

**MEDICAL EDUCATION**

**What Should Health Professions Students Know About Industrial Agriculture and Disease?**

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**Abstract**

Concentrated animal feeding operations (CAFOs) perpetuate deforestation, biodiversity loss, pollution, and climate change; increase risk of zoonotic disease transmission and antimicrobial resistance; and exacerbate environmental and health injustice. Risks CAFOs pose to human health demand the attention of clinicians and those who teach them, since they have duties to respond with care to patients and communities where health is undermined by CAFOs' presence.

**Industrial Agriculture and Health**

As the global population continues to increase, totaling 8 billion people in November 2022,<sup>1</sup> there is a growing trend toward industrial-scale farming in order to feed everyone. Yet industrial agriculture also poses serious risks to environmental and human health. Of particular concern is intensive livestock production, known as concentrated animal feeding operations (CAFOs). Thirty percent of all land in the world and 70% of all agricultural land is used in livestock production.<sup>2</sup> CAFOs contribute to increased risk of zoonotic disease, antibiotic-resistant bacteria, climate change, deforestation, biodiversity loss, environmental pollution, and environmental injustice and health disparities.<sup>2,3,4,5</sup> *Environmental injustice* refers to specific groups' and communities' disproportionate **exposure to environmental harms**, as well as their unequal protection under the law, regulations, government programs, and policies that simultaneously impact both human health and the environment.<sup>6</sup> Considering the many risks that CAFOs pose to human health and the accompanying ethical concerns that CAFOs raise with respect to health equity, it is important for physicians to understand these risks and the ethical responsibilities these risks entail.

**Zoonotic Disease**

Industrial animal farming increases the risk of emerging infectious diseases.<sup>3</sup> Approximately 75% of emerging infectious diseases are zoonotic in origin, the majority of which have been linked to environmental change and the growth of CAFOs.<sup>4,5,7</sup> Intensive animal farming is a primary driver of large-scale land use change that often leads to losses in biodiversity, or replacing natural biodiversity with a dense population of a single species with low genetic diversity.<sup>4,7</sup> Loss of biodiversity can increase the risk of pathogen spillover, as increasing livestock population size and density, as well as high

levels of genetic similarity among livestock, can facilitate pathogen transmission and mutation.<sup>8</sup> As more natural ecosystems are converted into agricultural land, interactions among humans, domesticated animals, and wild animals will increase, further increasing the risk of pathogen spillover from one population to another.<sup>8</sup>

### **Antimicrobial Resistance**

Each year, over 2.8 million antibiotic-resistant infections occur in the United States, causing roughly 35 000 deaths.<sup>9</sup> The primary driver of antibiotic resistance in humans is the widespread overuse of antibiotics.<sup>9,10,11</sup> CAFOs greatly contribute to the emergence of antibiotic-resistant bacteria because approximately 80% of all antibiotics sold in the United States are used in animal agriculture, and about 70% of these are medically important for human medicine.<sup>10</sup> Antibiotics are widely used in livestock farming for disease treatment and prevention as well as growth promotion and improved feed conversion efficiency.<sup>11</sup> While antibiotic use in chickens in the United States decreased 70% between 2013 and 2017 as a result of falling consumer demand, US Food and Drug Administration policy, and state regulations, the use of antibiotics in the cattle and hog industries is still exceedingly prevalent.<sup>9</sup> In one study of watercourses downstream of hog CAFOs in North Carolina, researchers found at least 1 antibiotic resistant bacterial gene in 100% of water samples and at least 3 antibiotic resistant genes in 92% of water samples.<sup>5</sup> The excessive use of antibiotics in animal agriculture can result in antibiotic pollution because though “the half-life of antibiotics ranges from hours to hundreds of days,” antibiotic residues can last much longer.<sup>12</sup> Many of these residues are contained in animal waste, which can contaminate the environment and act as a reservoir for the mixing of genetic elements, leading to new antibiotic-resistant bacteria through genetic exchange mechanisms or mutations.<sup>12</sup>

### **Climate Change**

Agriculture is one of the largest contributors to climate change, while also being one of the economic sectors most at risk from it.<sup>13</sup> Climate change has been associated with a wide range of **detrimental health effects**, including “increased respiratory and cardiovascular disease, injuries and premature deaths related to extreme weather events,” increased risk of hunger and malnutrition, increased prevalence of foodborne and waterborne illnesses, and adverse effects on mental health.<sup>14</sup> It is estimated that, in 2015, global food systems contributed to 34% of total anthropogenic greenhouse gas (GHG) emissions<sup>15</sup> and that, today, food systems may account for as much as 40% of all GHG emissions.<sup>13</sup> Livestock systems account for the majority of these emissions, making up 57% of all food system GHG emissions.<sup>5</sup> In addition to carbon emissions, livestock systems are emitters of other GHGs, such as nitrous oxide and methane, the latter of which is particularly significant because it has 23 times the global warming potential of carbon dioxide.<sup>2</sup> Animal agriculture is the second largest contributor to human-made GHG emissions after fossil fuels and, as mentioned, is also a leading cause of deforestation and environmental pollution, all of which contribute to climate change.<sup>16</sup>

