

**Do Poultry CAFOs Contribute to Negative Human Health
Outcomes: A Systematic Review**

by
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ABSTRACT

PERRY, JOANNA TRAYNOR. Do Poultry CAFOs Contribute to Negative Human Health Outcomes: A Systematic Review(Under the direction of Dr. Ayse Ercumen).

Introduction: Concentrated food animal production (CAFO) facilities are a source of environmental and human health hazards. Despite the growing evidence that CAFOs present health and environmental risks to both farm workers and proximate communities, CAFO regulations and their enforcement have not adequately protected human health and the environment (Sciablabba, 2022). To our knowledge there have been no comprehensive literature reviews focusing on poultry CAFOs and human health outcomes since 2015. Previous literature reviews primarily focused on swine or livestock CAFOs with very little to no focus on poultry. Therefore, we reviewed the literature published between the years of 2015 and 2023 identifying health outcomes associated with working on or living near poultry CAFOs: respiratory outcomes, gastrointestinal outcomes and community or public health outcomes. **Methods:** We developed a list of search terms that covered synonyms for (i) concentrated animal feeding operations (CAFO), (ii) poultry, and (iii) human health outcomes of interest and then searched: PubMed, Web of Science, CAB Direct, and Agricola databases for peer-reviewed articles between the years of 2015 and 2023. **Results:** We screened the titles/abstracts of 2007 articles; 23 studies were read in full text and 12 were identified as eligible and included in this review. In 9 out of 12 studies the authors found a negative impact on human health as a result of living near or working on a CAFO. The studies reviewed identified a correlation between poultry CAFO exposure and respiratory issues, odor annoyance, presence of extended-spectrum beta-lactamases (ESBL) *E. coli* in urine samples, and evidence of antibiotic absorption. **Conclusions:** Overall this literature review found that there is a correlation between working on or being in close

proximity to a poultry CAFO and a negative health outcome. Further research examining the relationship between poultry production and human health effects on the workers and communities concentrated around these facilities is warranted.

Keywords. Confined Animal Feeding Operations * Concentrated Feeding Operation * CAFO* Poultry * Chicken * Broiler * Fowl * Infectious Illness * Human Health * Community Health

BIOGRAPHY

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INTRODUCTION

The US EPA defines Animal Feeding Operations (AFOs) as agricultural operations where livestock is fed and maintained for at least 45 days within a year, no crops or other vegetation are grown in the confinement area, and contains more than 100 animal units ([US EPA, 2024](#)): an animal unit is defined as an animal equivalent of 1000 pounds live weight which is approximately 1000 head of beef cattle, 700 dairy cows, 2500 swine, 125 thousand broiler chickens, or 82 thousand laying hens or pullets ([USDA Natural Resources Conservation Service website, 2020](#)). Concentrated AFOs (CAFOs) are AFOs with more than 1000 animal units.

It has been well documented that CAFOs can negatively impact the communities that surround them. The main public health issue associated with CAFOs comes from the amount of manure they produce (Hribar, Carrie. c2010). Depending on the size of the farm and number of animals on it, manure production can range between 2,800 tons and 1.6 million tons a year (Government Accountability Office [GAO], 2008). While human waste is required to be treated via sewage treatment plants, there is no such facility for livestock manure.

Ground application of manure is one of the most common means of disposing of it. CAFO manure contains a variety of potential contaminants. It can contain plant nutrients such as nitrogen and phosphorus, pathogens such as *E. coli*, growth hormones, and antibiotics used for animal growth (Hribar, Carrie. c2010). When overapplied, this disposal method can be problematic because the contaminants found in livestock manure can be washed away then entering the surrounding surface water or groundwater. (C)AFOs also produce emissions from degrading manure which becomes an odor annoyance and breeding ground for insects.

In the United States, rural farming has changed drastically in the last fifty years, with the increase of large-scale industrial farms into the agriculture and livestock business and the decline of small-scale, family-owned farms becoming the norm (Hall et al., 2021). The increased industrialization of agricultural operations has resulted in an overall decrease in the number of farms, but an increase in the size. For example, the number of farms in the United States fell from approximately 6.8 million in 1935 to 1.9 million in 2022, and the average farm size grew from 154.8 acres to 463 acres in the same time frame (Hall et al. 2021).

