The Collaborative Data Analysis (CoDA) Study of Residential Exposure to Industrial Pollution and Health in Louisiana

An April 2026 report by the CoDA team

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Table of Contents

Executive Summary

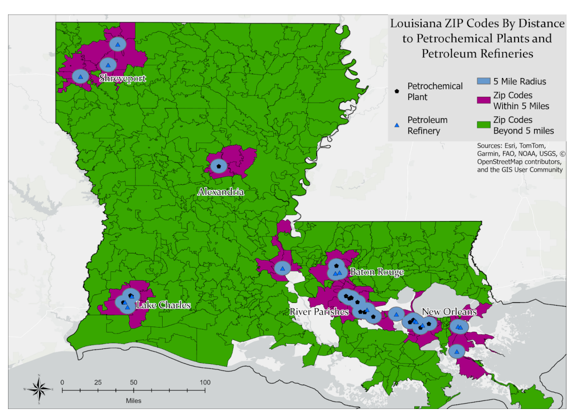
Introduction

Across heavily industrialized regions of Louisiana, residents have long described concerns related to industrial pollution exposures and patterns of illness, including extensive community-driven documentation of these issues.[1–9] Previous academic research has identified recurring patterns of increased respiratory illness, cancer, and other health issues in Louisiana's industry-adjacent communities.[8,10–20] However, regulatory decisions have often ignored community-based reports of health issues and instead relied on analyses done by government agencies,[21] which have inadequately addressed residents' questions about how industrial activity relates to health in their communities and/or minimized their concerns.[22] Our team's systematic review of the existing evidence on industrial pollution and health in Louisiana suggests a relationship between industrial proximity and health outcomes in the state.[23] However, one current gap in the research is using government-generated data to answer the questions residents are most interested in answering.

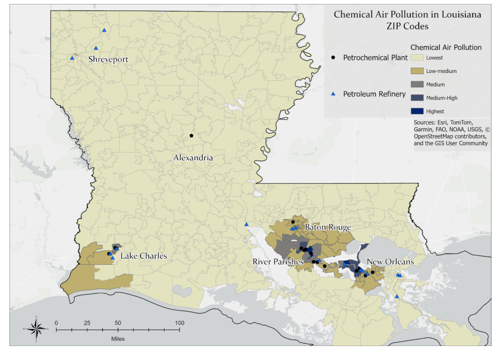
The Collaborative Data Analysis (CoDA) project sought to address this longstanding gap by combining rigorous quantitative analysis of state health and environmental data with collaborative, qualitative data interpretation processes involving residents across multiple regions of Louisiana. Through this multi-method approach, we sought to build meaningful epidemiologic insights that residents could easily understand, discuss, and communicate in policy-relevant settings.

Methodological Approach

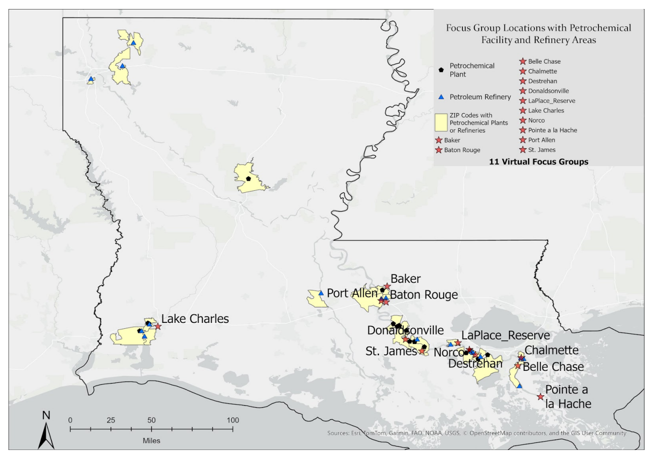
Our community-engaged research project used complementary quantitative and qualitative methods. First, we analyzed patterns of health outcomes and environmental exposures using government data. Health outcome data came from Louisiana Medicaid claims records from 2017–2019, covering approximately 40% of the state's population, including children, lower-income adults, pregnant women, and individuals receiving Supplemental Security Income. Because people ages 65 and older are eligible for Medicare, their health information is not included in this Medicaid dataset, so we are only able to study health issues among children and adults up to age 64.



Environmental exposure data were drawn from publicly available federal and state sources, including the U.S. Environmental Protection Agency (EPA) and the Louisiana Department of Environmental Quality (LDEQ), and operationalized using two complementary measures: (1) ZIP code-level proximity to 40 petrochemical plants and petroleum refineries identified in 2017 LDEQ records, and (2) ZIP code-level weighted estimates of toxic chemical air pollution based on 2016 EPA Risk Screening Environmental Indicators (RSEI) geographic microdata, which account for the quantity, toxicity, and atmospheric behavior of reported industrial emissions. We linked and analyzed these different datasets to assess whether certain health outcomes occurred more frequently in areas located nearer to industrial activity or with more industrial air pollution. We conducted analyses for a wide variety of health outcomes, including health outcomes related to respiratory health, cardiovascular health, neurological health, cancer, reproductive health, child health and infant health, among others. We calculated risk ratios to compare the chances of health problems in more industrialized areas versus less industrialized areas, and we estimated the number of additional cases among exposed residents that may be attributable to living in those industrialized regions.



To complement and enrich the quantitative analyses, we conducted 22 virtual and in-person focus groups across multiple regions of Louisiana, prioritizing communities situated near petrochemical and industrial activity. In these sessions, residents reviewed preliminary quantitative results, shared interpretations grounded in their lived experiences, raised additional questions or concerns that informed subsequent analyses, and offered ideas on next steps. We recorded these workshops to create anonymized transcripts, and analyzed these transcripts to identify overarching ideas and illustrative quotes. This dual approach—rigorous epidemiologic analysis combined with resident-guided interpretation—supported the project's goal of producing findings that were scientifically sound and directly responsive to community concerns.



Results

Quantitative analysis identified patterns of elevated health risks among residents living in areas with higher levels of petrochemical exposure. Across multiple analytic approaches, individuals residing in ZIP codes with higher pollution exposure experienced higher prevalence of certain adverse health outcomes compared to residents in lower-exposure areas, after adjustment for age and sex and exclusion of adult smokers. Here, we highlight findings that were statistically robust– that is, had similar findings– regardless of how we characterized industrial exposure.

Among children, living in an area with higher exposure to industrial pollution was associated with increased likelihood of being diagnosed with nutritional anemia and learning disabilities. For female children, living in an area with higher exposure to industrial pollution was associated with a higher risk of early puberty.

Table 1. Key findings of multivariate analysis of children's health outcomes (risk ratios and 95% confidence intervals), among all children aged 0-17 years (n=804,357).		
Health outcome	**Distance model RR (95% CI)**	**Air pollution model RR (95% CI)**
Nutritional anemia	1.34 (1.13-1.59)	1.16 (1.09-1.23)
Learning disabilities	1.20 (1.05-1.37)	1.12 (1.06-1.18)
Dermatitis and eczema	1.10 (1.01-1.20)	1.06 (1.03-1.08)
Early puberty (among girls only)	1.24 (1.10-1.41)	1.09 (1.04-1.16)

For non-smoking adult women who experienced pregnancy, higher residential exposure to industrial pollution was associated with higher risk of preeclampsia/eclampsia, miscarriage, and ectopic pregnancy. Among all non-smoking adult women, higher residential exposure to industrial pollution was associated with uterine fibroids and breast cancer.

