Resident Odor Reports and Differing Health Outcomes in Areas of Industrial Emission Odor, Louisville, Kentucky

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ABSTRACT

Background: Air pollution regulations have historically treated odors as a public nuisance. Participatory, or citizen science, can provide important data through systematic, mobile application-assisted odor reporting.

Objectives: This study leverages participatory public health science using the Smell MyCity app to investigate resident-reported odors and their association with census tract health outcomes in Louisville, Kentucky.

Methods: We analyzed 6,868 odor reports from 2018 to 2024 to identify census tracts where industrial and chemical odor reports cluster. Disease prevalences from the Centers for Disease Control and Prevention's PLACES data were compared between these tracts and the entire county.

Results: Results suggest associations between frequent odor reporting areas and increased health risks, highlighting the public health significance of environmental odors needing further investigation, and the importance of community-driven data collection in this field of study.

Conclusions: This community-driven reporting initiative may be a useful addition to health research in areas with high industrial emission odor.

KEYWORDS: air pollution, citizen science, community health experience, environmental health

1. Introduction

The Clean Air Act[1] does not consider olfactory properties as part of air pollutant criteria. Rather, air pollution regulations have historically treated odors as a public nuisance. In the absence of air monitoring or long-term exposure data, residents with no alternative source of air are left wondering if unpleasant industrial or chemical odors in their neighborhoods are harming them. Environmental odors may come from stationary, small area, mobile, or naturally occurring sources.[2] Community science is a powerful public health tool for real-time resident odor reporting.[3,4] Ambient odors, though typically acute and non-life-threatening, can degrade quality of life, causing symptoms ranging from headaches and gastrointestinal distress to respiratory issues and further influence perceptions of health risk.[4–6] Due to the lack of standardized and timely data about ambient odors, the extent of these symptoms, other health effects, and the possibility that these odors are indicators of specific air toxics is difficult to ascertain, given the science of olfaction versus toxicology.

The Louisville, Kentucky area had previously been the focus of the West Louisville Air Toxics Study (WLATS)[7] conducted between April 2000 and December 2005. This comprehensive air monitoring initiative occurred in response to longstanding resident concerns about air emissions from local industries by the West Jefferson County Community Task Force (WJCCTF) and Rubbertown Emergency Action (REACT) members. That work resulted in the Strategic Toxic Air Reduction (STAR) Program, which was enacted in June 2005 and aimed to reduce toxic air pollutants and address public health risks associated with industrial emissions in Louisville. Improved health outcomes have been observed in Louisville in tandem with air pollution burden reductions. For example, asthma outcomes improved following a coal power plant retirement,

retrofit, and conversion to natural gas activities.[8] Since WLATS, passive sampler measurements of volatile organic compounds in the Rubbertown industrial area have confirmed that benzene, toluene, ethylbenzene, xylene, styrene, 1,3-butadiene, and 1,1-dichloroethene concentrations remain highest closest to Rubbertown industrial operations compared with more distant areas.[9]

The goals of the project were to: (1) analyze resident-reported odors and identify geographic patterns, (2) compare disease prevalence in areas with more frequent industrial and chemical resident odor reports to the rest of the county, and (3) showcase participatory public health science as an innovative approach for prioritizing odor investigations by local authorities.

2. Methods

After a soft launch, the Smell MyCity app[10] was introduced to the Louisville community in March of 2019 with support from community-based organizations, the University of Louisville, and local government agencies.[11] The Smell MyCity app was developed by the Carnegie Mellon CREATE Lab as a way for residents, organizations, and regulators to crowdsource pollution odor reports.[10] In Louisville, community partners, WJCCTF and REACT, promoted using Smell MyCity to increase community participation, enhance transparency in reporting, bolster citizen trust, and effectively collect data on problematic areas.

The mobile phone applications prompt community members to rate the intensity of odors from 1 (just fine!) to 5 (almost as bad as it gets!), adding odor descriptions and other optional details, and capture location information from the phone. Smell reports are immediately displayed on the public Smell MyCity map[10], submitted to Louisville's Air Pollution Control District, and

available for public download. Our analysis focused on descriptions related to industrial and chemical odors (Table 1), March 2018 through September 2024. Coding was done by two authors (AR and LBA). The ArcGIS Pro version 2.9.5 (Redlands, CA) Kernel Density tool was used to identify areas where noxious odor reports were highest across the county. We then compared disease prevalence rates from the Centers for Disease Control and Prevention 2022 PLACES data[12] for asthma, cancer, chronic obstructive pulmonary disease (COPD), coronary heart disease (CHD), depression, diabetes, obesity, and stroke between the census tracts with higher odor reports and the countywide average.