### **Water, Air, and Soil Contamination**

CAFOs are a major source of environmental pollution. Fertilizers and pesticides used to grow feed crops often run off cropland, polluting surface waters and groundwaters. Excess nitrogen from chemical fertilizers can lead to harmful algal blooms that can affect drinking water and cause hypoxic dead zones in which aquatic life dies off due to reduced levels of oxygen in the water.<sup>17</sup> CAFOs also produce immense amounts of animal waste that is typically collected in large, open pits called lagoons. These lagoons

allow nitrogen, phosphorous, ammonia, methane, hydrogen sulfide, heavy metals, antibiotics, and microorganisms to enter the soil and contaminate surface water and groundwater and even the air.<sup>16,17,18</sup> In fact, CAFOs are considered sources of water pollution by the Environmental Protection Agency,<sup>18</sup> which reported in 1998 that farming accounts for 70% of the pollution in US rivers and streams, affecting more than 173 000 miles of waterways.<sup>19</sup> While many pesticides used in commercial agriculture, including for animal feed crops, have not been tested for their toxicity, approximately a third are classified as highly hazardous to human health, wildlife, or ecosystems.<sup>5</sup> Such pesticides are known to increase the risk of cancer; disrupt the body's reproductive, immune, endocrine, and nervous systems; and suppress the immune system.<sup>19</sup> Additional health risks caused by pollution from CAFOs include respiratory diseases, exposure to food-borne pathogens, and the emergence of antibiotic-resistant bacteria.<sup>19</sup> Individuals most at risk are those who work at and live near CAFOs.<sup>18</sup>

### **Environmental and Health Injustice**

Because individuals who work at and live near industrial farms are more likely to come from low-income communities of color, CAFOs directly contribute to health disparities, environmental injustice, and **environmental racism**.<sup>20,21</sup> Studies show that people living near CAFOs—who tend to be people of color with low income, irrespective of population density—are at elevated risk of developing respiratory symptoms, headache and nausea, neurobehavioral symptoms, and psychological impairments due to exposure to contaminants released by CAFOs.<sup>20,21</sup> Pregnant women and children are particularly susceptible to such risks. Workers in US factory farms face additional burdens, as they earn low wages with few benefits and have little, if any, job security. Moreover, because farm workers are exempt from both the Fair Labor Standards Act and the National Labor Relations Act, they regularly face systematic human rights violations with few protections and little legal recourse.<sup>16</sup> Reports show that food system workers experience high rates of occupational injuries, illness, and mortality.<sup>22</sup> Meat processing, in particular, is “one of the most dangerous jobs” in the United States, as meat processing workers are more than 3 times as likely as the average worker to suffer serious injuries while working—including an average of 2 accidental amputations per week.<sup>16</sup> Approximately 25% of CAFO workers also suffer from at least one serious respiratory problem, such as chronic bronchitis, sinusitis, nonallergic asthma, or organic dust toxic syndrome.<sup>2,18,21</sup>

### **Physician Duties**

Physicians have an ethical responsibility to educate themselves about the impacts that CAFOs can have on human health—including increased risk of emerging zoonotic diseases, antibiotic-resistant bacteria, and health-related conditions stemming from climate change and environmental pollution, all of which disproportionately burden low-income communities of color—and to work within their practices to minimize and **address these impacts**. Physicians working in rural communities in particular should familiarize themselves with the health effects of CAFOs among industrial agricultural workers and community members living nearby.<sup>18</sup> More broadly, physicians should communicate with patients about their jobs and work-related risks and be cognizant of the main industries operating in the area. Patients known to work at CAFOs should be monitored for viral and antibiotic-resistant bacterial infections, as they are at severe risk for such diseases.<sup>3,18</sup> Physicians' ethical responsibility of antibiotic stewardship should extend beyond limiting the prescription of antibiotics. Physicians should educate patients about antibiotic resistance, advocate for decreased use of antibiotics in livestock farming, and lobby their own hospitals and health care institutions to only purchase meat raised without the use of nontherapeutic antibiotics.<sup>9,10</sup> As consumers,

physicians can also choose to consume less meat and only purchase meat that is sustainably raised without the overuse of antibiotics. Physicians' ethical duty to inform patients of known health risks and to help manage those risks extends to risks posed by CAFOs. Because CAFOs are a large part of the modern food system, the health risks they pose also highlight how physicians' ethical responsibilities extend to their role as consumers. To better care for patients—and themselves—physicians have a duty to learn about the health risks associated with our food system, inform patients of those risks, and advocate for policy changes to minimize those risks.

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