also play important roles in pre-slaughter deaths.

The production cycle for broiler chickens lasts around seven weeks, at which time they reach slaughter weight. Chickens are born in hatcheries where thousands of fertilized eggs are incubated, hatched, and transported to grow-out facilities at one day old. Once they have reached the targeted weight in the grow-out facility, the chickens are transported to pre-slaughter holding before going to slaughter. At every point of this cycle, chickens are subjected to environmental and physical stressors that dampen their immune function, compromise their health, and contribute to high rates of mortality.

About Animal Equality

Animal Equality is an international animal protection organization working in eight countries to end cruelty to farmed animals through undercover investigations, legal advocacy, corporate outreach, and public awareness about plant-based foods.

Photo: Animal Equality

Mortality at the hatchery

At the hatchery, increased mortality begins in the embryonic stage. Broiler chickens have been bred extensively for rapid growth, and this is reflected in their embryonic development. Broiler chick embryos have greater yolk masses when compared to chickens bred for egg production, and larger yolk masses correlate to larger body size. This is particularly reflected in the later stages of embryogenesis, where broiler chick embryos have significantly higher body mass than other chick embryos.[2]

The rapid changes induced by high growth rates in the embryo has an effect on broiler chick mortality even in the very early stages of life. A comparative study of embryos of quail, laying chickens, and broiler chickens found that birds selected for greater body weight experienced higher rates of mortality due to disrupted embryogenesis,[3] and early embryonic death is greater than 16 percent.[4]

During an Animal Equality investigation, chicks at a U.S. hatchery were found being thrown and crushed by machines. (Credit: Animal Equality).

From incubation to hatching

During the production process, chicks are moved and handled several times from one stage to another. Many chickens are killed before they hatch by negligent management practices, equipment malfunctions, and employee carelessness. Shortly before hatching around day 21, eggs are moved from incubators to hatchers, plastic baskets where the chicks will complete the process for hatching. These transfers lead to high mortality rates from rough handling of eggs and inhumane methods of killing chicks.

In 2021, an Animal Equality undercover investigator documented the conditions of chicks at a Foster Farms hatchery in California. Over the course of several weeks, the worker observed egregious negligence and multiple practices and policies that resulted in pain, suffering, and high mortality rates.

In an official statement submitted to local authorities describing the transfer room[5] in the hatchery, the investigator stated:

> “Countless eggs break each day in the transfer room. Workers’ fingers go through eggs, or accidentally smash trays, as they are working quickly to keep up with the rapid speed of the factory. Machinery and equipment breaks or malfunctions. Each shift, some eggs end up being left on the trays as they go through the tray-washing machine, leaving chicks somehow ...alive and struggling on the other side. Cracked eggs with live chicks inside, just 3 days away from hatching, are deemed as “unusable,” and thrown into a large garbage bin along with all the rancid eggs. Many times I saw live chicks slide out of their cracked shells and sink into the rotten egg’s fluid that fills the garbage cans. A single incident in the transfer room broke thousands of eggs; the chicks that fell from the broken eggs were alive and spilled onto the floor before they were shoveled into a large bin and then into the grinder. The hatchery services so many eggs however, that these incidents are shrugged off by workers and management, and the lost chicks are barely noticed in comparison to the hundreds of thousands of eggs and chicks that survive each day.”

The live chicks that survive the transfer room die in a number of painful ways. Chicks often fall, get stuck, and are injured or killed by the mechanical conveyor system. Chicks are frequently thrown from the machinery onto the hatchery floor, where they are at risk of hypothermia, drowning, and severe injury. Chicks who are injured or otherwise deemed undesirable are tossed into a chute leading to a large pit, where they languish and succumb to their injuries or are buried by egg shells and dead chicks before being ground alive by a macerator.

The eggs that make it through the transfer room intact are collected in the hatchers, where the chicks begin the process of pipping, or pecking until they break through the eggshell. Chickens hatch at different rates, and their chances of dying depends on when they emerge from their shells. One study observed a significant increase in mortality in chicks who hatched later–with a death rate of 52.9% up to ten days of age for chicks who hatched later compared to 3.2% for chicks who emerged at the beginning of hatch and 1.2% for chicks at the peak of hatch.[6] Chicks hatching early were more likely to perish from dehydration, while chicks hatching later had higher incidences of leg weakness. Chicks are also born debilitated or deformed, which impacts their chances of early survival.[7]

Chicks may remain in hatchers for up to 48 hours until all eggs hatch, but during this time, they are dependent on reserves from their yolk sac for sustenance. Comparative to their body size, broiler chicks have smaller residual yolk sacs than layer chicks upon hatching[8], and in one study chicks who were held for 48 hours in hatchers experienced significant weight loss and debilitation, losing 12.5% to 21.7% of their hatching weight and 79.4% of their yolk sac weight.[9]

During an Animal Equality investigation, a chick was found crushed by machinery (Credit: Animal Equality)

Photo: Animal Equality

Culling and transport

Post hatching, chicks are moved through a mechanical processing line where sick, deformed, and other unwanted birds are culled.[10] Injuries are the main cause of death and major reason for culling at this stage, as chicks fall, are dropped, or are caught and injured in the machinery. The chicks who do not immediately die from their injuries are tossed into a macerator, which is the predominant method of killing culled chicks.[11] However, some chicks may face prolonged suffering when they are left alive in waste pits or buckets prior to being dumped into the mechanized grinders.

Chicks who are culled may also be killed using carbon dioxide, although this method has been shown to cause significant distress in chicks in some studies.[12]

Once culling is completed, the surviving chicks are sprayed with vaccines for several diseases, including Newcastle disease, infectious bronchitis, and coccidiosis. Chicks are then transferred to plastic crates where they will be transported to farms and grown to slaughter size. These crates are packed tightly with birds and stacked on top of one another in the transport trucks. Hatcheries will often ship thousands of chicks at a time to farms all over the country.[13]

During the processing and transport stages, day-old chicks do not receive their first food and water until at least 24-72 hours after hatching.[14] For sustenance, they are dependent on yolk sac reserves, which in broiler chicks are already reduced relative to their size at hatching. Depending on how early they hatched and how long they remained in hatching baskets, chicks may already be significantly depleted of their reserves prior to transport.