Table 2. Key findings of multivariate analysis of women's health outcomes (risk ratios and 95% confidence intervals), among all non-smoking women aged 18+ (n= 494,920).		
Health outcome	**Distance model RR (95% CI)**	**Air pollution model RR (95% CI)**
Uterine fibroids	1.16 (1.05-1.28)	1.06 (1.03-1.10)
Breast cancer	1.10 (1.02-1.19)	1.06 (1.03-1.09)

Table 3. Key findings of multivariate analysis of pregnancy-related health outcomes (risk ratios and 95% confidence intervals), among non-smoking adult women who have been pregnant (n=96,482).		
Health outcome	**Distance model RR (95% CI)**	**Air pollution model RR (95% CI)**
Ectopic pregnancy	1.18 (1.02-1.37)	1.09 (1.02-1.16)
Miscarriage	1.11 (1.02-1.21)	1.05 (1.01-1.08)
Preeclampsia / eclampsia	1.24 (1.14-1.35)	1.08 (1.05-1.12)

Among all non-smoking adults, living in a ZIP code with a higher exposure to industrial pollution was associated with increased risk of nutritional and other acquired anemias.

Table 4. Results of multivariate analysis of non-smoking adult health outcomes (risk ratios and 95% confidence intervals), among non-smoking adults ages 18+ (n=810,732).		
Health outcome	**Distance model RR (95% CI)**	**Air pollution model RR (95% CI)**
Nutritional anemia	1.15 (1.08-1.23)	1.06 (1.04-1.09)
Other acquired anemia	1.18 (1.10-1.26)	1.07 (1.05-1.10)

Community focus group discussions frequently reinforced the epidemiological findings and provided specific examples that aligned with the health outcomes presented. Participants described recurring experiences with childhood learning challenges, anemia, respiratory concerns, and reproductive health complications, often linking these issues to proximity to petrochemical facilities and long-standing environmental exposures in their neighborhoods. Participants also discussed conditions that were not among our quantitative analysis of Medicaid data findings, including cancer, asthma and other respiratory issues, and adverse birth outcomes, such as low birthweight and preterm birth. Residents emphasized cumulative and intergenerational health concerns, noting patterns of similar diagnoses occurring across multiple family members and generations. Discussions also highlighted structural factors—including barriers to healthcare access, limited environmental monitoring transparency, and historical disinvestment—that participants believed interacted with pollution exposure to shape health outcomes. In addition, community members provided feedback on data analysis and interpretation.

Collectively, focus group input strengthened interpretation and presentation of the statistical analyses, identified priority areas for additional investigation, and informed refinement of how results were communicated in the final report. Participants also had specific recommendations for action, including strengthening state and federal policies governing industrial emissions and improving transparency and frequency of chemical reporting from petrochemical facilities. Community members expressed wanting state legislators, local representatives and elected officials, and regulatory agencies to advocate for stronger environmental protections and accountability from industry, including supporting community-based environmental monitoring and public health surveillance systems. Community members also recommended that public health agencies and school districts conduct campaigns to increase awareness about health conditions that were common in industrialized areas, and advertise and provide more health and school-based services.

Conclusions

After analyzing large-scale Medicaid data with multiple government-generated measures of industrial pollution exposure in response to resident-driven questions, we found that exposures to industrial pollution were associated with elevated risks of certain health outcomes among particularly vulnerable populations (e.g., children, pregnant women) as well as adults overall. The consistency of findings across exposure metrics and alignment with existing scientific literature add to the body of evidence that suggest a connection between industrial pollution and health in Louisiana. Focus group feedback not only enhanced understanding of the findings but also shaped next steps related to additional analyses, dissemination strategies, and implications for public health and environmental policy. The CoDA Environmental Health Study demonstrates the value of integrating rigorous epidemiologic analysis with sustained community engagement to examine environmental health issues in Louisiana.

Introduction

History of environmental pollution and health disparities in Louisiana

From the 1960s to today, the state of Louisiana in the USA has been the site of extensive growth in the petrochemical industry [22,24] and currently has one of the largest concentrations of petrochemical industrial activity in the USA.[25] Much of the land industry occupies along the Mississippi River was former plantations sold to corporations for development purposes.[22] Directly adjacent to these large properties were smaller homesteads deeded to former enslaved people in extended family groups immediately following the Civil War. In many cases, their descendants still inhabit these properties.[22]

Today, the 85-mile stretch of the Mississippi River between Baton Rouge and New Orleans, referred to by many residents as Cancer Alley, is home to more than 200 petrochemical plants and allied industries.[26] The name Cancer Alley itself reflects the connections that residents have long drawn between the high environmental pollution and the high health burden they observe in their communities.[22] Although Cancer Alley is the most well-known industrial region in the state, there are many other industrial zones across Louisiana where local residents have organized for a cleaner environment and responsible industrial regulations. Many more facilities are located on the southwestern part of the state near the Texas border, and many oil refineries also dot the landscape in the northern part of the state.[27] Additionally, the petrochemical industry has been rapidly expanding and is projected for further growth.[24]

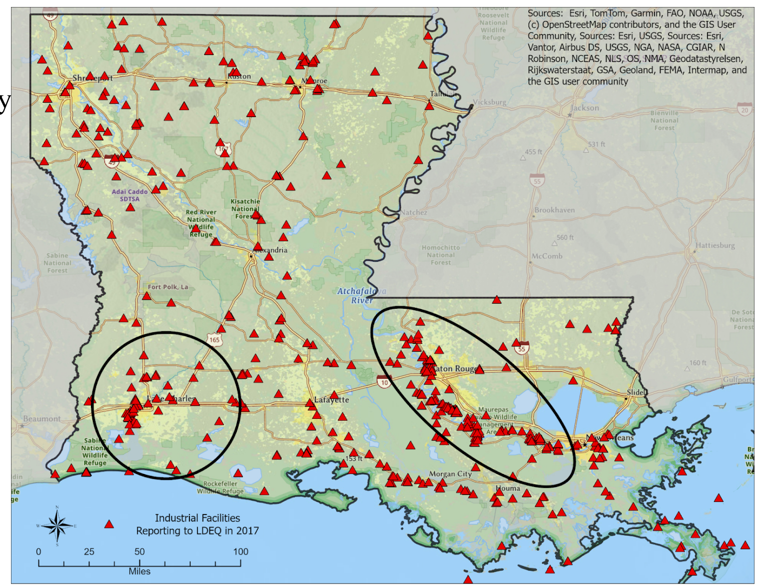


Figure 1. Map showing the locations of all facilities from coordinates provided in the Louisiana Department of Environmental Quality public records request for locations of petrochemical plants, allied facilities, and refineries. Ellipses enclose the industrial areas of particular interest (“Cancer Alley” and Lake Charles). Data from 2017.

Numerous focus group participants shared their concerns on living near industrial facilities, by reflecting on their past illnesses and illness of family members over generations:

“So, I'm from Chalmette, Louisiana and ***in [name of nearby town], we have a plant called [name], and then right across the river from us, which is really not that much when you really think about it, there's a new refinery that they just started****, and I know my brother suffers with* ***asthma*** *[since childhood], but my great-grandmother, she didn't get diagnosed with asthma until she was in her 30s. So I wonder if, once you have a diagnosis of asthma, they're not really looking into it as a chronic condition affected by pollution, since you had it since birth. ...And then I also think about my family members,... my great-grandmother, all her siblings had* ***cancer*** *of some sort.* ***My grandma, she had breast cancer, then she turned around and had skin cancer before she died, and I know her brother had colon cancer****. . . It*

was, like, 5 more of them, but also I think about ***skin conditions*** *like eczema. My sister has it real bad. She also has other* ***learning disabilities****. . . so I'm wondering. . . if they're impacted by that pollution as well, because those are things that you don't consider on a daily basis, and honestly, now that I'm thinking about it, my younger niece [is] allergic to everything. Like, my sister, I called [her] yesterday, and I'm like, the baby got a runny nose, and ...she was like, well, she's* ***allergic to everything****. So then I'm wondering if that's also part of it, because they live in [the nearby town]. You don't consider how things are multifaceted until we have these conversations."*
CoDA Focus Group Participant, Chalmette, August 2025

