A systematic review of animal feeding operations including concentrated animal feeding operations (CAFOs) for exposure, health outcomes, and environmental justice

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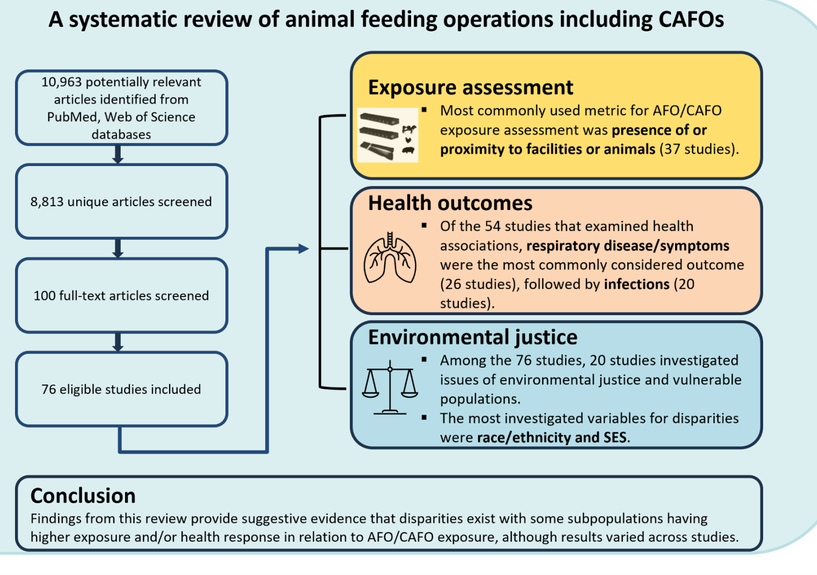
Key findings

- A relatively small number of studies investigated environmental justice (EJ) issues in relation to AFOs/CAFOs.
- Findings were inconsistent across studies, populations, exposure metrics, EJ related variables.
- The most commonly applied exposure metric was presence of or proximity to facilities or animals.
- The most investigated variables for disparities were race/ethnicity and SES.



Introduction

- Despite the growing literature on animal feeding operations including CAFOs, research on disproportionate exposure and the associated health burden is relatively limited and shows inconclusive findings.
- We systematically reviewed previous literature on AFOs/CAFOs, focusing on exposure assessment, associated health outcomes, and variables related to environmental justice and potentially vulnerable or susceptible populations.

Materials and Methods

Systematic search

- MEDLINE/PubMed, Web of Science databases for population-based studies of exposure to AFO/CAFO through 14 March 2023
- Citation screening

Selection criteria for eligible studies

- Consider exposure to AFO/CAFO and investigate exposure for human populations
- Be peer-reviewed
- Be written in English

Data extraction

- Study information: location, population, period, type, design, statistical methods, adjusted variables, main findings
- AFO/CAFO characteristics: animal type, data source, measure of exposure, exposure assessment
- Health outcomes or symptoms including physical, mental, and social well-being
- Information related to environmental justice and potentially vulnerable or susceptible populations: in relation to exposure and/or health associations, related variables, main findings

Statistical analysis

- Qualitatively summarized the findings
- Provided detailed information for each study and summarized findings using frequency and proportion of articles by study characteristics based on several criteria (e.g., study information, AFO/CAFO characteristics and exposure assessment, and EJ and potentially at-risk populations)

Results

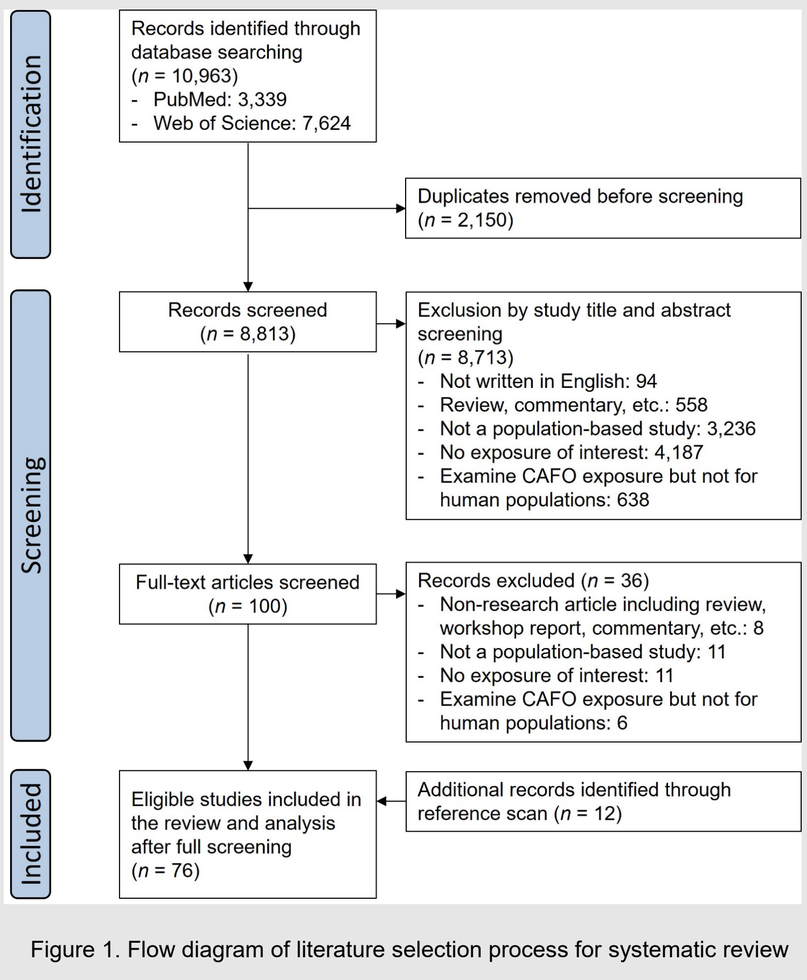


Figure 1. Flow diagram of literature selection process for systematic review

→ After initial screening of 10,963 papers, we identified 76 eligible studies.