According to the [2022 USDA census](#) of agriculture, 1% of farmland is used for poultry production. Census data also show that the number of the largest chicken farms increased by 17 percent, from 6,332 farms with 500,000 or more birds in 2012 to 7,406 farms in 2022. The number of chickens, cows, pigs, and turkeys in the US food system exceeded 10 billion for the first time in the census's history — up from 5.2 billion animals in 1987 ([2022 USDA census](#)). Poultry consumption is only estimated to increase in the coming years. Following highly published environmental disasters such as the aftermath of Hurricane Floyd on the swine industry in eastern North Carolina there has been more research into the effects of working on or living near swine CAFOs, but not as much attention has been given to the poultry industry.

Due to the concentration of animals and the density of industrial farms, these operations pose threats to environmental and human health which requires more focus on these operations and their potential human health impacts. Prior literature has found a correlation between CAFO exposure and respiratory issues, gastrointestinal (GI) issues, odor annoyance, and negative mental health outcomes. This paper will explore the currently available literature in an attempt to determine what those risks are and what gaps exist in the current literature.

METHODS

Search Strategy

We developed a list of search terms that covered synonyms for (i) concentrated animal feeding operations (CAFO), (ii) poultry, and (iii) human health outcomes of interest. For a complete listing of all search terms, reference **Table 1**. Once all search terms for each category were determined, we created one comprehensive search string that combined search terms with an “OR” operator within each of the categories and an “AND” operator across the three search categories. For this literature review we searched PubMed, Web of Science, CAB Direct, and Agricola databases for peer-reviewed articles. This search was conducted in November of 2023. The references were then exported into the Mendeley reference manager and duplicate reports were removed. Remaining references were imported into Covidence systematic review software

where titles and abstracts were screened using our inclusion and exclusion criteria. Studies were included if there were any references to poultry in the literature, meaning that the study could reference animal species in addition to poultry, but it must include poultry in order to be considered for our research review. For our purposes we also included any research that involved farms of any size. Any study that did not include poultry or did not include a human health outcome was excluded. Articles short-listed based on title/abstract screening were then reviewed in full to determine eligibility.

Table 1. Database Search Terms

CAFO		Poultry	Health Outcomes
"Confined animal feeding operation*"	"Animal operation*"	Chicken	"Infectious illness*"
"Concentrated animal feeding operation*"	"Animal production"	Hen	"Infectious disease*"
CAFO	"Animal farm*"	Broiler	Infection
"Animal feeding operation*"	"Livestock industry"	Layer	Colonization
AFO	"Livestock operation*"	Turkey	Zoonotic
"Industrial food animal production"	"Livestock production"	Goose	Gastrointestinal
IFAP	"Livestock farm*"	Geese	Respiratory
"Animal husbandry"	"Feeding operation*"	Duck	"Public health"
"Animal agriculture"	"Feeding facilit*"	Fowl	"Community health"
"Animal industry"	"Confinement facilit*"		"Human health"
			"Resistan*"

Data Extraction and Synthesis

The relevant data were extracted from the full-text literature using Google Sheets. The data on study year, location, animal type(s), size of facility, definition of (C)AFO, health outcome/how it was measured, population/number of people, and research findings were extracted from the relevant literature and tracked in a Google sheet. Extracted data were qualitatively synthesized to assess poultry exposures and health outcomes.

RESULTS

We screened 2007 titles/abstracts and reviewed in full text 23 studies. Based on our inclusion/exclusion criteria, 12 studies were eligible for inclusion in this literature review. We

excluded 11 studies because they either did not measure a human health outcome or because they did not include a measure of exposure to poultry. Additional details on the review process are located in **Figure 1**.