"so me personally, … ***from a younger age, I always had asthma problems*** *which… I'm not 100% sure if it's from the area or not, could be, because I spent the early part of my childhood down there going to school. So, could have been from that exposure. I have noticed since I moved to Texas that I do have a lot less …[of] those nagging health problems, even when it comes to different allergies. So, there could be some correlation, right, but it's just hard for us to…pinpoint it. It's stuff that shouldn't be as persistent as it is happening. So, it's definitely something that should be addressed, I feel, especially in those areas. You see it a lot in Louisiana [and] some other southern states where they kind of…* ***push those more rural areas to the side****, right? They don't give them the necessary attention, or* ***they just treat them like they're disposable****."*
CoDA Focus Group Participant, Chalmette, August 2025

"What can we do to get these people to say, this is not make believe?... ***These are the funerals that we're going to, these are the cancer cases that we're having. It's not make believe.*** *This is factual data. And these people are here to say, from your community, our community, because I don't divide Donaldsonville, St. James, Convent, we all are off the same… river. And* ***when those plants putting out stuff in there, we all breathe that****, so we cannot be divided, and that's why we have to stand together…I don't trust putting nothing in the soil because it's no good.* ***I took a trip with the fishermen in Lake Charles… We got dead oysters and purple shrimp. Can we even trust the food that we're eating?*** *If you want to go to Lake Charles and ride the oysters are lining the bed they're dead. So can you even trust the food? …No,* ***every plant that line this river, they got something that they run it off into it. And we all, we're not blinded, we all know that everything is getting right off in the river****...Yes, they have cases all over the world, but we have a whole lot more, and we have to get the data out.* ***We have to say something****, and we have to get documentation that we were not quiet. We didn't just lay down. We begged for help. Y'all ignored our voices, and that's what we're here for, asking us, we need help here we can you cannot be silent and get help. Closed mouths don't get fed.* ***And there's nobody speaking for us, not your governor, your city officials. This is where you got to speak for yourself.****"*
CoDA Focus Group Participant, St. James, August 2025

Louisiana communities' demands for more relevant environmental health research

The CoDA (Collaborative Data Analysis) Environmental Health Study emerged in response to longstanding community concerns about industrial pollution and health inequities in Louisiana, particularly in heavily industrialized "fenceline" communities. Decades of peer-reviewed research have linked industrial emissions to a wide range of adverse health outcomes, including cancer, respiratory disease, and adverse birth outcomes, particularly in communities located near petrochemical and refining infrastructure.[28–30] Communities in and beyond Cancer Alley had long reported visible emissions (smoke plumes), strong chemical odors, loss of local flora and fauna, high burdens of chronic disease, and premature deaths among family members and neighbors.[31,7,9,3,4,6,5,8,32] Despite this evidence, community members in industrial areas have continued to experience pollution and illness that they felt were not adequately recognized by state agencies or industry, contributing to persistent mistrust of official environmental health assessments.[33,34] The CoDA study was designed to respond directly to these concerns by combining rigorous analysis of government datasets with participatory methods that foregrounded local knowledge and lived experience.

First, the study was motivated by persistent local demand for more transparent health information and cumulative exposure data. Community members and organizations across Louisiana repeatedly asked not only whether individual facilities were "in compliance," but how multiple facilities, over many years, collectively shaped patterns of exposure, disease, and everyday wellbeing. Prior environmental justice scholarship has demonstrated that industrial hazards and health harms are spatially clustered and cumulative rather than isolated events, particularly in the U.S. Gulf South.[35,28,36,37]

Our team's systematic review of the existing peer-reviewed research literature on industrial pollution and health in Louisiana reinforced these findings, showing that existing studies, including multiple community-based studies, consistently identified certain communities bearing disproportionate industrial pollution and health burdens.[23]. Yet community-generated data and experiential knowledge are frequently discounted or refuted when they conflicted with state or industry-aligned datasets, a pattern documented in prior participatory environmental health research.[38,39] For example, several Louisiana-focused studies– particularly those closely tied to industry or regulatory agencies– had concluded that cancer or other health outcomes were not significantly elevated, often relying on aggregated parish-level cancer registry statistics.[40–42,21] In industrial zones in Louisiana around the world, government data were frequently used to justify permitting decisions and to dismiss residents' observations, reinforcing perceptions that official studies were misaligned with lived reality.[22,34]

As focus group participants explained, the mismatch between data and lived experience is magnified by local distrust in state data processes and perceived intentions on the part of state agents:

"[O]ur experience was the Department of Health, although the asthma rates were reported, ***the Department of Health actually smoothed the data for St. John the Baptist Parish, which had the highest rate in the state of asthma-related hospitalizations and emergency room visits****. . . But when I have a friend that's a researcher, when she went back to finalize her research it was changed. St. John Parish was no longer number one. They were average in the whole state.* ***They used a larger area when they didn't just do St. John Parish. They did, like, a tri-parish area instead****. So it balanced it out. . .I mean, it's crazy the things that we've learned in the last, wow, 9 years of advocacy with our state, the health department, and the LDEQ [Louisiana Department of Environmental Quality] They all work for the… petrochemical industry, they hide things."* =Focus Group Participant (Virtual) October 2025

*"**LDEQ doesn't do their job**, because they're pro-industry. And **our health department did not do their job**. Because they're covering it up. So how do we fix the people that we put in office?. . . I honestly believe that just starting from our local area with our parish officials who go in … with the rose-colored glasses on, I'm gonna save the world, I'm gonna help my community. And when they get in that seat … something sucks the humanity right out of them. It terrifies me to see how people turn on their own people as soon as they get this little piece of position."* -Focus Group Participant (Virtual) October 2025

The CoDA study's approach addressed a critical gap in Louisiana's environmental health research evidence landscape: no existing state or academic studies had systematically combined Medicaid records with environmental release inventories for the purpose of collaboratively answering residents' questions. Community-engaged secondary analysis of state health datasets had not previously been conducted in Louisiana. Additionally, by analyzing government-generated datasets through a collaborative, community-based lens, the project created a structured process in which residents could see, question, and interpret some of the same or similar datasets as those relied upon by regulators.[38]

This strategy aligned with what prior scholars have described as a form of "data judo"– the deliberate re-purposing of state data sources to assess for the presence of harms that have historically been overlooked or dismissed.[43] Unlike traditional environmental health studies in Louisiana that relied on parish-level aggregation, single-community surveys, or narrowly defined exposure windows, CoDA's multi-dataset, statewide, high-resolution approach represented a methodological innovation designed to fill a long-identified gap in usable environmental health evidence.

Producing trusted, participatory environmental health science

The CoDA study was motivated by the desire to produce trusted environmental health science that integrated epidemiology, government datasets, and local health narratives within a community-based participatory research framework.[44,45] Building on prior community-based participatory research for health studies,[33,46–50] the CoDA team designed a strongly participatory structure that included a Formal Advisory Board of fenceline community leaders, iterative focus groups, collaborative data-analysis workshops, and cross-community meetings. These processes brought residents together with researchers to collaboratively interpret statistical findings.

Prior research has shown that combining quantitative environmental health data with participatory interpretation can strengthen resident voice, enhance collective meaning-making, and build shared ownership of scientific results.[47,38] By integrating statewide datasets with collaborative interpretation, CoDA aimed to address gaps in how environmental health knowledge had historically been produced and used in Louisiana.