Post-hatch food and water deprivation has been shown to have detrimental effects on the physical health and welfare of chicks, with negative impacts on growth, immune system activation, organ development, and digestive enzymes.[15] Early food deprivation has also been linked to higher mortality rates, and one study found that chicks fed at greater than 48 hours post-hatching had higher total mortality at 42 days than chicks who were fed at 24 hours after hatching. Additionally, chicks who were given food and water at greater than 84 hours post-hatching had higher rates of mortality during the first week of life than other chicks who were fed earlier.[16]

Chicks are not only deprived of food and water at this stage, they are also subjected to multiple stressors and noxious stimuli like loud noises of machinery, disinfecting chemicals, movement from darkness into glaring light, frequent handling, and high dust and pathogen loads.[17]

Mortality at the farm

After reaching the farms, chicks are subjected to additional processing and handling. When they first arrive, the stacked transport crates are unloaded from the trucks and wheeled into large sheds. Employees then begin systematically dumping the chicks out of the transport crates onto the ground.

Animal Equality documented this process in an undercover investigation into nine Pilgrim's Pride chicken farms in the United Kingdom, in the fall of 2019. Employees were recorded emptying chicks out of the crates from a substantial height. They were observed forcefully jerking the trays to ensure that all chicks were released from the tray in one movement. Workers deposited the trays of chicks in a single spot, resulting in large piles of chicks landing on top of each other.

The rough handling of the chicks as they are removed from transport crates leads to physical trauma and death. Due to the height and velocity at which the chicks are dumped, higher concentrations of dead chicks can be found in the spots where the dumping occurs. As one employee stated in a conversation with the investigator regarding numbers of dead chicks:

> "You will find some here and there, but the majority of your dead and injured is in one area. Like you'd be tipping here, then [redacted] will be over this side, tipping. So you'll do a lot here, walk a little bit, another lot here in one or two rows. I suppose it's not easy but you will see a pattern the more you do the job. You will see a pattern developing."

Sometimes the deaths are not immediately apparent, and high numbers of deaths may be observed the day after the chicks arrive. According to the employee, "...some of them can move a bit and they go over there and then they die."

The worker also noted that often increased mortalities would be observed in chicks arriving from the hatchery due to illness:

> "Sometimes the problem comes from the hatchery as well...they won't admit it, the hatchery, but they get disease, they get infections. Then they put the birds in these trays, send them to us, and then we have to deal with it in the sheds. Like you saw today. 500, 400, 300 [dead chicks]."

Photo: Animal Equality

First week mortality

First-week mortality (FWM) is used as a welfare indicator in flocks.[18] Chicks experience a high degree of stress in their first week of life as they are transported from the relatively controlled conditions of the hatchery to being housed in large, open-floor sheds with up to thousands of other chickens. Multiple factors contribute to high rates of FWM, including egg weight, strain, genetic line, and age of the breeding flock that produced the chicks.[19] Environmental factors that contribute to FWM include conditions at the hatchery prior to arriving on the farm, feed type and quality, housing temperature and climate, air quality (exposure to excessive ammonia and dust), and season. [20] One study reported that the type of ventilation used in housing, as well as the distance chicks were shipped from the hatchery to the farm, contributed to higher overall deaths.[21] The strain of chicks' changing environment, competition with other chicks, overcrowding, fluctuations in body temperature regulation, and exposure to pathogens all lead to high mortality in the first week of life.[22]

Chicks must adjust to acquiring food and water for themselves and are forced to compete with other chicks for these resources. This poses a significant challenge for birds who are smaller in size, sick, injured, or debilitated from transport, as these chicks are likely to perish from dehydration and starvation. [23] Peak mortality in the initial week occurs in the first three to four days, when any remnant of the yolk sac disappears, and chicks who do not begin to feed themselves starve.[24]

Overstocking in broiler sheds is a common issue that prevents weakened chicks from reaching food or water. In Animal Equality's 2019 investigation into Pilgrim's Pride UK farms, many instances of extreme stocking density were observed. In some cases, birds were overstocked to the point that they were unable to stretch their wings, reach feeders or drinkers, and exhibit natural behaviors. The investigator observed chicks struggling to reach water lines in broiler sheds, and chick deaths from dehydration and other contributing factors, like small size, were routinely documented. Studies have also shown that, after infectious diseases, dehydration is one of the leading causes of death, along with metabolic disorders like visceral gout.[25]

Water administration systems may also play a role in chick mortality due to dehydration. Nipple systems are often preferred for ease of management, but chickens naturally drink by spooning water into their beaks and raising their heads to swallow. Nipple systems require that they learn an unnatural drinking behavior and have been linked to higher rates of FWM.[26] Water lines are set for standard breed expectations, and any chicks who fall under the average growth rate either die when they cannot access water, or are culled.

Chicks' immune systems are undeveloped at this early age, leaving them vulnerable to infectious diseases.[27] This factor, combined with the commercial poultry industry's dependence on raising high numbers of broilers at high stocking densities to maintain profitability, results in conditions conducive to the spread of infectious diseases within broiler chick populations. Bacterial, viral, and parasitic diseases all contribute to chick mortality, and of these, bacterial infections cause the most deaths.[28,29] Half of all deaths in chicks during the first week can be attributed to bacterial infections.[30]

To address the ongoing problem of mortality caused by bacterial diseases, poultry producers have routinely administered low doses of antibiotics, called growth promoters, in the feed of broiler chicks since the 1950s. Growth promoters increase feed conversion, causing animals to grow larger and faster. They may also prevent some bacterial infections in flocks. In 2017, concerned with the growing prevalence of antimicrobial-resistant

strains of bacteria, the US Food and Drug Administration prohibited the sale of growth promoters directly to producers and instead required a veterinary prescription for antibiotics. By this action, the FDA hoped to curb the rampant use of subtherapeutic antibiotics and prevent further strains of resistant bacteria from emerging.[31]