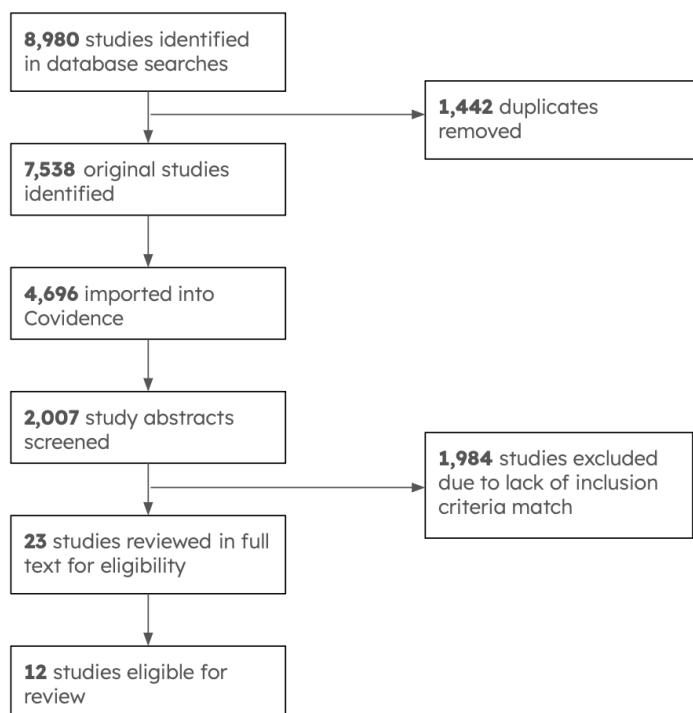


Fig. 1 Flowchart for systematic review search and screen process

Study Characteristics

The 12 studies included in our review were conducted between 2015 and 2023. Most (10) of the studies were conducted in high-income countries (8 in Europe and 2 in the United States) and 2 lower-middle-income countries (Vietnam and Egypt). Full details on study characteristics can be located in **Appendix A**.

Study Population

The majority of the studies (8) focused on chickens plus other livestock (goat, pig, cattle, mink) and 4 out of 12 studies focused exclusively on poultry (1 duck, 3 chicken). The study population consisted of 2 distinct groups: farm workers or residents that lived in close proximity to an

(C)AFO or in an area that had a concentration of (C)AFOs. The majority of the studies (8 of 12) measured health outcomes of residents of areas neighboring (C)AFOs and 4 measured health outcomes of individuals employed on a (C)AFO. The majority of the studies (3 out of 4) that focused on farm workers were located in high-income countries (France, Germany, United States) with only 1 study including workers of a lower-middle-income country (Egypt). 7 out of 8 studies involving residents in proximity to (C)AFOs were conducted in high-income countries (France, Netherlands, United States) and 1 of 8 studies involved residents of a lower-middle-income country (Vietnam).

Measurement of Poultry CAFO Exposure

In order to measure the proximity to (C)AFOs a combination of GIS and national registries were used to determine the distance between study subjects and (C)AFOs. Data on farm characteristics in the study area (location, animal type and density) were obtained from provincial environmental license databases (Hooiveld et al., 2015). Residents' addresses were geocoded and 500m radius calculated using GIS (Hooiveld et al., 2015). National agricultural surveys were used along with active farm registries with the Netherlands Food and Consumer Product Safety Authority and GIS to determine exposures in 5 distinct distance categories: 0 - 250m, 251 - 500m, 501- 750m, 751- 1000m, >1000m in another study (Hogerwerf et al., 2022). Larramendy et al. (2021) defined the geographical unit as the Area of Residence of Individuals using the same Laboratory (ARIL) (Larramendy et al., 2021). Longitudinal health data from electronic health records and longitudinal data from national registries were also used to measure (C)AFO exposures (Simões et al., 2022; Baliatsas et al., 2020). In 4 of the studies poultry exposure was measured by employment at a (C)AFO. Dang-Xuan et al. (2017) measured (C)AFO exposure by ownership of livestock and/or exposure to livestock waste (Dang-Xuan et al., 2017).

How animal density and size of facilities were measured varied across studies. For the majority of studies (10) the number of animals per (C)AFO was either undefined or a range for number of animals was provided but an exact number of animals per (C)AFO was not provided. Estimates were generated by the authors based off of publicly available data from national or state registries, or estimates were generated based off of the average number of animals processed at the facility averaged over the length of the study. In Guillam et al. (2017) the study authors did

not include how many ducks were at each hatchery, but rather the number of ducklings produced each week (Guillam et al., 2017). For the Dang-Xuan et al. (2017) study authors did not measure the number of animals but rather livestock ownership and what type of animals were farmed (Dang-Xuan et al., 2017). In Kearney et al. (2016) animal exposure was simply defined as working in poultry houses (Kearney et al., 2016). While van Dijk et al. (2016) did not specify the size of the facility or the number of animals for livestock farm exposure, they stated that their data were collected from provincial databases of mandatory environmental licenses for keeping livestock (van Dijk et al., 2016). In 3 of 12 studies, the size of the facility was undefined (Baliatsas et al., 2020; Simões et al.; vanDijk et al., 2016). In these scenarios facility size was defined by obtaining data from compulsory environmental license, Geographic Information System for Agricultural Holdings, and agricultural census data.

