

Article

Zoonoses Transfer, Factory Farms and Unsustainable Human–Animal Relations

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Abstract: Infectious diseases are rooted in unsustainable and unjust human–animal relationships. Zoonoses are facilitated by human proximity to animals, epidemiological risk embedded within factory farms, and exploitation of animals and humans in these intensive livestock production systems. The five major categories of epidemiological risk that factory farms propel include: intensification of production for which homogenous populations are congregated, creation of multi-species farms for which different animals are held within the same farm, long and intensive animal transport increases the likelihood of interaction with other wildlife, ecological characteristics of the pathogen lead to altered pathogen dynamics and antibiotic resistance within a human population through the overuse of antibiotics. Layer and broiler operations in the North American context illustrate these linkages. One Health is offered as a concluding conceptual and aspirational frame for pursuing a more sustainable and just world. This article offers two main messages. First, our relationships with animals directly impact the health of human populations through the transmission and creation of Emerging Infectious Diseases (EIDs). Second, adopting One Health offers a means forward for more just and sustainable human–animal relations and reduction of zoonoses transmission.

Keywords: infectious disease; livestock production; poultry; One Health



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1. Introduction

Since the 1970s, approximately 40 infectious diseases have been discovered, with over 70% of these borne by zoonoses or transferred from animals to humans, including Severe Acute Respiratory Syndrome (SARS), Middle East Respiratory Syndrome (MERS), Ebola, Avian Flu, Swine Flu, Zika, and SARS-CoV-2 (COVID-19) [1–3]. The World Health Organization warns that infectious diseases are emerging at rates not seen before [4]; they will arise more frequently and with greater velocity in the future [5–7]. Dynamics between wildlife, livestock, and our changing environment are exacerbating this scenario [8]. Specifically, habitat destruction, illegal wildlife trade, and intensive livestock production bring animals in close and vulnerable proximity to humans. It is within these human–animal contact zones that pathogens can flourish and evolve into zoonoses. In turn, as experienced during the COVID-19 pandemic, such novel diseases wreak havoc upon human and nonhuman lives alike [9].

This paper argues that zoonotic diseases are rooted in unsustainable and unjust human–animal relationships. It highlights intensive livestock production (aka factory farms) as a primary driver of zoonoses-based infectious disease [10–12] as it draws humans into proximity to, and exploitative relationships with, animals. The paper highlights the poultry industry in Canada and the United States as an illustration of how humans, animals, and the environment are trapped in a feedback loop of exploitation, providing an opportune breeding ground for infectious disease and inhumane exploitation of animals and humans who are mechanised, harmed, and devalued in the process. Based on the literature involving human–animal relations, zoonotic diseases, factory farming, and both human and animal workers, we sought to explore how these board topics related to

one another. While those were keywords searched in databases such as Google Scholar, JSTOR, and EBSCO, there were pervasive overarching themes such as human–animal relationships, epidemiological risk, exploitation, and emerging infectious diseases that formed the foundation of this work. The paper is organised as follows: first, it explores infectious diseases as facilitated by human proximity to animals; second, it explores factory farms as sites of epidemiological risk; and third, it explores animal and human exploitation as a root of zoonoses transfer. It concludes by offering One Health as a conceptual frame through which to understand these linkages and an aspirational frame through which to pursue just and sustainable human–animal relations vital for healthy people, animals, and the planet.

2. Zoonoses Facilitated by Human Proximity to Animals

Infectious diseases are a direct result of human–animal proximity [10]. A historical overview demonstrates that many diseases affecting humans have zoonotic origin from animal reservoirs that occurred in the recent past, including H1N1 Influenza, Swine-origin H1N1, H5N1, SARS-CoV, MERS-CoV, and SARS-CoV-2 [10,13–16]. These viruses have emerged, given human interactions with and dependence on animals for food and agricultural production.

For example, the H1N1 Influenza of 1918, identified as the most catastrophic infectious disease event, arose from avian influenza [12,17]. It infected half of the global population, ultimately killing more than 50 million people [13,17–19]; a further one million people later died from encephalitis lethargica, which was regarded as a direct consequence of brain damage from the virus [19]. H1N1 was thought to have originated in farm animals, whereby the virus jumped from domestic fowl to humans. Swine-origin H1N1 was first identified in Mexico in 2009 and was declared a phase five pandemic after it quickly spread to 74 nations [5,17,20,21]. Notably, between 2005 and 2009, 12 human cases of infection emerged in factory farm settings and subsequent infection of slaughterhouse workers [22]. This is thought to be linked directly to the proliferation of American livestock production operations moving to Mexico following the installation of the North American Free Trade Agreement (NAFTA) and attractiveness of lesser labour costs and fewer environmental regulations [17,23].