The most common bacterial pathogens in chicks are Escherichia coli and Enterococcus spp., although Streptococcus, Pseudomonas, Staphylococcus, Proteus, Klebsiella, Enterococcus, Corynebacterium, Citrobacter, Aeromonas, Bacillus, Clostridium, Micrococcus, Yersinia, Enterobacter, Aerobacter, Achromobacter, and Alcaligenes can also cause illness and death.[32] Colibacillosis, the disease caused by E. coli infection, causes death in chicks in a number of ways, including acute fatal septicemia, subacute pericarditis, airsacculitis, salpingitis, peritonitis, and cellulitis, and is responsible for large numbers of deaths in broilers.[33]

In a study examining the causes of death in neonatal broiler chicks, Enterococcus spp. were identified in deceased chicks 29.7% of the time, and E. coli was identified 19.4% of the time. However, the study also detected a high prevalence of co-infections, with 56% of the E. coli samples showing co-infection with Enterococcus.[34]

In another study, E. coli was pinpointed as a significant cause of death in the first 48-72 hours of arriving at the farm. Seventy percent of the dead chicks in the study showed signs of E. coli infection and 30 different virulence profiles were identified in E. coli isolates cultured from the tissues of dead chicks.[35] In a study of 48 layer chicken flocks, more than half of FWM could be attributed to bacterial infections, with yolk sac infections and septicemia found in 94% of the flocks. Salmonella was also a frequently isolated pathogen present in yolk sac infections.[36]

Sudden death syndrome, or “flip-over disease,” causes sudden death in young broiler chicks, usually after the first week and peaking between days 12 and 28. This condition occurs in chicks that otherwise appear to be healthy and is thought to be linked to fast growth. Birds experience rapid convulsions and flip over onto their backs and die. They are often found in this position, in good body condition with no visible lesions. The exact cause is unknown although the condition may be triggered by stress. Sudden death syndrome has been linked to cardiac arrhythmias–broiler breeds, due to their fast growth, are 27% more likely to have cardiac arrhythmias than layer breeds. The condition may affect .5%-4% of an intensively farmed flock, and mortality rates of 0.25% to 0.5% may occur over a few days.[37]

Mortality rates generally peak around one week post-hatch–three to four days after arriving at the farm–then gradually increase as the chicks approach slaughter weight.[38] Numbers of deaths may decline until around day nine or ten, then stabilize until approximately day 30. After day 30, mortality rates begin to rise again leading up to slaughter. [39]

Photo: Animal Equality

Late mortality

In later growth stages, broiler chickens are susceptible to many ailments from both infectious and noninfectious causes. While mortality rates depend on many factors, such as breed, type of facility, climate, ventilation, light management, feeding errors, wet versus dry litter, and others, noninfectious diseases like metabolic and cardiovascular disorders are responsible for many deaths. Bacterial and viral diseases also contribute significantly to late mortality in flocks. A study of a broiler chickens in Brazil identified the following most frequent causes of death: metabolic disease (44%), infectious disease (26%), chicks killed due to being sick, weak, or otherwise undesirable for production purposes (10%), locomotor disorders (8%), starvation (6%), management failures (3%), and congenital defects or malformations (2%).[40] Another study in Danish flocks attributed 41% of pre-slaughter deaths to noninfectious causes and 55% to infectious causes.[41]

Noninfectious causes of late mortality

The abnormally rapid growth rate of broiler chickens causes a number of diseases, which lead to an increase in deaths after day 45. Genetic selection of broiler breeds over the past 60 years has resulted in enhanced size and musculature, and a compressed production cycle where chickens are growing larger and faster to be slaughtered at younger ages.[42] Growth rates have increased over 400% from 1957 to 2004,[43] and it now only takes chickens around 38 days to reach a slaughter weight of approximately 2.5 kg (5.5 lb), compared to 63 days in the 1960s.[44] Eighty-five to 90% of this increase can be attributed to selective breeding, with the remainder due to dietary changes to increase nutrient consumption.[45] As a result, the modern broiler chicken grows from around 44 grams (0.1 lb)[46] at hatch to 2.6 kg (5.7 lb) just seven weeks later.

This accelerated growth coupled with high nutrient intake has come with serious welfare consequences for broilers–they are subject to a variety of conditions, including metabolic and cardiovascular disease, contact dermatitis, and musculoskeletal disorders. Concerns about cardiovascular disease like sudden death syndrome and ascites[47] from pulmonary hypertension have been raised for decades, and other problems linked to fast growth include bone deformities causing leg weakness, lameness, and extended periods of immobility on wet litter. This in turn contributes to the development of painful pressure sores and footpad dermatitis.[48] Lame birds who cannot reach food or water die of dehydration and starvation.

Studies of broiler flocks have found moderate to severe lameness in 15-25% of broiler chickens, with heavier birds exhibiting more severe lameness.[49] While footpad dermatitis is related to genetic selection, weight, and type of litter the chickens are kept on, lameness has a more complex etiology arising from both infectious and noninfectious causes.[50]

Infectious causes of late mortality

The crowded, stressful, and unnatural conditions on broiler farms create conditions that favor the development and spread of infectious diseases. The chicken microbiome consists of around 1,000 bacterial species, although the composition varies over time, between breeds and lines of birds, between flocks, individuals, and at different sites within the gastrointestinal tract. These microbes can have the properties of either pathogen or commensal depending on the bacterial pathotype, host immune status, diet, and the presence of coinfections. Bacterial, fungal, and viral infections are common causes of high mortality in broiler flocks. Acute outbreaks of some infectious diseases, like infectious bursal disease, can decimate flocks with death rates as high as 50%.[51]

Culling

Throughout the time on the farm daily mortality is represented by chickens that die from disease, injury or other pathologies and ones that are killed because they would likely succumb to these stressors.

Bacterial diseases

Campylobacter jejuni

Raw and undercooked chicken contaminated with Campylobacter jejuni is one of the most common causes of foodborne illness in the US. C. jejuni is considered to be a commensal bacteria in the gastrointestinal tract of chickens, meaning it should generally be harmless to its host.