Health Outcomes

Health data were collected primarily via electronic medical records (EMR), lab testing, medical exams and health questionnaires. The health outcomes measured fell into 1 of 3 categories, those studies that exclusively evaluated respiratory effects of poultry exposure, studies that evaluated respiratory effects along with other body system impacts and those that focused on an alternative outcome. Half of the studies (6 of 12) focused exclusively on respiratory health outcomes, 3 studies focused on respiratory health outcomes plus additional outcomes such as gastrointestinal (GI) or mental health outcomes, and 3 of the studies examined other health endpoints (extended-spectrum beta-lactamases (ESBL) *E. coli* presence in urine samples, odor annoyance, and antibiotic exposure).

75% of the studies (9 of 12) showed a positive relationship between exposure to a poultry CAFO/AFO and negative human health outcomes. 25% (3 of 12) showed no connection between poultry CAFO/AFO exposure and negative health outcomes.

Respiratory Impacts

Of the 8 studies measuring respiratory outcomes, 5 found an increase in negative health outcomes (asthma, COVID, Chronic obstructive pulmonary disease (COPD) exacerbations, nasal irritation and cough) (Baliatsas et al., 2020; Guillam et al., 2017; Hogerwerf et al., 2022; Kearney et al., 2016; vanDijk et al., 2016) while 3 did not find a correlation between poultry exposure and negative respiratory outcomes (no decrease in lung function, no increased risk for contracting bird flu, no increase in asthma exacerbation) (Dang-Xuan et al., 2017; Gharieb et al., 2019; Simões et al., 2022).

Non-respiratory Impacts

Of the 4 studies that included additional outcomes, 1 study found a positive correlation between proximity to poultry CAFOs and increased stress due to odor annoyance (Hooiveldn et al., 2015). Another study found a positive correlation between ESBL-*E. coli* detected in urine samples for residents with community acquired urinary tract infection (UTI) and proximity to pig and poultry CAFOs (Larramendy et al., 2021). According to one of the studies there was no increased incidence of UTI associated with poultry exposure (Holcomb et al., 2022). Paul et al. (2019) found a relationship between workers' handling of antibiotics and their excretion via their urine (Paul et al., 2019).

DISCUSSION

Prior Research

Prior literature has found a correlation between CAFO exposure and respiratory issues, gastrointestinal (GI) issues, odor annoyance, and negative mental health outcomes. Previous literature reviews found that proximity to swine CAFOs puts residents at an increased risk of GI issues such as vomiting and diarrhea, especially after a heavy rain event (Quist et al., 2022). Additional literature reviews found a positive association with living near a CAFO and respiratory outcomes, methicillin-resistant *Staphylococcus aureus* (MRSA), and stress/mood (Casey et al., 2015)

Study Limitations

The primary limitation of this literature review was a general lack of studies. Of the 2007 study titles/abstracts reviewed only 12 meet our inclusion criteria. Few studies (2) were conducted in the US despite the US being a leading producer of poultry in the world and few studies (2) were conducted in a low-middle- income country. No studies were identified as being conducted in a middle income country. This is an issue in part because there is typically an environmental justice issue with industrialized farming, at least in the United States, where lower income and people of color are disproportionately impacted by (C)AFOs. The studies that were conducted in Europe were only conducted in Western Europe which may also bias some of the study results. Only 4 of the studies focused on farm workers despite the fact that farm employees have regular direct exposure to poultry. The size of the facility was not defined in 3 out of 12 studies.

Future Research

This review summarizes the results of 12 studies on the impacts of poultry (C)AFOs on human health outcomes. Future research should focus solely on poultry farms in order to have more data on health outcomes from a single species. Future studies should include a more diverse selection of countries to collect data on. There should be more middle and low income countries included, there should also be more research focused on the US.