The data analyzed were publicly available; therefore, institutional review board approval was not required. Smell MyCity data is anonymous, census tracts are geographically masked, and no personal identifiers are collected.

3. Results and discussion

The study was implemented in Louisville, Kentucky, a city with a long history of industrial odors and air pollution and a population of 793,881.[7,13] In the study period, residents submitted 6,868 smell reports with odor descriptions to the Smell MyCity app; 1,119 reports described "industrial" and "chemical" odors and assigned smell values of 3 or greater. While odor reports were submitted across Louisville, many originated in the city's northwestern area. Kernel Density analysis highlighted two census tracts with high frequencies of industrial and chemical odor reports: Census Tract 14 (21111001400) with 163 reports and Census Tract 50 (21111005000) with 83 reports, in the Chickasaw (estimated population 6,424) and California

(estimated population 6,533) neighborhoods, respectively (Figure 1).[14,15] Higher disease prevalences between the census tracts of interest and Louisville were observed for asthma, COPD, CHD, diabetes, obesity, and stroke (Table 2). The Chickasaw neighborhood is located directly north of the historically important industrial corridor known as "Rubbertown" due to its prominence in the chemical production of synthetic rubber and related petrochemical activities. The California neighborhood is home to a smaller industrial and transportation zone.

One clear example of this analysis, and how community members and collaborators contributed to the research question, analysis, dissemination, and use of findings, occurred in 2019 when residents submitted Smell MyCity reports about a strong cat urine smell in Shelby Park. In response, Louisville's sewer utility flushed sewer lines, deodorized catch basins, replaced utility hole covers, and surveyed industrial operators, commercial facilities, and residents. Additionally, the Air Pollution Control District searched for a source through daily air samples, regular visits, and maintained ongoing communication with the Shelby Park Neighborhood Association. A connection was made to the North Carolina Division of Air Quality, which had previously experienced a similar cat urine odor issue. With that knowledge, the sewer utility focused on addressing wastewater effluent from a single business. The company voluntarily reviewed its waste streams, discovered the source, and responded promptly by adjusting the pH of its wastewater to prevent odor. By bringing together resident odor reports, community partners, the sewer utility, the Air Pollution Control District, and a local business, the problem was solved through scientific investigation, regulatory oversight, and proactive measures. The success of this collaboration relied on several key factors: open communication between the regulatory agency and the community using Smell MyCity, information sharing and cooperation between agencies

with relevant expertise, and proactive engagement with the responsible party once the issue was identified.

The initial results included here were also featured in a keynote presentation at the 2023 WJCCTF/Kentucky National Association for the Advancement of Colored People Annual Environmental Justice Conference to collect community feedback and to inform further analysis culminating in this manuscript. WJCCTF incorporated some of the initial approaches to the analysis in their monthly member meetings throughout 2023–2024. During these meetings, community members offered suggestions for the kinds of health conditions of greatest interest. They raised valuable concerns about the need for peer-reviewed publications to refer to when interacting with policymakers about the health uncertainty surrounding odor reporting. The Louisville Metro Air Pollution Control District has demonstrated interest in this community science work by creating an Application Programming Interface that transmits these odor reports directly to their response team. It has additionally communicated this recognition to the Mayor's office.

This study was motivated by the need to re-evaluate odors, particularly those originating from industrial sources, not merely as public nuisances under current air quality regulations, but as possible indicators of environmental health risks for residents. Even when no health or odor thresholds are violated, environmental chemical mixture odors can be unbearable for residents.[16] Worry and poor mental well-being from industrial air pollution are also health risks.[17,18] Benzene (CAS 71-43-2) illustrates this complexity.[19] Between 2021 and 2023, Louisville reported 3,628 lbs of benzene release to the United States Environmental Protection Agency Toxics Release

Inventory.[20] Benzene is described as having a pleasant aromatic scent, yet it is a known human carcinogen and has an odor threshold of 4.68 ppm.[5,19] This contrasts with hydrogen sulfide, which is not considered a carcinogen, but has a distinguishable, strong rotten egg odor at concentrations as low as 0.1 ppm.[5,21] By empowering residents to report their odor observations in a participatory science framework,[22] communities can more directly affect public perception and policy around air pollution.