However, studies have challenged that idea within the context of rapidly growing chickens in modern industrial production systems. In broiler chicken breeds, C. jejuni was found to incite a strong inflammatory response within the gastrointestinal tract leading to diarrhea, which in turn increases the likelihood of footpad dermatitis as chickens stand and lay on wet, dirty litter. Thus, C. jejuni may have a considerable impact on the welfare and health of broiler chickens.[52]

Colibacillosis (coliform infections)

Colibacillosis is a common condition in broiler chickens caused by avian pathogenic E. coli (APEC). It contributes to high numbers of deaths, with mortality rates up to 35% in some cases. A study in Italy found colibacillosis in 35% of chicks and 53% of late stage broiler chickens in one population.[53]

Colibacillosis can vary in severity, and pathogenesis can range from severe acute infections with sudden and high mortality to mild, chronic infections with low morbidity and mortality. Primary routes of infection are respiratory and gastrointestinal, and birds with the acute septicemic form may exhibit rapid progression of sudden illness. While birds in apparently good condition can die, in most cases affected chickens are listless with ruffled feathers, fever, diarrhea, and if respiratory infection is present, labored breathing, occasional coughing and rales.[54]

Fowl cholera

Fowl cholera is a disease caused by Pasteurella multocida that occurs in many species of commercially-farmed birds. P. multocida is a resilient organism that can survive at least one month in droppings, three months in decaying carcasses, and two to three months in soil. It infects birds via oral and upper respiratory routes. Animals other than birds may be reservoirs of infection and actively spread the disease, including raccoons, opossums, dogs, cats, pigs, and wild rodents.

Fowl cholera signs can vary depending on the stage of the disease and individual birds. In the peracute form of the disease, signs may be absent. In the acute form some birds may die without showing symptoms, but others show signs of severe illness prior to death. Symptoms include lethargy, loss of appetite, rapid weight loss, lameness from joint infection, swollen wattles, respiratory distress, watery yellowish or green diarrhea, and cyanosis of the head and wattles.[55]

Necrotic enteritis

Necrotic enteritis (known as rot gut, crud, cauliflower gut) is a sudden-onset disease that destroys the intestinal lining of the digestive tract in chickens. It is caused by Clostridium perfringens, which produces bacterial toxins that result in the marked intestinal damage characteristic of this disease, though coinfection with coccidiosis may be a contributing factor.

Transmission is thought to occur by the fecal-oral route when birds come into contact with infected droppings. Outbreaks of necrotic enteritis occur suddenly in flocks, with apparently healthy chickens becoming depressed and dying within a span of hours. Mortality ranges from 2-10%, though death rates can be as high as 30%.[56]

Pullorum disease

Pullorum disease is caused by Salmonella pullorum and manifests as both acute and chronic conditions. It can affect many species of wild and domestic birds. S. pullorum is primarily transmitted via the egg, but can also be spread from infected hen to egg, egg to chick, and chick to chick in incubators, chick boxes, brooders, or barns. Chicks can also be exposed by workers with contaminated clothing, shoes, and equipment, or they can be exposed by an environment where there has been previous infection. Birds can be asymptomatic carriers of the disease as well and shed pathogens that infect other birds.

Transmission occurs via oral and respiratory routes. Most infections occur in hatcheries and outbreaks are seen commonly in chicks under three weeks of age. Pullorum disease is highly fatal to chicks, who may die shortly after hatching without any noticeable signs of illness. Mortality rates are extremely high–up to 90%. Infected chicks exhibit lethargy, ruffled feathers, heat-seeking or huddling behavior, labored breathing, and white diarrhea with fecal matter pasting around the vent. Because of this, the term "bacillary white diarrhea" was previously often used in association with this disease.[57]

Fowl typhoid

Fowl typhoid,[58] caused by Salmonella gallinarum, can affect a variety of bird species at any age. However, the disease occurs primarily in young birds over 12 weeks old. Fowl typhoid presents as both acute and chronic conditions, but is most often seen as acute disease. S. gallinarum is transmitted in the same ways as S. pullorum, but mechanical transmission from clothing, shoes, equipment is more common.

Mortality for this disease ranges widely, from less than 1% to 40% or higher. Affected flocks will experience sudden or sporadic deaths, listlessness, green or yellow diarrhea and pasting of the vent feathers, loss of appetite, increased thirst, and pale combs and wattles.[59]

Omphalitis

Omphalitis means inflammation of the umbilical stump, or navel, and in chicks the term refers to the improper closure and resultant bacterial infection of the navel. This condition is sometimes called navel ill or mushy chick disease.

Mixed bacterial infections of common coliforms and various species of Staphylococcus, Streptococcus, Proteus, and others contribute to omphalitis. It is not transmitted from bird to bird, but rather occurs in the first few days after hatching when unsanitary equipment contaminates the unhealed navels of newly hatched chicks. Factors that contribute to the occurrence of omphalitis include faulty incubation, poor hatchery sanitation, and chilling or overheating soon after hatching (such as in transit). Chicks with omphalitis appear lethargic with "puffed up" down, seek out heat sources, and exhibit little interest in food and water. They will sometimes have diarrhea. Deaths in newly-hatched chicks usually are first seen within 24 hours and peak by five to seven days.[60]

Photo: Animal Equality

Viral diseases

Newcastle disease

Newcastle disease is a highly contagious infection caused by a paramyxovirus. It manifests as a respiratory and nervous disorder in chickens. Circulating viral strains vary in their ability to cause

nervous system disorders, visceral lesions, and death and are characterized as lentogenic (mild), mesogenic (moderate), and velogenic (severe sickness and death). Mesogenic and velogenic strains were reclassified as virulent Newcastle disease virus (vNDV) and cause infections of high concern in the US. Lentogenic viruses (loNDV) are used in vaccines and circulate in wild birds in the US. These viruses are also prevalent in commercial flocks but generally do not lead to the high mortality and morbidity of vNDV. The virulence of the virus also depends on the immune status, age, and susceptibility of the birds.[61]

In an outbreak, all birds within a flock can become infected in just three to four days via fecal-oral, aerosol, and bodily fluid transmission. Newcastle disease can also be spread by contaminated equipment, shoes, and clothing. After an outbreak, the virus usually does not persist in the environment after 30 days.[62]