The CoDA Team

The CoDA (Collaborative Data Analysis) Study of Environmental Health in Louisiana was led by an interdisciplinary team whose expertise spanned environmental sociology, epidemiology and health sciences, and community-engaged research. The project was supported through a collaborative National

Science Foundation grant awarded to Dillard University, the University of California San Francisco, and Virginia Tech University. Team leadership included Dr. Barbara Allen at Virginia Tech, a sociologist with expertise in environmental sociology and participatory science; Dr. Alison Cohen at UCSF, an epidemiologist with extensive experience in community-based participatory environmental health research; and leadership at Dillard University, including Dr. Michelle Smith, who contributed expertise in public health; Dr. Eric Buckles, who brought experience in NSF-funded scientific research; and Dr. Sharon W. Hutchinson, who provided leadership grounded in community nursing science and health conditions in Louisiana. Two staff members at Dillard University played central roles in the project's implementation: epidemiologist Juliet Nussbaum and project manager Austin Banks.

The project team also included Dr. Kenya Goodson, a community-engaged research specialist; Dr. Sherman Horn III of the Center for Human Environmental Research, who provided GIS expertise; Becky Staiger of UC Berkeley, a specialist in Medicaid data; and Patti Lemon, a Medicaid billing code expert. In addition, the project engaged numerous students across institutions, including Miriam Simon and Eushavia Bogan from UCSF; Isabella Yalif from Vanderbilt University; and Venus Azamnia and Danielle Thompson from Virginia Tech, who supported analysis, coordination, and dissemination activities.

The project was guided by a Formal Advisory Board (FAB), whose members played a critical role in shaping the study's direction and community engagement strategy, to make sure our study remained responsive to community concerns and was grounded in local experiences. The FAB members, who all had personal and/or professional experience in Louisiana communities experiencing industrial pollution, were Selena Bolton, Vickie Boothe, Kanitra Caston, Ashley Gaignard, Kadesha Minor, and Breon Robinson. They provided ongoing guidance on research priorities, assisted in coordinating focus groups, and supported recruitment efforts in industrial-adjacent and affected communities across Louisiana. Through their established relationships across Louisiana—particularly in areas exposed to higher levels of pollution—they strengthened connections between the research team and trusted local networks. Their professional insight informed how findings were framed and communicated, and they provided thoughtful, critical feedback on presentations, outreach materials, and dissemination strategies. In addition, FAB members were instrumental in identifying community partners, supporting focus group efforts, and ensuring that our research reflected lived experience and community priorities. Their leadership and credibility within their respective communities significantly enhanced both the rigor and responsiveness of the CoDA Environmental Health Study.

Methodological approach

Methods overview

We layered quantitative and qualitative methodologies to conduct our community-engaged research.

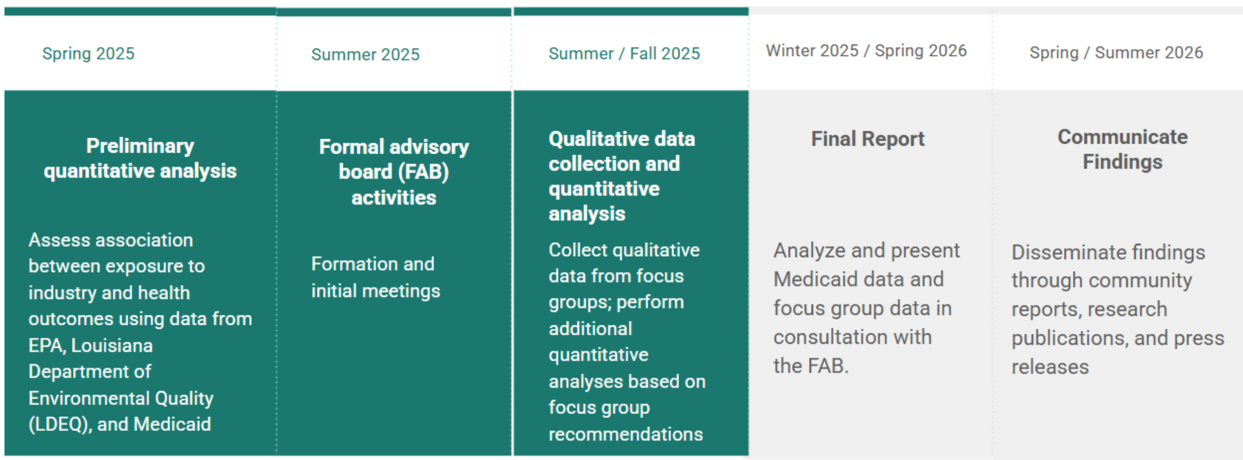


Figure 2. Overview of methods and timeline for the CoDA project.

First, we conducted epidemiologic analyses of secondary government data to quantitatively assess associations between environmental pollution and health. Specifically, we used Louisiana Medicaid data, which has data on myriad health issues for the subsample of ~40% of Louisianans who receive Medicaid (a lower-socioeconomic position population).[51] Medicaid data are highly trusted in government-decision making contexts and allow for replicability of methods elsewhere, as these data exist for all states. Medicaid data also includes extensive health information for its recipients, many of whom are pregnant women (nonsmoking women who experienced pregnancy made up 5% of our total sample, and 12% of the adult sample (aged 18-64)) and children (44% of our sample was age 17 or younger). Environmental data on locations of polluting facilities and amounts of pollution released were taken from a Louisiana Department of Environmental Quality (LDEQ) public records request and from US EPA's Risk Screening Environmental Indicators (RSEI) geographic microdata, respectively. As the official regulatory body overseeing facility permitting, compliance, and emissions reporting within Louisiana, LDEQ maintains authoritative records of facility locations and operations. RSEI is a nationally standardized, peer-reviewed analytical tool developed by the EPA that enhances comparability across facilities and accounts not only for emission volume but also for relative toxicity/human health impacts and atmospheric behavior of chemicals. Additionally, the RSEI geographic microdata estimates are available at the ZIP code level,[52] which aligns directly with our health outcomes data without the need for reassigning pollution data across mismatched geographic boundaries (i.e., geographic interpolation), in contrast with other authoritative pollution datasets, such as the EPA's National Air Toxics Assessment (NATA), that are reported at the census tract level.[53]

Second, we conducted collaborative workshops (using a focus group methodology; alternatively referred to as collaborative workshops) across the state with residents and local stakeholders to discuss our quantitative analyses. We held open community workshops throughout the state's industrial areas, and invited residents to discuss the preliminary findings and co-interpret findings based on their own lived experiences. The workshops were facilitated to encourage open and inquisitive sharing about living near polluting industries and health experiences. Additionally, residents were asked to critique what may be missing from the data or what additional analyses may be relevant to pursue to complement their experience living in their community. We also discussed any other topics of interest to residents. Given the iterative nature of these workshops (e.g., conducting new analyses in response to questions from focus group participants), we returned to communities to conduct subsequent workshops to share follow-up analyses. This iterative process was conducted in each location and/or virtually. This includes a total of 8 in-person focus groups and 14 virtual focus groups of a total of 22 workshops total across the state.

Our research was reviewed and approved by the Institutional Review Boards at Virginia Tech and Dillard University.

Medicaid data

This section provides an overview of the Medicaid data used to assess health outcomes. Additional detail is available in Appendix A.