Sustaining and promoting applications like Smell MyCity empowers residents to document and report odors, facilitating detailed investigations into odor clusters and their related health impacts, improving public health, and strengthening environmental justice initiatives. The sustainability of this activity is supported by strong collaborations among community organizations, academic institutions, and local government agencies committed to analyzing air quality data and engaging the public in discussions about it. These partnerships foster collaborative problem-solving and drive active community involvement for data-driven public health advocacy. However, sustainability ultimately depends on ongoing application maintenance by third-party providers and ensuring the app remains free for public use. Unlike other research that aligns odor reports with major spatial landmarks for prioritization,[23] our work uniquely integrates these countywide reports with health outcomes. Environmental odor pollution is known to have psychosocial effects,[4,24] with increasing dose exposure linked to increased annoyance, risk perception, and behavioral interference, which is not captured in the PLACES data[12] and warrants additional study.

Despite the utility of this practical tool, our methodology has some limitations. The study design fails to account for confounding variables that may explain the observed health disparities (e.g., socioeconomic status, healthcare access, and demographic factors). The study did not establish temporal relationships between odor exposure and health outcomes. Finally, resident-reported data have inherent biases, particularly regarding representativeness and objectivity, as odor thresholds are a sensory metric.

4. Conclusion

Our project aimed to investigate the association between industrial and chemical odor reports in an area with industrial activity and the prevalence of specific health conditions, expanding data sources that may be useful to identify and address potential health disparities and prioritize investigations by local authorities. Research and analysis of participatory community data, made possible through programs like Smell MyCity, can preserve trust and increase engagement in public health activities. In areas with chemical and industrial odor events, the nuisance and exposure residents experience can be tracked and linked to neighborhood health metrics. Without regulatory frameworks for unpleasant odors, our approach offers an alternative for residents to collect and report data in real-time. Ultimately, this approach offers a model for how grassroots odor reporting efforts can be recognized and respected in environmental health and public health policy arenas, benefiting local communities and broader public health initiatives.

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COMPETING INTERESTS

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

CONTRIBUTORS

Conceptualization: TS; Methodology: LBA, TS; Formal analysis: AR, LBA; Writing-original draft preparation: LBA, RHH; Writing-review and editing: AR, LBA, RHH, TS; Supervision: TS; Project administration: LBA. All the authors have read and agreed to the published version of this manuscript.

DATA SHARING

Smell MyCity source data are publicly available; links are provided in the references.

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Table 1. Code analysis for reported odors from the Smell MyCity app. This study was limited to odor descriptions related to industrial and chemical odors (ID 2).

ID	Resident-reported odor detail
1	Biological Mixture (fecal, rancid, decay/death, JBS)
2	Chemical Mixture (plastic, glue, rubber, sweet, polish remover, burnt/burning, garlic, cat pee/ammonia/urine, acid, industrial, chemical, alcohol)
3	Natural Gas/Fuel (gas, oil, fuel, cabbage, rotten eggs, sulfur)
4	Sewage (MSD, sewage, feces)
5	Misc (garbage, trash, open burns, drugs, etc.)

Table 2. Summary of mean 2022 PLACES disease prevalence rates[12] for asthma, cancer, chronic obstructive pulmonary disease, coronary heart disease, depression, diabetes, obesity, and stroke for census tracts with a high density of odor reports compared to Louisville as a whole. 95% confidence intervals are provided for the countywide group.