Signs of Newcastle disease include gasping, coughing, sneezing, and rales. Birds may also develop depression, inappetance, and diarrhea. Young chickens will present with gasping, sneezing, and difficulty breathing for about 10 to 14 days, after which the illness may progress to neurological symptoms. Chickens may develop paralysis of one or both wings and legs, incoordination, tremors, twisted necks, and head tilts. [63] [64], Outcomes in flocks infected with Newcastle disease range from 100% mortality to no deaths. Vaccinations against Newcastle disease are available but mass vaccination may result in less than 85% of the flock receiving immunity-inducing doses.[65]

Infectious bronchitis

Infectious bronchitis is a respiratory disease caused by an avian coronavirus that affects only chickens. It presents as coughing, sneezing and rales, though chickens can also develop conjunctivitis and facial swelling. Some strains cause kidney inflammation that progresses to death.[66] Infectious bronchitis is considered one of the most contagious poultry diseases. During an outbreak, all susceptible birds on the farm become infected, regardless of sanitary or quarantine precautions. The virus is transmitted via aerosol, contaminated food and water, and clothing, crates, and equipment. It can travel through the air at considerable distances during an active outbreak.[67]

The severity of the disease depends on age, breed, diet, immune status, and cold stress of the flock. Coinfections with Mycoplasma gallisepticum, M. synoviae, E. coli, and Avibacterium paragallinarum can worsen the disease. Mortality ranges from 5% to 60%. Vaccines are available but they are very strain-specific and will not protect against all possible viral strains.[68]

Marek's disease (visceral leukosis)

Marek's disease is a highly contagious herpesvirus that generally affects young chickens, although older birds can also be susceptible. Marek's disease is ubiquitous in flocks, with subclinical infections present on most farms. It causes T-cell lymphomas and enlargements in peripheral nerves. Affected chickens exhibit paralysis, depression, and incoordination. Paralysis is the main cause of death, as chickens cannot reach food or water. In addition to age, immune status, and genetics, environmental stress can also play a role in the development of Marek's disease.[69]

The virus causing Marek's disease concentrates in feather follicles and is shed in dander made up of skin and feather cells. The virus has a long survival time in dander, and viable virus has been isolated in operations that have been depopulated for many months. It is transmitted by aerosolized dander and dust.[70] Vaccines are available that are around 90% effective at preventing disease.[71]

Infectious bursal disease (gumboro)

Infectious bursal disease is a highly contagious condition in young chickens caused by a birnavirus called infectious bursal disease virus. Chickens are most susceptible to this disease between 3-6 weeks of age. The virus is spread via a fecal-oral route and can be transmitted on clothing, equipment, and contaminated litter. [72]

Affected chickens display signs of extreme prostration, incoordination, diarrhea, vent picking, ruffled feathers, dehydration, and cloacal inflammation. In an outbreak, 100% of the flock will be infected, with mortality rates between 5% and 60%. Infectious bursal disease also reduces a bird's ability to develop immunity to other diseases by causing immune suppression in surviving birds.[73]

Airsacculitis

Airsacculitis is a respiratory infection in chickens characterized by inflammation in one or more of the air sacs, which store air in a chicken's lungs and are necessary for normal respiration. In cases of airsacculitis, air sacs thicken and fill with purulent or caseous discharge, causing respiratory distress and swelling around the lower neck.

Airsacculitis is caused by many bacterial, viral, or fungal pathogens, and common pathogens include E. coli and M. gallisepticum. This condition is associated with the following diseases as well: avian chlamydiosis, Newcastle disease, chronic respiratory disease, aspergillosis and ornithobacteriosis.[74]

Avian influenza

Avian influenza is a highly transmittable disease that affects birds of many species. It is caused by avian influenza A viruses. Wild birds, and particularly ducks, serve as reservoirs for this virus, and domestic chickens can become infected via contact with their saliva, nasal secretions, and droppings. Surfaces contaminated with the virus can also spread the disease.[75]

Avian influenza is classified into two categories based on severity: Low pathogenic avian influenza (LPAI) and high pathogenic avian influenza (HPAI). Regardless of pathogenicity, both forms spread quickly through flocks. LPAI causes mild to no symptoms in chickens and represents the most common form of avian influenza. However, LPAI outbreaks are concerning not only because they can cause illness, but also because the virus can mutate and become HPAI. The highly pathogenic form of avian influenza causes high numbers of deaths and severe disease. In chickens, HPAI can attack multiple internal organs and result in 90-100% mortality in just 48 hours. Both types of avian influenza can also cause mild to severe illness in humans.[76]

Because of the transmissibility and severity of HPAI, the USDA monitors its occurrence in US flocks. When outbreaks occur in flocks, most chickens do not die of the disease, but rather entire flocks, both healthy and sick, are killed in a process called depopulation in an attempt to control the spread of the virus. In 2015, over 50 million chickens died in an outbreak that affected commercial operations in 21 states. Until 2022, this was the most significant outbreak in U.S. history.[77]

In late 2021, HPAI was detected in wild birds in Canada and since then has been found in major migration pathways across the U.S.[78] In early 2022, the virus began appearing in commercial flocks, resulting in over 23 million birds killed either by the virus or depopulation since April.[79]

Photo: Animal Equality

Methods of depopulation

According to the American Veterinary Medical Association (AVMA), depopulation is "the rapid destruction of a population of animals in response to urgent circumstances with as much consideration given to the welfare of the animals as practicable."[80] Situations where depopulation methods may be used include controlling diseases that put public health at risk and national and human-caused disasters.