Medicaid data access

Beneficiary-level identifiable Medicaid data is available to researchers, for a fee, in the form of various research identifiable files (RIFs) that can be requested through the Research Data Assistance Center (ResDAC), a Centers for Medicare and Medicaid Services (CMS) contractor housed in the University of Minnesota School of Public Health.[54] The fee is applied based on the population size of beneficiaries, the number of years of data requested, the complexity of the data request, and the number of people who will access the data for a given number of years. For these reasons, we only had enough funds to pay for access to three years of data for all Louisianans. The Centers for Medicare and Medicaid Services' Chronic Conditions Warehouse (CCW) has many privacy restrictions in place to maximize patient privacy, including no sharing of data at the beneficiary ZIP code-level or more local. Due to this restriction, we were unable to produce estimates of ZIP code-level prevalence or risk, and instead had to group ZIP codes together by level of exposure (described in more detail below). In order to access the Medicaid data, academic researchers must submit a research request packet and execute a data use agreement (DUA) between CMS and the requesting organization (i.e., a university with which the researcher is affiliated). Our DUA was approved in early 2025.

Creation of Medicaid analytic sample

We used the Medicaid Transformed Medicaid Statistical Information System (T-MSIS) Analytic Files (TAF) Research Identifiable Files (RIF) for Louisianans enrolled in Medicaid at any time between January 2017 and December 2019. We drew from the Demographics and Eligibility (DE), Inpatient (IP), Other Services (OT), and the Medicaid Enrollee Supplemental File: National Death Index (NDI). Together, the DE, IP, and OT files provide Medicaid beneficiary demographic characteristics, Medicaid eligibility information, and information about adjudicated healthcare claims, including diagnosis and procedure codes, for inpatient and outpatient health services paid for by Medicaid. The NDI files are linked files to the National Death Index and were used to identify all-cause and cause-specific mortality; these files include only beneficiaries who have a date of death reported in the annual Medicaid enrollment file.

Medicaid research file	Description of file	Variables used in CoDA analysis
Demographics and Eligibility (DE) base file	Demographic, enrollment, and Medicaid eligibility data	Date of birth/age, sex, race/ethnicity, household size, residential ZIP code, dual enrollment in Medicaid/Medicare, days of enrollment
Inpatient (IP)	Contains data about inpatient hospital health services paid for by Medicaid, including dates of hospital admission and ICD codes (diagnoses)	Dates of service/admission, diagnostic codes
Other Services (OT)	Contains data about outpatient and other health services paid for by Medicaid, including dates of service and ICD codes (diagnoses)	Dates of service, diagnostic codes
Medicaid Enrollee Supplemental File: National Death Index (NDI)	Contains cause of death information from death certificates provided through linkage with the National Death Index (NDI).	Date of death

Table 5. Names and descriptions of Medicaid data files and variables from each file that were used in our analysis.

Our analytic sample (the subset of the Medicaid data that was used for our data analysis) consisted of beneficiaries who met the following criteria in at least one year from 2017-2019: aged 64 or younger (since those ages 65 and up are automatically eligible for Medicare), not dually eligible for Medicare, lived in Louisiana (residential address with Louisiana as the state and a valid Louisiana ZIP code), not missing eligibility data or data on key variables for the analysis (e.g., date of birth, biological sex), enrolled in Medicaid for a minimum of one day in the year (see Figure 1 in Appendix A for a more detailed description), and, among adults aged 18 and older, no recorded history of tobacco use in the Medicaid records. This led to a total sample size of **1,615,089** individuals. The years 2017-2019 were selected because they are the years immediately prior to the COVID-19 pandemic, which had wide-ranging effects on population health, healthcare utilization, and the healthcare system. In addition, there is typically a delay of several years before CCW processes Medicaid data into the research files available to investigators, meaning more recent years after the height of the COVID-19 pandemic are not yet accessible.

Identification of diagnoses from Medicaid claims data

We identified or developed lists of medical diagnosis codes (International Classification of Diseases, Tenth Revision, Clinical Modification, or ICD-10-CM) and procedure codes (International Classification of Diseases, 10th Revision, Procedure Coding System, or ICD-10-PCS) for a variety of health outcomes (see Appendix B). Where possible, we used standard lists from the CMS CCW 30 Chronic Conditions or Other Chronic and Disabling Conditions categories.[55] For health outcomes of interest that were not included in these lists, we generated our own list of codes based on the ICD-10-CM codebook.[56]

We used two approaches to operationalize health outcomes. The first used an adapted version of the CCW Chronic Conditions and Other Chronic or Disabling Conditions algorithms, which are standardized and widely used in Medicare and Medicaid claims research. These algorithms require either a single inpatient claim (and in some cases, a single home health claim), or two or more outpatient claims (which may be restricted to specific service types) for a beneficiary to qualify as having a diagnosis. The CCW algorithms also specify a look-back period; in our analysis, we extended the look-back period to include the full three years of available data (2017-2019) to capture any diagnosis during this interval. Where possible, we applied the CCW algorithms directly. For conditions without a CCW algorithm, we either applied the rules of a similar CCW condition (e.g., applying the CCW anemia algorithm to nutritional anemia and other acquired anemias) or used a commonly applied rule requiring one inpatient claim or diagnoses on any two non-drug claims. Specific ICD-10 codes and claim type/number criteria used to identify each health outcome in our study are shown in Appendix B.

Our second operationalization used a less restrictive definition: beneficiaries were coded as having a condition if they had at least one relevant diagnostic code on any inpatient or outpatient Medicaid claim. This approach was intended to capture conditions that may be documented during only a single outpatient clinical encounter, including certain one-time events or acute experiences.

In general, we prioritize findings based on the CCW definitions, because they apply more scientifically conservative criteria intended to identify confirmed diagnoses. However, the CCW definition also likely underestimates the number of affected individuals. For some health conditions, the CCW approach excluded nearly all cases, suggesting that certain conditions may typically be documented only during a single outpatient visit. As such, we present findings from both operationalizations in this report. In particular, when we applied the CCW algorithm criteria for Other Chronic and Disabling Conditions (i.e., a diagnosis code present on one inpatient claim or on at least two non-drug outpatient claims on separate dates), nearly all cases of early puberty among girls (99%) identified under the less restrictive definition (diagnosis code on any claim) were no longer classified as cases. This suggests that most diagnoses of early puberty are recorded during a single outpatient visit rather than across multiple encounters. This pattern is consistent with the clinical course of the condition: puberty onset is a discrete, time-limited event, rather than a chronic condition requiring ongoing management. As such, the adapted CCW definition does not appear appropriate for this outcome, and we therefore relied on the less restrictive case definition to capture cases of early puberty. Cross-tabulations comparing the number of cases identified by the two approaches for statistically significant findings are provided in Appendix G.

We explored many adult and child health outcomes in the Medicaid data, including: blood disorders (e.g., nutritional/other acquired anemias), autoimmune disorders, cancers, cardiovascular diseases, endocrine/reproductive health conditions, metabolic disorders (diabetes), mental health conditions, neurodevelopmental disorders, neurodegenerative disorders, respiratory condition, and various other chronic health conditions. A complete list of health outcomes with corresponding diagnostic and procedure codes can be found in Appendix B.

Description of environmental data used (e.g., TRI, RSEI)

We assessed exposure to industrial pollution using two complementary approaches: (1) proximity to major industrial facilities and (2) modeled estimates of toxic air pollution. Using both measures allowed us to capture different ways that industrial activity may affect community health.