H5N1 emerged in Hong Kong as a highly pathogenic form of avian influenza, which resulted in high mortality rates in poultry [24]. The 2003–2004 epidemic exemplifies the profound effects of transmission from smallholder production units of poultry to higher-density units [25]. Millions of birds were killed owing to the combination of mammalian diversity within commercial poultry operations, contact with wild birds, and the conditions within which poultry were held [26,27]. By 2007, there were 167 human fatalities reported in 12 countries [27]. H5N1 continues to pose a significant threat to public health. H5N1 has a case fatality rate ranging from conservative estimates of 14 to 33 percent to as high as 60 percent and continues to be grounded in human contact with infected birds [28–31]. It is believed to be a few mutations away from transmitting effectively from humans to humans, posing a concern to the proliferation of another pandemic [19,26], particularly should confined spaces and animal diversity in intensive farming contexts continue [19,27].

Coronaviruses, including SARS-CoV, MERS-CoV, and SARS-CoV-2, are a group of viruses causing mild to severe respiratory infections in humans [32,33]. Severe Acute Respiratory Syndrome (SARS) emerged in China in 2003, originating in close confines of wet markets that facilitated transmission from Horseshoe bats to masked civet cats and then spreading to humans [32–35]; SARS spread to 26 countries, infected some 8000 people, and resulted in 774 deaths [34]. Middle East Respiratory Syndrome (MERS) emerged in Saudi Arabia in 2012, again originating in bat populations which transmitted to dromedary camels and ultimately to humans, given the dependence on these animals as transport; MERS caused fatal respiratory illness, infecting 2468 people and resulting in 851 human fatalities [36,37]. The most recent coronavirus, namely SARS-CoV-2, which causes the disease known as COVID-19, also causes severe acute respiratory syndrome. Rooted in a

genetic sequence of more than 200 coronaviruses, COVID-19 reflects a new manifestation of multiple existing coronaviruses [33,38]. COVID-19 emerged in 2019 in China through transmission from bats in wet markets [32,33,38].

Beyond these specific examples, many other infectious diseases with zoonotic origin stem from human interactions with and dependence on animals, including Ebola, West Nile Virus, Nipah, Hendra, Eastern Equine Encephalitis (EEE), Western Equine Encephalitis (WEE), Venezuelan-Equine Encephalitis (VEE), Rabies, Avian Infectious Bronchitis, Porcine Epidemic Diarrhoea, Swine Acute Diarrhoea Syndrome (SADS), and Bovine Spongiform Encephalopathy [2,32]. Indeed, human proximity to animals in spaces such as food markets and agricultural production sites are central to the origins and transmission scenarios of zoonotic disease. This, in turn, is exacerbated by mobility (globalised trading of animals), urbanisation (human encroachment and development in wild areas), and environmental change (land change processes that are bringing animals closer to urban developments), creating a transmission network that establishes pathogens to spread across the globe [32]. As such, human proximity to animals is a substantive catalyst of zoonoses transfer.

3. Factory Farms as Sites of Epidemiological Risk

With many infectious diseases rooted in human dependence on animals for food and agricultural production, the dynamics of this relationship are important to unpack to mitigate and ideally lessen zoonoses transfer between animals and humans. One such avenue to highlight is the role that industrial livestock production plays in the creation and risk of virus mutation, transmission, and proliferation of zoonoses. Specifically, factory farming heightens the risk of new versions of existing viruses emerging and disseminating [12,39]; in turn, exploring this avenue reveals that animal and human exploitation are at the root of Emerging Infectious Diseases (EIDs). According to the United Nations report Preventing the Next Pandemic [32], agricultural intensification practices are believed to have caused more than 50% of zoonotic infectious diseases that have emerged in human populations. Factory farming thus manifests tangible public safety risks that, if continued to go unnoticed and unchanged, will result in increased pandemics and viral strains of EIDs [32].