The AVMA designates depopulation methods as "preferred," "permitted in constrained circumstances," and "not recommended." Methods preferred for broiler flocks include suffocation in water-based foam, gassing, cervical dislocation, mechanically assisted cervical dislocation, and captive bolt gun. Under certain circumstances, gunshot, controlled demolition, decapitation, exsanguination, and VSD plus may be used. VSD alone is not recommended.[81]

Ventilation shutdown, or VSD is a method by which producers turn off ventilation in chicken barns with the birds sealed inside to slowly die of overheating or suffocation. VSD plus requires the addition of heat (to a minimum temperature of 104-110 degrees Fahrenheit within 30 minutes) or carbon dioxide gas in an attempt to kill the birds more quickly.[82] Depopulation methods are intended to kill animals as quickly as possible, however, when VSD plus is used, it can take chickens up to two hours to die.[83]

The use of water-based foam, which is sprayed over chickens on the floors of barns and obstructs their tracheas, and carbon dioxide gas are the most common methods used for depopulation and kill by inducing hypoxia.[84] However, producers have been increasingly turning to VSD plus as a method that does not require any special equipment, and for the 2022 HPAI outbreak, the USDA is permitting the use of VSD plus under certain circumstances.[85] VSD plus is widely condemned as inhumane by animal welfare experts. In 2021 more than 2,900 veterinary professionals signed a petition asking the AVMA to reclassify VSD plus as "not recommended.", [86,87]

Mortality in pre-slaughter phase

When broilers reach slaughter weight they are caught, put in crates, loaded onto a truck, transported to the slaughter plant, unloaded, and put in holding pens until they are slaughtered. Each stage of the pre-slaughter phase inflicts stress and physical trauma on broiler chickens. Birds are subjected to many stressors during this time that result in significant negative welfare outcomes–including weight loss, injury and death. [88,89]

Studies of broiler chickens during the pre-slaughter phase in Europe have shown that much of the physical injuries occur from the methods used to catch and crate chickens. These rough handling methods result in frequent bruising and trauma to wings, legs, breasts and vents. Longer transport and holding times were associated with dehydration and higher numbers of mortality in birds during this phase as well. [90,91]

Catching

Catching is the first step in the pre-slaughter phase for broiler chickens. It may be performed manually, with workers grabbing and carrying multiple birds at a time and loading them into crates, or mechanically, using specially-designed vehicles with attached conveyor belts.

Chickens are commonly caught and carried by a single leg, with up to seven birds in one hand and up to four in the other hand of the worker. The chickens are then carried upside down to a transport container consisting of several narrow drawers in which they are crated.[92]

Catching and crating can cause distress, injuries, and death. Studies of catching methods report variable percentages of injuries to the legs, breast, and vents of chickens, but wing injuries, including fractures, are reported consistently across studies.[93]

According to a study conducted in broiler flocks in Germany, heavier birds experienced more injuries than lighter birds. Wing trauma and injury occurred at a rate of up to 15.32%, while injuries on the body and legs were rare.[94] Other studies have reported a range of injuries, with bruises on wings, legs, and breasts, and a higher number of injuries were reported in transports where more birds were packed per crate.[95] A study conducted by a team of researchers from the US, UK, and Brazil noted that chickens exhibited signs of agitation and distress during catching, such as wing flapping, kicking, and struggling. The researchers also observed that the chickens' heads, wings, and legs often struck the crates when being loaded.[96]

Transportation

Transportation is a critical stressor in the life of a broiler chicken, the effects of which can range from discomfort to pain to death.[97] Chickens are subjected to a number of physical stressors during transportation, including denial of food and water for over 26 hours, temperature extremes of heat or cold, severe overcrowding over long distances, and physical aggression due to lack of space and stress.[98] These factors contribute to mortality and result in a percentage of chickens who arrive dead at slaughter facilities. Mortality rates in chickens found dead on arrival vary from around 0.19%[99] to 0.25%,[100] to rates as high as 0.72%.[101]

Temperature regulation within the transport vehicle has been identified as the major factor in mortality, followed by loading density, bird age and size, state of health, and duration of transport.[102] Post-mortem assessments of birds arriving dead in transport trucks have revealed that 40% of deaths were due to thermal stress caused by improper ventilation of the truck.[103] Birds loaded in crowded conditions have little opportunity to thermoregulate and protect themselves from extremes of heat or cold. [104] [105], Furthermore, in a population of birds where a percentage has been sufficiently stressed to the point of death, it follows that many more will be significantly debilitated and have compromised welfare.[106]

USDA records from 2017 to 2019, obtained by the Animal Welfare Institute via a Freedom of Information Act request, exposed disturbing incidents illustrating the stressors, risks and injuries chickens experience during transportation. In 2018, 34,050 Pilgrim's Pride birds died during transport to a slaughter facility due to severe cold and windy conditions. In an incident at OK Foods, a USDA inspector observed dead chickens that were too numerous to count after being transported in cages that were not shielded from 17 degree Fahrenheit temperatures. At Butterfield Foods, 50% of the birds on trucks–9,750 birds–were frozen solid after being held for over 22 hours in single digit temperatures. In one 2019 incident at Butterball, turkeys suffered large exposed wounds due to aggressive pecking after being held without food or water for over 26 hours. Tyson Foods packed chickens so densely on a transport truck that birds were lying on top of one another. More than 300 birds died from suffocation, with many others experiencing trauma and skin abrasions from rubbing against the sides of the cages.[107]

Transport accidents are another contributor to pre-slaughter mortality. In an incident in 2019, 3,000 birds were killed when a Peco Foods truck overturned and live and dead chickens were heaped on top of each other. At Mar-Jac Poultry in 2019, 100 chickens were severely wounded and killed when a cage of live birds fell off a truck.[108]

In addition to injury and environmental stress during transport, birds suffer and die from excessive force in handling. After a Sanderson Farms truck overturned in 2017, workers used inhumane handling practices while attempting to recapture birds. Chickens were forcefully grabbed, thrown, and poked with rods. Birds with serious injuries were not properly euthanized. Inhumane handling is also evident at slaughter–in 2017 nearly 100 Kralis Bros. Foods chickens were condemned[109] due to severe bruising that likely occurred during loading and transport.[110]

Pre-slaughter catching and transport results in weight loss and traumatic injuries, leading to debilitated birds. In the catching stage, wing fractures are prevalent, and in the transportation and holding stages, birds exhibit soiling of feathers, decreased body temperatures, and frequent huddling. There are higher numbers of splay-legged birds, birds with toes stuck in crates, and birds arriving dead at the slaughterhouse due to the injuries sustained during the pre-slaughter phase.[111] Overall, the stages of pre-slaughter–catching, crating, transportation, and holding for slaughter–together contribute to considerable numbers of deaths in broiler chickens.