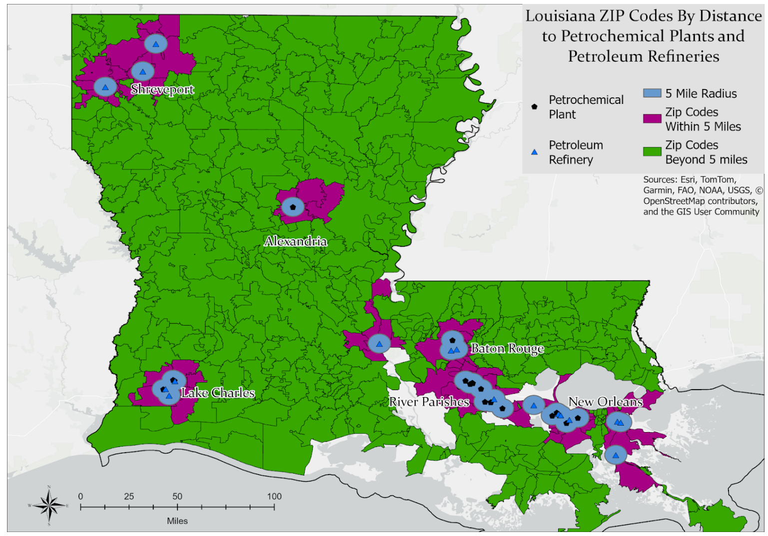


Figure 3a. Map of locations of 40 petrochemical facilities and petroleum refineries in Louisiana in 2017 LDEQ data, with ZIP codes by distance to those 40 petrochemical plants and petroleum refineries.

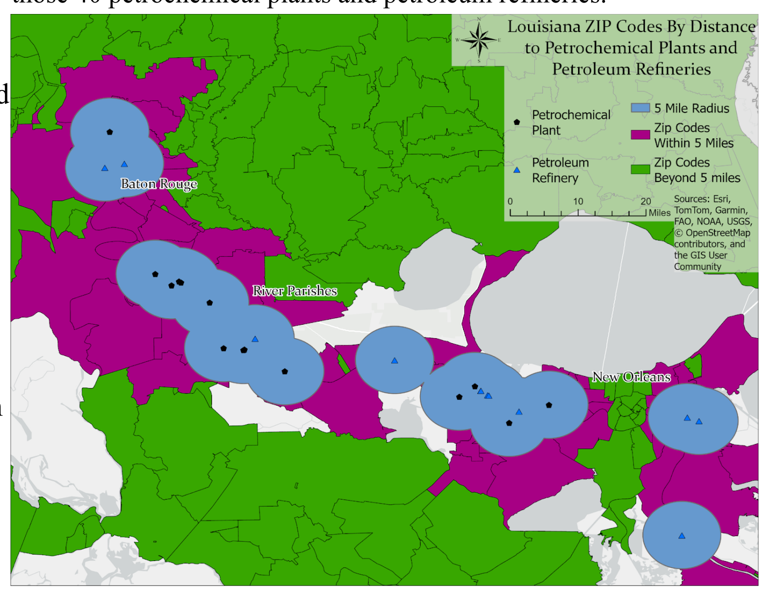


Figure 3b. Inset of Cancer Alley region. Map of locations of petrochemical facilities and petroleum refineries per 2017 LDEQ data, with ZIP codes by distance to those petrochemical plants and petroleum refineries.

First, we measured exposure based on how close people lived to major industrial sources. We identified 40 large petrochemical facilities and petroleum refineries operating in Louisiana using 2017 data from the Louisiana Department of Environmental Quality (LDEQ), which can be obtained by a public records request.[57] Facilities were selected based on North American Industry Classification System (NAICS) codes[58] that identify petroleum refining and petrochemical manufacturing activities (see Appendix C for more details). Since Medicaid data reported patients' residential locations only at the level of the ZIP code, we calculated the distance between the center of each ZIP code tabulation area (ZCTA, a geographic unit created by the US Census Bureau to assess statistics by ZIP code that often is equivalent to a single ZIP code but sometimes combines adjacent ZIP codes) and the address of each facility. ZCTAs– which we will refer to as ZIP codes from here– were then categorized based on whether they were located closer to or farther from these major industrial sites, allowing us to compare health outcomes among communities with different levels of potential industrial exposure.

Because distance to industrial facilities alone is an imperfect proxy for how much pollution is actually released and how toxic that pollution may be, we also used a pollution-based exposure measure derived from the Environmental Protection Agency (EPA)'s Risk-Screening Environmental Indicators (RSEI) program.[59] RSEI uses data from the EPA's Toxics Release Inventory (TRI),[60] which requires certain industrial facilities to report annual releases of specific toxic chemicals.

RSEI combines information on the amount of chemicals released with scientific data on their potential toxicity to human health, as well as modeling of how pollutants move through the air based on local weather patterns such as wind speed and direction.[61] The result is a toxicity-weighted concentration of a chemical in the year for a given geographic region. These estimates are not direct measurements of air quality, but they are widely used as screening-level indicators to compare pollution burdens across communities.[61] Estimates are available for specific chemicals (e.g., benzene only) or groups of chemicals (all modeled toxic chemicals, all carcinogenic chemicals), and for a variety of geographic units, including ZCTAs. Toxicity-weighted concentration reflects both the volume and toxicity (level of harmfulness to human health) of industrial emissions and provides a more direct indicator of potential pollution exposure than proximity or emissions data alone.

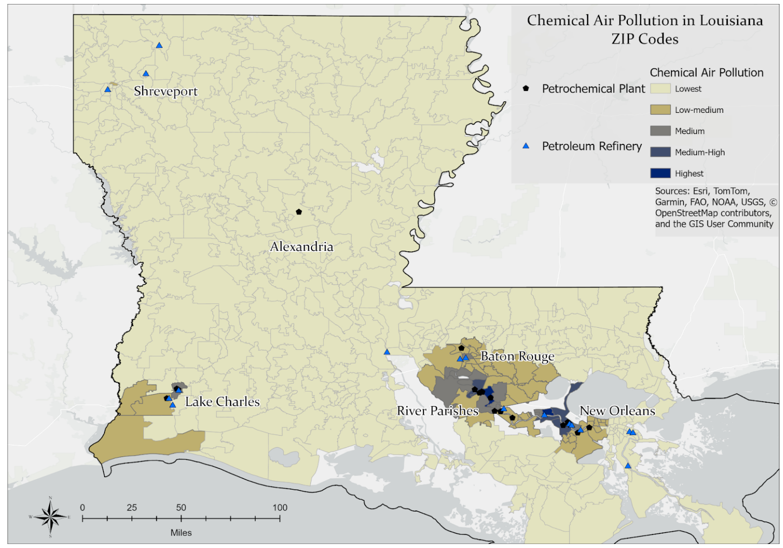


Figure 4a. Louisiana ZIP code tabulation areas (ZCTAs) by estimated toxicity-weighted concentration of chemicals in the air ("Chemical Air Pollution"), per 2016 RSEI geographic microdata. Air pollution concentration categories, measured in μg/m^3, are: lowest: 0-23,963; low-medium: 23,964-80,751; medium: 80,752-203,654; medium-high: 203,655-363,305; highest: 363,306-783,144.

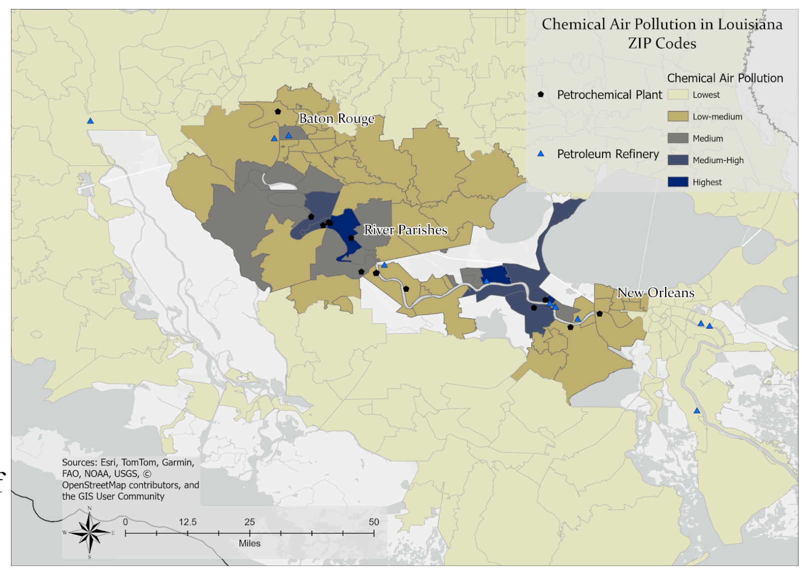


Figure 4b. Inset of Cancer Alley region. Louisiana ZIP code tabulation areas (ZCTAs) by estimated toxicity-weighted concentration of chemicals in the air ("Chemical Air Pollution"). Lighter colors indicate lower pollution levels. From 2016 RSEI geographic microdata. Air pollution concentration categories, measured in μg/m^3, are: lowest: 0-23,963; low-medium: 23,964-80,751; medium: 80,752-203,654; medium-high: 203,655-363,305; highest: 363,306-783,144.