Factory farms are large-scale facilities that centralise and intensify animal rearing, espouse productivity and efficiency, and focus on producing vast quantities of meat and animal products at the fastest rate possible [40–42]. These operations contain, at one time, more than 1000 beef cows, 700 dairy cows, 10,000 pigs, and 30,000 laying hens or ducks [41]. Concentrated Animal Feeding Operations (termed herein as CAFO) predominance in the food chain has intensified, given escalating demand for meat and animal products as part of global diets. Intensified livestock production facilitates human proximity to animals on a globalised scale and poses significant health risks [43].

The specific epidemiological risks manifested consequently in factory farms are five-fold. First, factory farms focus on productivity intensification, whereby they present an extensive, homogenous host population that is concentrated in a limited space and increasing the potential for viral transmission [15,44]. Second, factory farms may crowd together animal populations from multiple species, thus creating conditions for viral mutations that are more transmissible to humans; the lack of ventilation and sunlight increases the virus survival, enabling the potential and susceptibility of immunosuppressed animals to become infected [45]. Third, animal transport to and from factory farms increases the likelihood of interaction with wild animals, whereby external parasites (i.e., parasites that are currently attached to wildlife) or diseases (from wildlife such as rabies) may combine with other viral strains [32]. Fourth, ecological characteristics of a pathogen (such as geographical location, habitat, season, weather, and viral genetic composition) can alter pathogen and host dynamics in meaningful ways. These characteristics are thus key elements in play when transporting animals to slaughter due to the ability and propensity of pathogens to mutate and shape into more powerful pathogens [2]. Fifth, antibiotic resistance increases human susceptibility to zoonoses transfer. What is important is to

examine how factory farms offer the conditions through which humans can ingest antibiotic-resistant bacteria directly by handling antibiotics offered to animals or indirectly through consuming meat, animal-fertilised crops, or water sources that contain antibiotics [46]. Thus, factory farms are the mechanisms through which zoonotic disease risk is proliferated.

To illustrate these risk scenarios, consider the outbreak of the highly pathogenic avian influenza H5N1 disease in poultry from 2002 to 2004, which was unprecedented in geographical extent and in its transmission to humans [30,31]. First, H5N1 was facilitated by a marked transition from smallholder poultry production in 1980s Hong Kong to higher-density units by the early 2000s [5,29]. This intensification of production meant that up to 400,000 birds could be housed per square kilometre and some 150 to 200 chicken farms had the combined capacity to supply 3 million chickens (equating to about 20% of the poultry consumed in Hong Kong) to retail markets per year [25,47]. Second, high bird concentrations facilitated the spread of the virus through a homogenous commercial broiler chain, as well as mixed species operations of poultry and swine [15,47]. The highest risk was posed by smallholders and commercial units coexisting in a space which acted as an interface for the easiest transmission of infection [15]. Third, transport from commercial operations to live poultry markets facilitated zoonoses transfer pathways [15,47,48]. Moreover, the intermingling of chickens within farming areas where ducks, quails, and pigeons were also reared, as well as markets where imports from Southern China appeared, increased the potential exposure of chickens to other domestic and wild animals [26,47]. Fourth, H5N1 is highly pathogenic—this innate ecological characteristic means that once it develops and infects poultry, widespread transmission and mortality occurs [49]. While only a few cases of human fatalities occurred, it has been noted that an increased risk of mutations via bridging species such as pigs is possible that could allow widespread human transmission [26,50]. Fifth, human antibiotic resistance from ingesting poultry is a real concern; once antibiotics are ingested via the consumption of poultry, the resistant bacteria settle in the human intestine and spread throughout the human body, threatening the efficacy of treatment for bacterial infections [51]. In short, H5N1 emerged from factory farms, which offered ideal epidemiological risk conditions for its transmission.

4. Animal and Human Exploitation as a Root of Zoonoses

In addition to the epidemiological risk presented by industrial livestock production, it is important to acknowledge that industrial livestock production is rooted in the oppression and exploitation of animals [52,53]. Infectious disease transfer and associated threats to public health can then be mitigated through changes in human relationships with animals. Specifically, human dependence on animal meat and other foodstuffs is facilitated by devaluing animals' lives and relegating humans as superior to, and in constant control of, animals [52–55]. This is clearly illustrated through poultry production in the United States, which elevates practices of farming that are detrimental to animal wellbeing [56–61].