Photo: Animal Equality

At the slaughterhouse: post-mortem inspection

Once chickens are killed, their carcasses undergo inspection to be classified as fit or not fit for human consumption. If a carcass is deemed unfit, it is condemned. Postmortem inspections can further illuminate conditions present in broiler chickens that impact their health and welfare and contribute to mortality. In 2021, the USDA, which oversees food inspections, condemned 41,754,970.[112]

Of this number, 2,176,263 were condemned for septicemia, a serious bloodstream infection caused by bacteria and their toxins. 1,550,196 were condemned due to airsacculitis, 61,482 for bruising (likely from poor handling), and 363,884 for the presence of tumors.

Other reasons for condemnation included leukosis, which encompasses several viral infections causing abnormal cell growth and proliferation, and synovitis, or joint inflammation.

Legal and agency oversight

In 1958, Congress enacted the Humane Methods of Slaughter Act (HMSA), a law designed to minimize the suffering of animals slaughtered for food. The HMSA requires the humane slaughter and handling of livestock in USDA inspected establishments. In 1978, the HMSA was amended to authorize USDA inspectors to enforce the law by halting operations at facilities until compliance with the HMSA was achieved. Unfortunately, the definition of livestock is limited to cattle, sheep, goats, and pigs, excluding poultry.[113] The HMSA applies to the roughly 166 million livestock killed each year at approximately 800 federally inspected slaughter plants, but does not protect the 9.3 billion chickens slaughtered every year in the US, nor does it cover chickens killed on farms.[114]

According to the USDA, poultry are not covered by the HMSA because they are regulated by the Poultry Products Inspection Act,[115] which requires that birds be handled in a manner consistent with Good Commercial Practices (GCP).[116] However, industry compliance with GCP is completely voluntary. Welfare practices for poultry currently fall under the regulatory requirement for GCP. While the USDA can issue reports to facilities violating GCP, they cannot enforce these practices.[117]

In the early 1990's, members of Congress introduced three separate bills requiring birds be rendered insensible to pain before or after shackling prior to slaughter. None of these legislative efforts proceeded past a subcommittee hearing. In the 2000's, animal advocacy groups filed lawsuits to include poultry in the definition of "livestock" in the HMSA. Unfortunately, the district court ruled that Congress did not intend poultry to be covered under the HMSA. Groups have also filed formal petitions for rulemaking to the USDA in an attempt to ensure oversight of the humane slaughter of poultry. In response to a petition stating that effective stunning was required to prevent suffering and ensure the wholeness of poultry products, the USDA stated "the promulgation of humane handling and slaughter regulations would not serve to prevent the movement or sale of adulterated or misbranded poultry products[...]" In response to additional rulemaking petitions, the USDA has also stated that existing system for monitoring the handling of birds under the PPIA is adequate "the HMSA does not include poultry as 'livestock' for the purposes of the Act." [118]

In 2005, the USDA published a Federal Register Notice that described a systematic approach for the industry to use when handling live poultry. The notice focused on treating live poultry in ways that minimize agitation, discomfort, and accidental injury the entire time live birds are held for slaughter. But again, industry compliance with these GCP remains voluntary.[119] Documents received via a Freedom of Information Act request by the Animal Welfare Institute (AWI) in 2019 revealed the USDA's consistent failure to respond to the mistreatment of birds. Inspectors took action to stop the abuse of birds in only 14% of the incidents that were documented in the records. AWI discovered that thousands of birds have suffered greatly due to violations of industry GCP, including intentional cruelty to birds by facility employees. Lack of enforcement power and reliance on voluntary industry compliance has been ineffective, as demonstrated by repeated GCP violations at facilities.[120]

In 2014, the USDA issued the Modernization of Poultry Slaughter Inspection rule. The rule allows companies and the USDA to divide inspection duties into two separate arenas. In the past, USDA inspectors oversaw both quality and safety issues, but this rule allows companies to shift the first inspection of carcasses from government inspectors to company employees.[121] Allowing companies to self-regulate further reduces the amount of government oversight and inspection in chicken slaughter facilities.

There are currently no federal laws in the United States that govern the treatment of animals used for food while on farms. Animal cruelty is prohibited in every state, but cruelty statutes often treat farmed animals differently from companion animals or make exemptions for "common farming practices. Even when the law does not exempt farmed animals from protection, they are rarely applied due to the lack of transparency into the conditions inside facilities and a lack of understanding of their applicability.

While all states, including the top five where most chickens are raised and killed, outlaw egregious cruelty to poultry, common cruel but industry-accepted husbandry and slaughter practices are exempted. Live-shackle slaughter, extreme stocking density, and exposure to high ammonia levels may cause pain, stress and mortality, their wide-spread use shields producers from anti-cruelty prosecution.[122]

At slaughterhouses that kill chickens for meat federal inspectors document egregious violations of Good Commercial Practices that would also seemingly be violations of state anti-cruelty codes. Animal welfare training materials provided by FSIS to inspectors list procedures for documenting any cruel treatment they witness as adulteration of the meat product.

Stress as a facilitator of pathogen invasion

Environmental stressors

Immune system function is essential for good health and necessary to protect against disease. However, factors like environmental stress and adverse living conditions can lead to poorly functioning immune systems. From the hatchery to the slaughterhouse, broiler chickens are confronted with multiple, repeated stressors that can impact how well their immune system responds to diseases. They experience loud sounds, noxious odors, unsanitary conditions, restriction of movement, and inability to express natural behaviors–all of which impact their stress levels.[123] Housing, temperature, air quality, light and dark cycles, and genetics are all potential stressors that can also significantly impact a bird's ability to mount a healthy immune response. Alterations in immune system function can prevent a chicken from responding adequately to vaccines or infectious pathogens.[124]

When birds are faced with acute and chronic stressors that compromise their health and wellbeing, this activates the hypothalamic–pituitary–adrenal (HPA) axis and the sympathetic–adrenal–medullary axis and stimulates the release of glucocorticoids and catecholamines. In birds, corticosterone is the main glucocorticoid produced, which in times of stress can have immunosuppressive effects.[125]

In a 2020 review, Hofmann, et al. found that stressful conditions are associated with high levels of circulating corticosterone and increased fearfulness in broiler chickens, which impair the ability of the immune system to adapt and fend off diseases. Other consequences of stress include poor responses to vaccinations and persistent, increased inflammation. When they remain in a chronic state of stress, chickens can experience poor health and welfare. Multiple environmental factors and management practices can interact to create an additive detrimental effect on the immune system.[126]

Genetic stressors

Over the past 60 years, broiler chickens have been intensively bred for rapid growth and enhanced feed efficiency[127]–resulting in a more than 400% increase in growth rate in the past several decades.[128] Studies have demonstrated that rapid growth has serious health effects on chickens. A 2013 study found that Campylobacter was associated with increased incidences of footpad dermatitis and hock lesions in rapidly growing birds versus slower-growing birds.[129] In addition to causing significant health and welfare problems like leg disorders, cardiovascular diseases, and footpad dermatitis, genetic selection has also altered the immune system of broiler chickens.