CONCLUSIONS

Overall this literature review found that there is a correlation between working on or being in close proximity to a poultry CAFO and a negative health outcome. Further research examining the relationship between poultry production and human health effects on the workers and communities concentrated around these facilities is warranted particularly in the United States and the states that produce most of the poultry in this country such as North Carolina. Future studies should include an environmental justice component where appropriate as many CAFOs are located in communities of color and communities at an economic disadvantage. We also noted a lack of studies conducted in low-middle and middle income countries; future studies should include more diverse economies.

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APPENDICES

Appendix A - Study Characteristics

Author	Year	Location	Type of animals	Size of Facility	Definition of CAFO Exposure	List of Health Outcomes	How was the health outcome measured?	Study population/those with outcome measurement	# of People in Study	Findings/conclusions
Guillam et al	2017	Western France	Ducks	14 hatcheries, # of animals unspecified	Working at hatchery, or at specific locations (sorting rooms) within hatchery	Respiratory: Asthma, rhinitis; Dermatological: eczema	Medical examinations performed by a physician where subjects completed questionnaires and spirometry tests. Workers also wore 2 personal air samplers for 3 hours during a shift.	Hatchery workers	90	Hatchery workers were at increased risk of compromised respiratory health due to dust exposure, particularly those who work in sorting rooms. Asthma and rhinitis were in excess in this population of workers.
Hooiveldn et al	2015	Netherlands	Cattle, pig and poultry	Varies per species - Pig farms 1 - 2600+ animals; Poultry farms 1 - 39,000+; Cattle - 1 - 400+ animals	Living in the region of the Netherlands with a high concentration of AFOs. Varied distances though typically 500m radius from the AFO.	Reduced general health and increased reporting of respiratory, gastrointestinal, neurological and stress-related symptoms	Questionnaires and EMR	Neighbors of AFOs	753	The number of animals around the homes was associated with odour annoyance. Odour annoyance was associated with reduced health
Hogerwerf et al	2022	Netherlands	Cattle, goat, sheep, pig, poultry, horse, rabbit, mink farms	cattle farms (at least 5 animals), pig farms (≥ 25), poultry farms (≥ 200), goat farms (≥ 50), sheep farms (≥ 50), horse farms (≥ 20), rabbit farms (≥ 200), and mink farms (≥ 200)	Distance to the nearest livestock farm (range of distance = 0 - 1000 m)	Increased risk of positive SARS-CoV-2 infection	laboratory-confirmed positive SARS-CoV-2 test. Data extracted from national database.	2, 223, 692 residents with positive SARS-CoV-2 infections	Dutch population on January 1, 2019 excluding strongly urbanized areas - 12,628, 244	Proximity to livestock was associated with SARS-CoV-2 infection.
Larramendy et al	2021	Western France	Poultry, pigs, cattle	Mean Cattle - 59.9; Mean Pig density - 131.4; Mean poultry density - 738.3	#poultry/km ²	ESBL-E. coli rate in urine samples from individuals with	ESBL data from 92 labs where individuals with UTI presented	Residents of western France	358,291	There is a positive association between the E-Coli rate and proximity to poultry