Chicken exploitation is inherent in factory farming layer (egg) operations in the United States and Canada. Male and female chickens are separated into economically profitable and valueless groups starting at birth [62]. The male chicks (valueless group) are disposed of, often by way of plastic bag or grinder [62]. Female chicks, as the economically profitable group, move through the system with two rounds of debeaking without anaesthesia [54,56,60,61]. Beaks are removed without anaesthetic to avoid birds maiming or killing each other within the high-stress, overcrowded conditions of factory farms [54,60,61]. Chickens are then forced into cages, approximately 12-by-20 inches in size. This wire-bottom cage contains at least five to ten chickens, rendering them effectively immobile with limited ability to extend their wings, move around the cage, or pursue natural behaviours such as dusting [54,56]. Their food and water intake are regulated, such as their free will to nourish themselves is curtailed [56]. Their faeces are excreted onto the floor beneath the cage, exposing them to high concentrations of ammonia and leading to mass respiratory health issues amongst chickens [54,63].

Chicken exploitation is also inherent in factory farming broiler (meat) operations. The United States is a global leader in the broiler industry, producing approximately 41.6 billion pounds of chicken [64], which is loosely regulated, given poultry exemptions to animal welfare laws [65]. All aspects of chicken lives—feeding systems, water access, temperature, lighting—are automated and controlled for economic efficiency [66]. Growth-promoting drugs stunt chicken abilities to move, given their body weight is too great for their legs, and prompt tibiotarsal bone disorders and ascites cardiopulmonary challenges [67–69]. Once ideal weight is reached, chickens are transported to slaughter: this involves being caught by their feet, wrestled into shallow containers, and denied food and water [65,70,71]. The transport itself generates high stress amongst chickens with limited ventilation, extreme temperatures, and overcrowded conditions; many perish before arrival [72,73]. Broilers experience slow death: they are hung, oftentimes fully conscious by their feet, throats cut to drain their blood, and shackled to a conveyor belt in darkness, after which a hot water bath facilitates feather removal [65,73].

While intensive layer and broiler operations are sites of animal exploitation [54,56,57,59,60], they also feature exploitation of human labourers who are exposed to bodily harm, excessive and unnecessary risk, and lack of protection [74–77]. The work is physically and emotionally demanding, with workers grabbing chickens, hanging them from conveyor belts, slashing their throats, and deboning carcasses [75,78–81]. Workers receive little training or safety equipment and work overtime without proper compensation [77,79]. Notably, workers facing these precarious labour conditions are primarily immigrants and those in low socioeconomic brackets whose options for employment are limited [77,81].

The exploitation of human labour increases the prevalence and susceptibility of zoonoses transfer from chickens to human workers [15,82,83]. Myriad examples exist of avian influenza outbreaks in industrial poultry farms around the world: Australia in 2010 where two workers contracted A (H10N7) (see [84]); two cases of A (H7N3) in 2004 in British Columbia (see [85]); two cases of A (H7N3) in Mexico in 2012 (see [86] for more); a further six people were diagnosed with A (H3N2) and nineteen cases of A (H7N7) in the Netherlands (see [87] for more). Many argue that poultry workers should be included in influenza control plans focused on the decreased risk of generating novel viruses within factory farms, the risk of workers acting as a bridging population of influenza viruses that can transmit to other species, and the threat of workers to act as accelerants of pandemics within their communities [88,89]. Although the literature points to worker sanitation and hygiene as contributing factors in outbreaks resulting in factory farms, the larger enterprise of that farm breeds in heightens risks that are of importance. Often, it results from time constraints imposed by the factory farm management; workers are unable to maintain sanitation practices. Rather than imposing liability onto the workers, who already bear the consequences of outbreaks within and outside of farms, the focus should be on highlighting how injustices and exploitation situate workers and humans at disproportionate risk and cruelties.

5. Conclusions

This paper argues that emerging infectious diseases are rooted in unsustainable and unjust human–animal relationships. As an illustration, layer and broiler factory farm operations are drivers of zoonoses transfer as sites of intensive animal–human proximity within the context of human dependence on animals for food and agricultural production. Along with this epidemiological risk comes the intensive exploitation of both animals and humans, who are mechanised, harmed, and devalued in the process. In short, then, factory farms are sites of intensive animal and human exploitation that create prime conditions for epidemiological risk via zoonoses transfer.