One study that compared the genomes of chicken breeds from 1957 and 1978 with modern broiler chickens identified changes to two genes, TLR3 and PLIN3, that predicted enhanced growth performance at the expense of immune function.[130] Another study evaluated fast- and slow-growing chicken breeds at two different stocking densities and found that the lowest welfare was associated with fast-growing chickens kept in more crowded conditions. Slow-growing chickens were healthier and expressed more indicators of positive welfare. The study concluded that significant welfare improvement occurred in breeds that did not experience rapid growth.[131] In 2021, Vissers et al. showed that shifting from a fast-growing broiler breed to a slower-growing breed resulted not only in improved welfare, but also lowered antibiotic use.[132]

Immunosuppression and pathogenic transmission

Environmental stressors and intensive genetic selection for fast growth and large musculature places immense physical strain on modern broiler chickens and causes changes in their immune systems.

The constant stress broilers chickens experience leads to decreased appetite and growth as well as greater susceptibility to diseases and infections.[133]

For instance, broiler chickens are frequently exposed to gastrointestinal pathogens on the farm, where stress and immune system changes can interact to increase the likelihood of serious disease. In a study that subjected one group of chicks to cold stress and another group to normal temperatures, chicks in the stressed group had high corticosterone levels and demonstrated significant immune system suppression. The study concluded that early exposure to stressors in chicks leads to long-term immune cell dysfunction. Immune system changes also allowed microorganisms like Salmonella to move more easily from the gastrointestinal tract to systemic circulation.[134]

Photo: Animal Equality

This can increase the risk of serious illnesses like septicemia. Another consequence of stress is the release of catecholamines, such as norepinephrine, from nerve terminals in the gastrointestinal tract. These hormones can promote both the growth and virulence of pathogenic bacteria in the gut, like Campylobacter jejuni.[135]

Overcrowding

Overcrowding is another stressor that impacts immune function and leads to increased rates of sickness and death. Musculoskeletal disorders, particularly in the legs and feet, as well as abnormal behavior was associated with overcrowding.[136] High stocking densities have been found to decrease the relative weight of the bursa of Fabricius, an organ critical for normal B-lymphocyte development in chickens, and this finding can be linked to possible immune suppression.[137]

Stress from overcrowding also activates the HPA axis, stimulating the release of corticosterone and proinflammatory cytokines that can compromise the intestinal immune barrier in the mucosal lining of the intestines. Crowded conditions increase the likelihood that a chicken will encounter a harmful pathogen, and when the integrity of intestinal immune function is damaged, pathogenic bacteria can infiltrate and cause inflammation in the gastrointestinal tract. This not only enhances disease susceptibility, but also decreases nutrient absorption from food. These interactions become even more serious in overcrowded chickens who exhibit decreased appetites and slowed growth. In one study, Salmonella was observed in high numbers in the livers of chickens kept in high stocking densities. Lower immune cell activity and immunoglobulin levels were also noted in these chickens, which may have contributed to the prevalence and severity of Salmonella infections observed.[138]

Poor air quality

Air quality is an important factor that influences the stress levels, health, and welfare of broiler chickens. In commercial production systems, thousands of birds are kept indoors in crowded barns. An absorbent substrate called litter is spread on the floor to soak up wastes, but the litter is not changed until the entire flock is transported to slaughter. Then, once the barn is emptied of birds, the litter is disposed of and new litter is spread on the floor to prepare for the next group of broiler chicks. As a result, chickens are forced to live in unsanitary conditions where excrement accumulates. Damp and dirty litter contributes to pressure sores, skin infections, and footpad dermatitis, particularly in heavier birds. The buildup of uric acid and feces releases ammonia and hydrogen sulfide–noxious gasses that have a number of negative health effects and can be life-threatening in some circumstances. Ammonia levels are affected by wet litter and ambient temperatures, and hydrogen sulfide is produced when the waste is broken down anaerobically.[139]

Exposure to high concentrations of these gasses is commonplace in broiler productions, and their overall toxicity depends on length of exposure, concentration of the gas, genetics, and management. Harmful concentrations affect growth rates, nutrient absorption, and immune function.[140] Ammonia and hydrogen sulfide also impair the nervous, cardiovascular, and respiratory function of chickens and can lead to abnormal behaviors.[141,142,143]

The respiratory system is most affected by these gasses. Ammonia can damage tracheal tissue and impair normal immune defenses in the trachea, creating conditions conducive to the invasion of respiratory and other pathogens.[144] Chickens exposed to high levels of ammonia are more susceptible to Newcastle disease virus[145] and E. coli infections.[146] Ammonia also affects the bursa of Fabricius, where oxidative stress and cell death can decrease immune function. Chickens exposed to these gasses may also have persistent systemic inflammation.[147,148]

Photo: Animal Equality

Conclusion

Millions of chickens raised for meat die before they reach the slaughterhouse due to inhumane culling practices, infectious diseases, husbandry and management practices, and noninfectious diseases related to breeding.

Over the course of their approximately seven-week life cycle, chickens experience multiple and cumulative stressors, including unsuitable environments, intensive genetic selection for abnormally rapid growth, overcrowding, and exposure to toxins and pathogens. These factors can interact with the immune systems of birds, beginning at hatch, to make them more susceptible to disease and death. Pre-slaughter mortality rates and causes are generally indicative of the profound welfare and health issues affecting chickens in the meat industry.

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