For this analysis, we used ZCTA-level RSEI toxicity-weighted concentration that combines exposure across all modeled toxic chemicals from 2016 RSEI geographic microdata. We used the ZCTA to ZIP code crosswalk published by the US Health Resources and Services Administration (HRSA) to assign ZCTA-level estimates to residential ZIP codes. RSEI data from 2016 were used so that pollution exposures occurred prior to recorded health outcome diagnosis date within the dataset, though the timing of true disease onset cannot be determined and may have preceded exposure assessment. Together, these distance-based and pollution-based exposure measures offer complementary pictures of how industrial pollution may relate to health risks in Louisiana.

Quantitative data analysis

Analytic subsamples

For adult health outcomes, we restricted the analytic sample to non-smoking adults aged 18 and older. Smoking status was determined using the less restrictive method described above for identifying health outcomes- specifically, if any diagnosis on any claim in any year contained one of a list of ICD-10-CM diagnostic codes that corresponded to tobacco use. We used the codes listed for "Tobacco Use Disorders" from CCW's Other Chronic Health, Mental Health, and Potentially Disabling Conditions code list for "Tobacco Use Disorders.[62] Non-smoking adults were defined as adults who had no documented ICD-10-CM codes for tobacco use on any claim record.

For analyses of health outcomes only applicable to women (e.g., uterine fibroids) or men (e.g., prostate cancer), we restricted the analytic sample to non-smoking women aged 18 and over and non-smoking men aged 18 and over, respectively. For analyses of pregnancy-related health outcomes, we restricted the analytic sample to non-smoking women aged 18 and older who had ever been pregnant. To identify the history of pregnancy, we used the less restrictive method described above for identifying health outcomes: specifically, if any diagnosis on any claim in any year contained one of a list of diagnostic or procedure codes related to pregnancy, the beneficiary was considered to have been pregnant. The list of pregnancy-related diagnostic and procedure codes included all ICD-10-CM and International Classification of Diseases, 10th Revision, Procedure Coding System (ICD-10-PCS) codes listed in the "Ever pregnant" tab of the CMS TAF-RIF "Maternal and Infant Health (MIH): Identifying Pregnant and Postpartum Beneficiaries in Medicaid and CHIP Administrative Data" reference codes document.[63]

For child health outcomes, we restricted the analytic sample to beneficiaries whose age at study inclusion was 17 years or younger. For birth-related outcomes, we restricted the analytic sample to those whose age at study inclusion was 1 year or younger.

Data source	Years	Relevant variables
Medicaid Research Identifiable Files (RIFs)	2017-2019	Age, sex, race-ethnicity, household size, tobacco use, health outcomes
Louisiana Department of Environmental Quality (LDEQ)	2017	Locations of industrial facilities; facility North American Industry Classification System (NAICS) codes
Risk Screening Environmental Indicators (RSEI)	2016	Toxicity-weighted concentrations of chemicals in the air (based on TRI-reported emissions from certain industrial facilities)

Table 6. Summary of quantitative data sources

Multivariate analysis

Understanding "Risk" vs. "Rate"
In everyday conversation, we often say things like "the rate of asthma is higher in this area." In casual use, rate is often used to mean "how common something is" or "how likely it is to happen." In statistics, however, risk and rate have specific and different meanings.

Risk refers to the chance that a person will develop a health condition in a specific period of time. When we report a **risk ratio**, we are comparing that chance between two groups.
For example:
If one group has a risk ratio of **1.20**, that means that their chance of developing the condition is **20% higher** than the group they are being compared to.

Rate refers to how quickly new cases occur in a population over time. Rates account for both the number of cases and how long people are observed (often expressed per 1,000 or 100,000 people per year).

In this report, we use the term **risk** because our analysis estimates differences in the likelihood of being diagnosed with a condition between groups, rather than how quickly cases occur over time.

We conducted two parallel sets of multivariate analyses with (1) the ZIP code distance-based binary variable and (2) the ZIP code toxicity-weighted air chemical concentration (log-transformed in the models, to adjust for skewed distribution of the data) as the primary explanatory variable. We calculated adjusted risk ratios (RRs) with 95% confidence intervals (corresponding to an α of 0.05) using modified Poisson regression with robust (sandwich) standard errors, implemented through generalized estimating equations (GEE), with an exchangeable correlation structure to account for clustering of individuals within ZIP codes. In both models, RRs were adjusted for age and sex (except in the case of analyses conducted among a sex-based subgroup, such as non-smoking women). For the analyses of nutritional anemia and other acquired anemia, we also controlled for the proportion of the individual's residential ZIP code that was within food desert census tracts (see below). Outcomes with risk ratios (RRs) whose 95% CIs included 1 (the null value) were considered not statistically significant. All multivariate analyses were conducted in SAS Enterprise Guide within the CCW VRDC. Additional detail on these methods is available in Appendix A.

Excess cases among the exposed

To help interpret the public health impact of observed associations, we calculated the attributable fraction among the exposed (AFe) for each health outcome that was statistically significant in both the distance-based and pollution-based exposure models described above. The AFe estimates the proportion of cases among individuals living in ZIP codes closest to petrochemical facilities and petroleum refineries that may be attributable to higher levels of industrial pollution exposure, assuming the association is causal. We then multiplied the AFe by the number of observed cases among exposed individuals to estimate the approximate number of excess cases associated with higher exposure levels. Although causal relationships cannot be established in this type of observational study, we calculated the AFe/excess cases to provide a more tangible estimate of the potential magnitude of public health impact associated with these exposures. These calculations were conducted in RStudio using exported, CMS-reviewed data output. Additional detail on these methods is available in Appendix A.

Other sensitivity analyses

Given that one of our consistent findings was that residential exposure to industrial pollution was associated with anemia, we chose to conduct a sensitivity analysis to assess if this finding could be explained away by any other nutrition-related exposure that might have similar patterns as industrial pollution, like living in an area where it is difficult to access healthy foods, often referred to as a "food desert". To assess the contribution of living in a food desert to the association between industrial pollution and anemia, we constructed a variable representing the proportion of residential area within each ZIP code designated as low-income and low-access to grocery stores. These designations were based on 2015 data from the USDA Food Access Research Atlas.[64] Because the Food Access Research Atlas data are available at the census tract level, we used the 2017 U.S. HUD ZIP Code Crosswalk to convert these data to ZIP code tabulation areas (ZCTAs). The Food Access Research Atlas provides a binary indicator for whether a census tract is classified as "low-income and low-access" (defined as no grocery store within 1 mile for urban tracts or within 10 miles for rural tracts). Using the crosswalk, we calculated the percentage of residential area within each ZCTA that falls within census tracts designated as low-income and low-access (i.e., a food desert). We then assigned ZCTAs to residential ZIP codes using a ZCTA to ZIP code crosswalk published by the US Health Resources and Services Administration (HRSA).[65] This variable was included in multivariate analyses of nutritional anemia and other acquired anemias as a covariate to account for any potential confounding by living in a food desert. The Food Access Research Atlas has a web-based interactive map feature, which we used to create a map of census tracts designated as food deserts.