2022 PLACES disease	High density odor report census tract 14 (21111001400)		High density odor report census tract 50 (21111005000)	
	Census tract mean %	Countywide mean % (95% CI)	Census tract mean %	Countywide mean % (95% CI)
Asthma	14.7%	11.3% (11.1–11.5)	13.5%	11.3% (11.1–11.5)
Cancer	4.8%	7.9% (7.6–8.2)	7.7%	7.9% (7.6–8.2)
Chronic obstructive pulmonary disease	11.1%	9.2% (8.7–9.6)	15.1%	9.2% (8.7–9.6)
Coronary heart disease	7.8%	7.6% (7.3–7.8)	11.9%	7.6% (7.3–7.8)
Depression	24.3%	25.6% (25.3–25.9)	26.9%	25.6% (25.3–25.9)
Diabetes	21.7%	14.3% (13.7–14.9)	21.8%	14.3% (13.7–14.9)
Obesity	51.7%	37.9% (36.9–38.8)	44.0%	37.9% (36.9–38.8)
Stroke	6.4%	4.1% (3.8–4.3)	7.7%	4.1% (3.8–4.3)

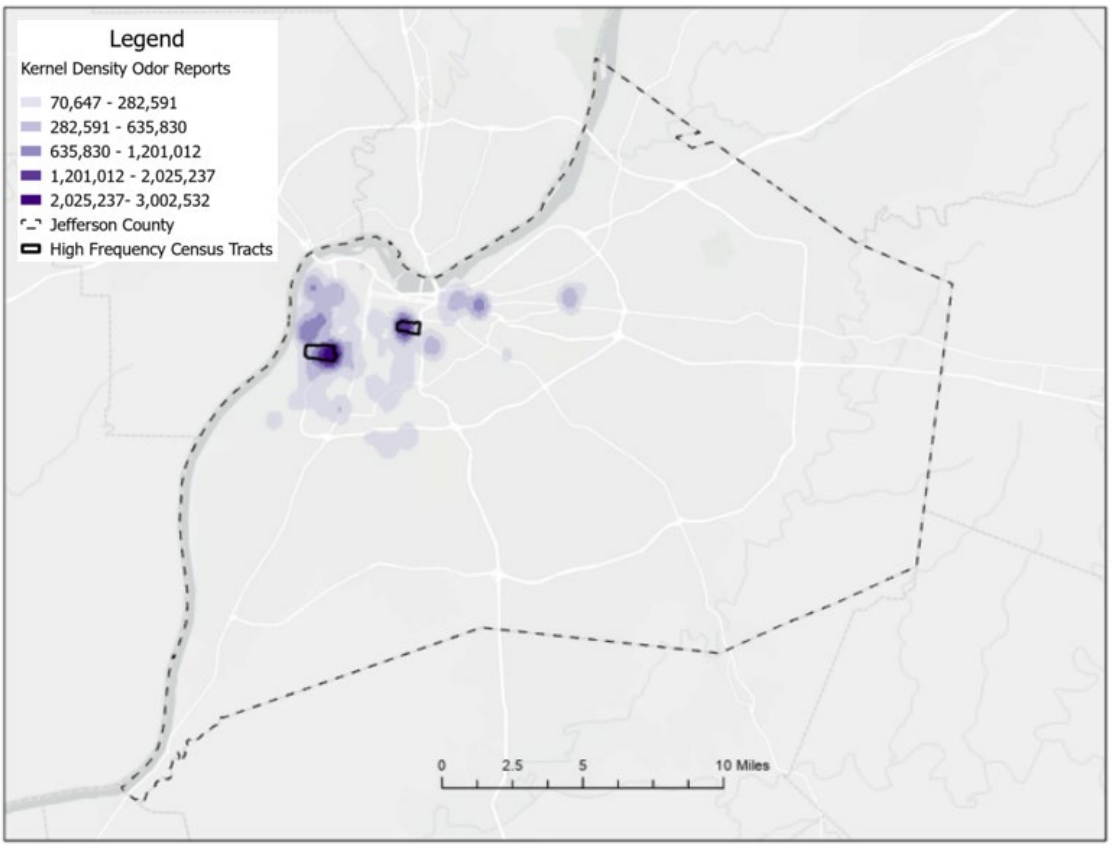

Figure 1. Map of Louisville, Kentucky: Census tracts with high odor report frequency, March 2018 through September 2024, are outlined in black. Kernel Density analysis highlighted two census tracts with high frequencies of industrial and chemical odor reports: Census Tract 14 (21111001400) with 163 complaints and Census Tract 50 (21111005000) with 83 complaints.