Figure 2. Summary of study characteristics

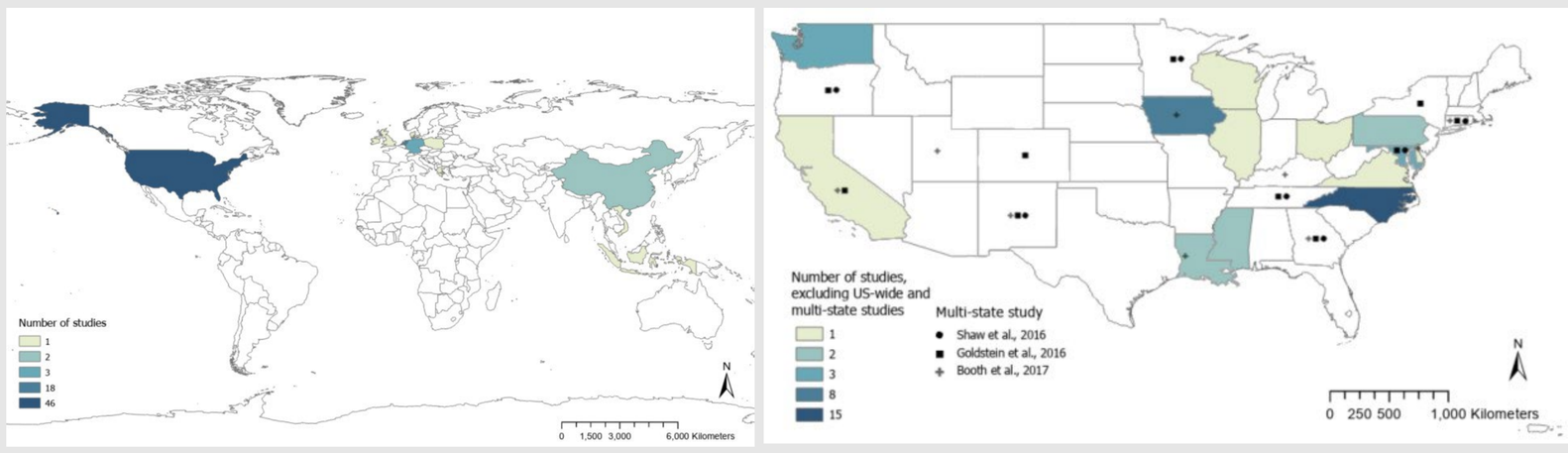


Figure 3. Spatial distribution map of published AFO/CAFO studies (A) in the world and (B) across US states

→ The most represented country was the United States (46 studies), followed by the Netherlands (18 studies).
→ Among the 46 studies conducted in the US, the most investigated state was North Carolina (15 studies), followed by Iowa (8 studies).

Criterion	Number of Studies
Health outcomes/symptoms	
Respiratory diseases/symptoms or lung function	**26**
Immune-mediated diseases	8
Infections	20
Mortality	5
Birth outcomes	4
Cancer	5
Gastrointestinal symptoms	3
Neurological symptoms	5
Mental health, quality of life	6
Blood disorder	4
Kidney disease	2
Endocrine disease	3
Digestive disorder	2
Cardiovascular disease	3
Bone disease	2
Others	3

Criterion	Number of studies
Exposure	
Air pollution	27
Water quality	2
Odor	6
Presence/proximity of facility/specific farm animals within boundaries (e.g., county), buffer	**37**
Density within boundaries, buffer	34
Other	7

	Number of studies	
	EJ and vulnerability in relation to exposure	EJ and vulnerability in relation to health association
Race / ethnicity	**13**	**5**
Low SES	**14**	**4**
Immigrant, foreign born status	2	-
Urban/rural, population density	4	3
Age (e.g., younger or older)	3	5
Sex	-	5
Health behavior	1	1
Others	-	2

→ We found differences in findings across studies, populations, the metrics used for AFO/CAFO exposure assessment, and variables related to EJ and vulnerability.

→ Of the 54 studies that examined health associations, **respiratory diseases/symptoms** were the most commonly considered outcome (26 studies), followed by infections (20 studies).

→ The most commonly used metric for AFO/CAFO exposure assessment was the **presence of or proximity to facilities or animals**.

→ The most investigated variables related to disparities were **race/ethnicity and SES**.

→ Most studies were conducted in the United States (US) (60.5%), published between 2016 and 2020 (43.4%), and examined associations between exposure and health outcomes (71.1%).
→ Among the 76 studies, 20 studies investigated issues of vulnerable populations and environmental justice.
→ Of these 20 studies, 13 evaluated exposure disparity.

Conclusions

- We observed suggestive evidence that disparities exist with some subpopulations having higher exposure and/or health response in relation to AFO/CAFO exposure, although results varied across studies.
- The findings from this review provide valuable knowledge on AFOs/CAFOs exposure assessment, health outcomes and symptoms associated with AFO/CAFO exposure, and environmental justice and vulnerability, and highlight needed areas of future research.

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