						community-acquired UTI				density, pig density and agricultural land.
Dang-Xuan et al	2017	Vietnam	Poultry, Swine, and Other (undefined animal species)	Small scale farms # of animals per farm is undefined but total #s of animals for study participants is as follows: Swine - 296, Poultry - 327, Swine and Poultry Combined - 238, Other - 222	Livestock ownership and/or exposure to livestock waste	Respiratory - Coughing; General - Fever; Gastrointestinal - diarrhea/nausea/vomiting	Self-reported health symptoms; cross-sectional survey data collected from a subset (N = 5520) of the Chi Linh Health and Demographic Surveillance System	Residents of the Chi Linh district is in the northern province of Hai Duong, Vietnam	5520 residents who fully participated in the survey	livestock ownership does not increase risk of coughing, fever, or diarrhea/nausea/vomiting
vanDijk et al	2016	Netherlands	Undefined - poultry included	Undefined	Exposure to high density livestock farming	Asthma exacerbation; COPD exacerbation	Pharmaceutical treatment of exacerbations in COPD and asthma patients using 2006–2012 prescription data of electronic medical records. Farm exposure was assessed by comparing the study area with the control area, and with individual exposure estimates in the study area using Geographic Information System data.	COPD and asthma patients in a rural area with a high livestock density and COPD and asthma patients in a control area in the Netherlands	899 COPD and 2546 asthma patients from 15 general practices in a rural area with a high livestock density and 933 COPD and 2310 asthma patients from 15 practices in a control area in the Netherlands were included.	The exacerbation rate was higher in the study area compared with the control area in COPD, but not in asthma patients
Kearney et al	2016	North Carolina	Poultry - undefined #	Small farms with <10 employees	Working in an enclosed poultry housing facility	Eye irritation, nasal irritation, dry cough, throat irritation, phlegm when coughing, sinus trouble, headache, tiredness, skin problems, vertigo, and nausea	Spirometry, fractional exhaled nitric oxide (Feno), and an interviewer-administered questionnaire	Poultry workers	24	Poultry workers had an increased risk of experiencing eye and nasal irritation, dry cough, and phlegm when coughing. There were no dramatic decreases in predicted values of lung function, nor increased levels of airway inflammation as measured by Feno among workers.

Holcomb et al	2022	North Carolina	Poultry and Hogs	Hog density ranged from 0 to 1099 hogs/km ² ; poultry ranged in density from 0 to 39,499 birds/km ²	Proximity to poultry and/or hog farms	UTI	Hospital medical records for ED visits for UTIs (years of 2016 - 2019) within the zipcodes of interest that correlated with hog and poultry spatial densities	Rural residents of North Carolina; metropolitan areas and outer banks residents were excluded from the study. Residents from 620 mainland zipcodes were included.	6,596,383 (3,038,922 CAFO exposed individuals)	There was no association between poultry exposure and UTI incidence. Hog exposure was associated with increased UTI incidence. The higher the hog density the higher the UTI rate. Poultry was observed to reduce UTI rates relative to poultry-free ZIP codes, particularly at low poultry densities
Gharieb et al	2019	Egypt	Poultry	A total of 100 birds comprised of 50 chickens, 25 ducks and 25 wild egrets were sampled	Working on a poultry farm	AI H5N1 flu virus (bird flu)	Positive test for AI H5N1 virus	Individuals with an occupational exposure to infected poultry	65, 50 farm workers and 15 hospitalized individuals	The AI H5N1 virus was not found in the farm workers included in the study.
Paul et al	2019	Germany	Poultry	2 chicken farms; 40-50,000 chickens per farm	Working on a poultry farm	Antibiotics detected in the urine of the farm workers in the study.	Four biomonitoring campaigns monitoring systemic exposure of workers to antibiotics were run at two farms over four fattening periods. Urine samples of potentially affected employees were sampled and analyzed for the antibiotics of interest by liquid chromatography–mass spectrometry.	farm workers	5 employees	There is a relationship between workers handling of antibiotics and their excretion via their urine. Dust in animal husbandries is a potential antibiotic related health-hazard for employees due to inhalation.

Simões et al	2022	Netherlands	Cattle, Pigs, Chicken, and Mink	Undefined	Residential proximity to (intensive) livestock farming.	Respiratory system diseases, chronic lower respiratory diseases, pneumonia	Historical data was used for location of farms and registry date. The Dutch Environmental Longitudinal Study (DUELS) registry. National mortality database used as well.	Residents in rural and semi-urban areas living up to 2000m from a CAFOs	4 million residents of the Netherlands	They found adverse respiratory effects in people living near livestock farms (pig and mink). They did not find a clear pattern indicating higher risk of respiratory mortality in people living near chicken.
Baliatsas et al.	2020	Netherlands	Goat, Cattle, Pigs, Chicken	Undefined	Proximity to CAFOs	Pneumonia, asthma, COPD, upper respiratory infection, lower respiratory infection	Longitudinal health data from electronic health records	Residents in livestock dense areas	Livestock dense - 117,459 Control - 85,796	Prevalence of pneumonia, lower respiratory tract infections, and respiratory symptoms was significantly and consistently higher in the areas with high livestock density.