Such dynamics are best understood through the interdisciplinary framework of One Health, which illuminates the inextricable and, indeed, unsustainable interconnections of animals, humans, and the broader ecosystem. The One Health concept focuses on consequences, responses, and actions at the animal–human–ecosystems interfaces, especially in

terms of emerging and endemic zoonoses [90]. One Health recognises that sustainability can only be achieved by reducing risks from interfaces of human–animal ecosystems to foster a healthier relationship between animals and humans [91]. Said differently, necessarily improving the wellbeing of animals means improving the wellbeing of humans (and vice versa) and the environment upon which all depend (Figure 1).

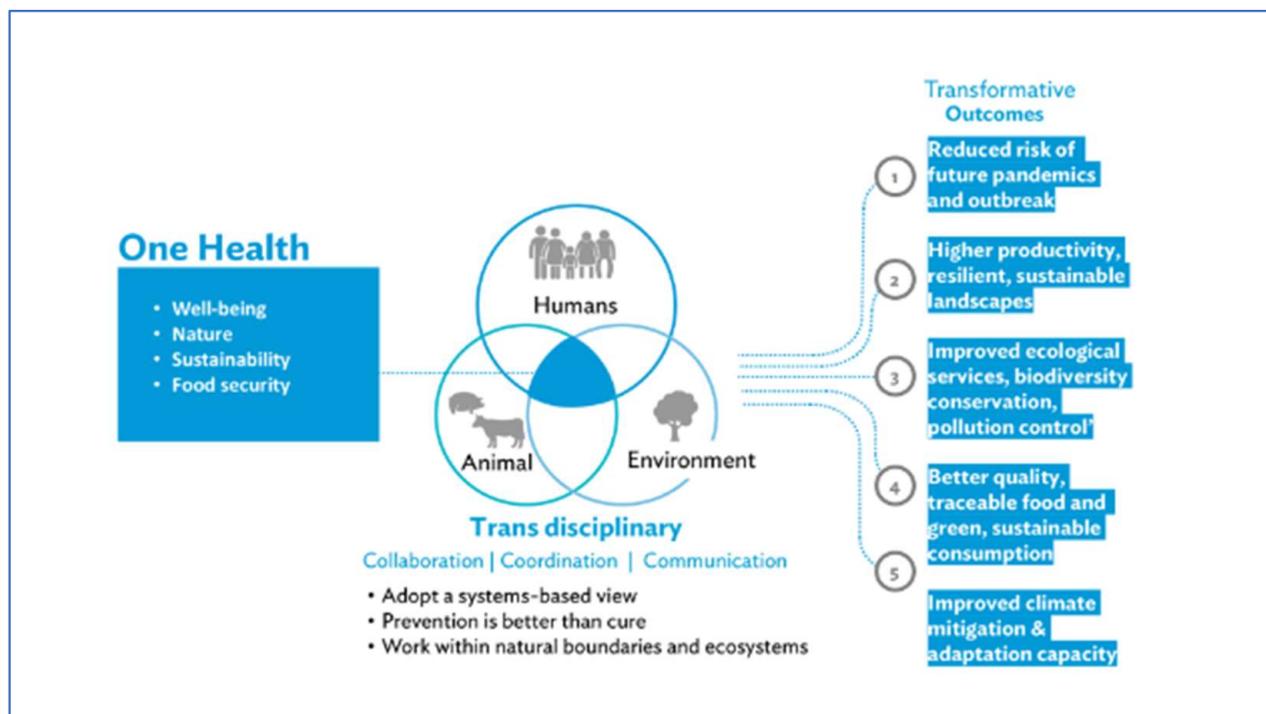


Figure 1. The One Health Model [92].

In terms of intensive livestock production, One Health may be achieved by improving the conditions and reducing risks within factory farms and ultimately by removing factory farming from the global food system given that it undermines efforts for shaping a just and sustainable future. Tenets of One Health espouse the need for a harmonious balance between human–animal interactions and the responsibility of humans to change behaviour and adopt approaches that recognise the importance of animal welfare [93]. As noted by Urbanik and Hovorka [9], the recent COVID-19 pandemic has brought forward concerns about intensive livestock production and human consumption of animal products. Scientists increasingly agree that zoonoses acceleration being driven, in part, by increasing human demand for animal protein and unsustainable agricultural intensification [32]. Recent calls urge attention to uniting animal, human, and environmental health—fully compromised in contemporary factory farming—as essential for preventing the next pandemic [32].

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Informed Consent Statement: Patient consent was waived due to the fact that we reviewed pre-existing literature on human exploitation which didn't use a particular persons experience. Rather,

we explored common themes to explore and highlight those realities within and amongst factory farms in the United States and Canada.

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