We conducted additional sensitivity analyses with variations of health outcome definitions and restricting the sample to people with longer enrollment periods; more details are available in Appendix A.

Formal Advisory Board

We recruited Formal Advisory Board (FAB) members primarily through peer-to-peer communication and relationship-based outreach to individuals who lived across Louisiana and had relevant lived and/or professional experience in disproportionate burdens of environmental pollution and/or health in Louisiana. We leveraged established community networks and longstanding relationships with local leaders, organizers, and advocates, as well as seeking to go beyond initial networks to ensure a variety of different perspectives. Prospective FAB members participated in structured interviews as part of the selection process to assess candidates' understanding of communities' environmental health concerns, depth of connection to community members, and interest in supporting collaborative research activities. FAB members were selected with an eye towards geographic representation across Louisiana, community involvement, and capacity to support project activities.

The FAB was formally engaged and contracted in Spring 2025, with active participation spanning May 2025 through May 2026. Engagement began with two initial full-board meetings that introduced members to the research team, clarified roles and expectations, and outlined the project timeline and community engagement strategy. During the first month of service, the project team also conducted individual one-on-one meetings with each FAB member to discuss community-specific recruitment strategies, identify potential focus group locations, and coordinate in-person logistics. Individual consultations continued periodically throughout Summer 2025 to support recruitment efforts and address emerging needs. Prior to the launch of focus groups in June 2025, the team convened an additional full-board meeting to review and refine the CoDA presentation materials; this provided an opportunity for members to offer feedback on language, framing, and accessibility before community dissemination began. Throughout the project period, communication occurred regularly via scheduled meetings, email correspondence, and phone conversations, reflecting a flexible and responsive engagement model. FAB members also played a critical role in reviewing draft sections of the final report, providing guidance on terminology, contextual framing, and community relevance to ensure that findings were presented accurately and respectfully.

Spring 2025	Summer 2025	Fall 2025	Spring 2026
FAB recruitment and selection FAB kick-off and focus group coordination	FAB advising on focus group recruitment and focus group content FAB advising on preliminary quantitative analyses	FAB advising on continued focus groups FAB advising on continued quantitative analyses	FAB advising on finalized quantitative findings FAB advising on dissemination activities

Table 7. Timeline of Formal Advisory Board (FAB) activities

Focus groups

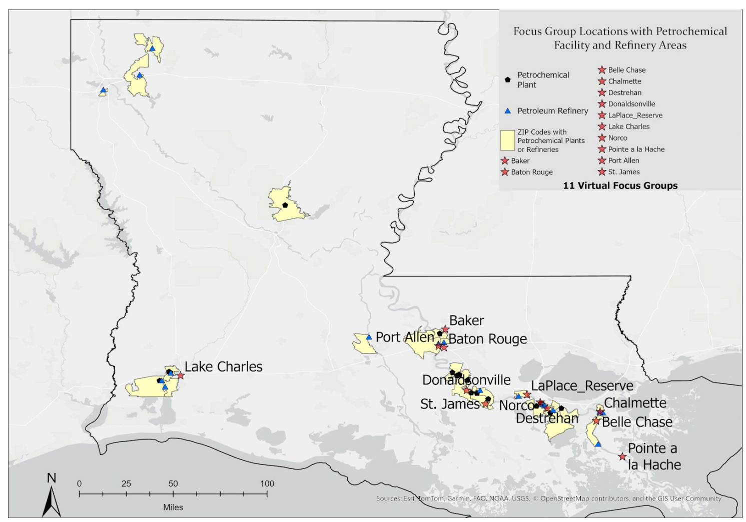


Figure 5. Locations of in-person focus groups; virtual focus groups were conducted with residents from industrial zones across the state.

The purpose of the focus groups was to interpret and contextualize quantitative health and environmental findings from a community perspective and to identify additional questions or analyses that residents considered relevant to their lived experiences.[38] Rather than serving solely as data collection activities, the focus groups functioned as collaborative analytic forums in which residents reviewed preliminary findings, discussed observed patterns, and offered explanations grounded in local knowledge. As part of these conversations, participants also often described health concerns they had personally experienced or observed in the areas where they lived, providing narrative context that helped situate statistical patterns within everyday community conditions.

Recruitment for focus groups was conducted through relationship-based outreach and direct community engagement, prioritizing trust and authenticity in participant selection. The team contacted local community organizations, advocacy groups, and neighborhood-based networks to share information about the project and upcoming sessions. The most effective approach was through connection with community leaders established through Formal Advisory Board members' introduction. Initial recruitment relied heavily on word-of-mouth referrals facilitated by FAB members and other trusted community leaders. These individuals then often played an active role in disseminating information within their respective communities to recruit additional participants, leveraging established relationships to encourage participation and engagement around environmental health concerns.The project team developed a recruitment flyer and QR code that allowed interested residents to review available dates, times, and locations and register for participation. For in-person focus groups, team members attended local events to table, distribute flyers, and speak directly with residents about the purpose of the study. FAB members also connected the team with local organizations engaged in environmental and health advocacy, which led to additional outreach through direct phone calls to community members who expressed interest. Virtual focus groups followed a similar referral-based approach, with participants often recommending others within their networks. This personalized recruitment strategy helped ensure that participants had lived experience relevant to the study areas and contributed to the need for multiple focus groups in several communities due to strong local interest. Eligibility for participation required individuals to be adults (ages 18+) residing in, or closely connected to, the region under discussion and willing to engage in a group-based discussion focused on health and environmental conditions.

Location	Date	Setting	# of Participants
Baker	July 9, 2025	In-person	5
Baker	July 16, 2025	In-person	6
Baker	August 14, 2025	Virtual	5
Baker	August 17, 2025	Virtual	4
Baker	August 20, 2025	Virtual	4
Chalmette	August 24, 2025	Virtual	1
Destrehan	August 21, 2025	Virtual	5
East Baton Rouge	July 30, 2025	In-person	12
East Baton Rouge	August 4, 2025	In-person	8
East Baton Rouge	August 6, 2025	In-person	2
Lake Charles / Sulphur	July 26, 2025	In-person	16
Laplace	July 23, 2025	In-person	8
St. James	July 18, 2025	In-person	42
Statewide	October 28, 2025	Virtual	2
Statewide	October 14, 2025	Virtual	3
Statewide	October 16, 2025	Virtual	3
Statewide	October 24, 2025	Virtual	1
Statewide	November 11, 2025	Virtual	2
Statewide	November 13, 2025	Virtual	2
Statewide	April 1, 2026	Virtual	2
Statewide	April 6, 2026	Virtual	2
Statewide	April 8, 2026	Virtual	2

Table 8. Summary of CoDA focus groups.

The project team conducted eight in-person and 14 virtual focus groups to promote accessibility and equitable participation across Louisiana. Across the project period, a total of **135 participants** took part in the focus groups to workshop preliminary analyses and identify next steps. These participants contributed critical insights that informed data interpretation, guided additional analyses, and strengthened the project's commitment to collaborative, community-engaged research. Virtual focus groups were held using a secure videoconferencing platform (Zoom) and allowed participation from residents who faced transportation, scheduling, or mobility constraints. In-person focus groups were hosted at accessible, trusted community locations, including local public libraries and community organization facilities. These venues were selected to foster participant comfort, reduce barriers to attendance, and support open, respectful discussion.

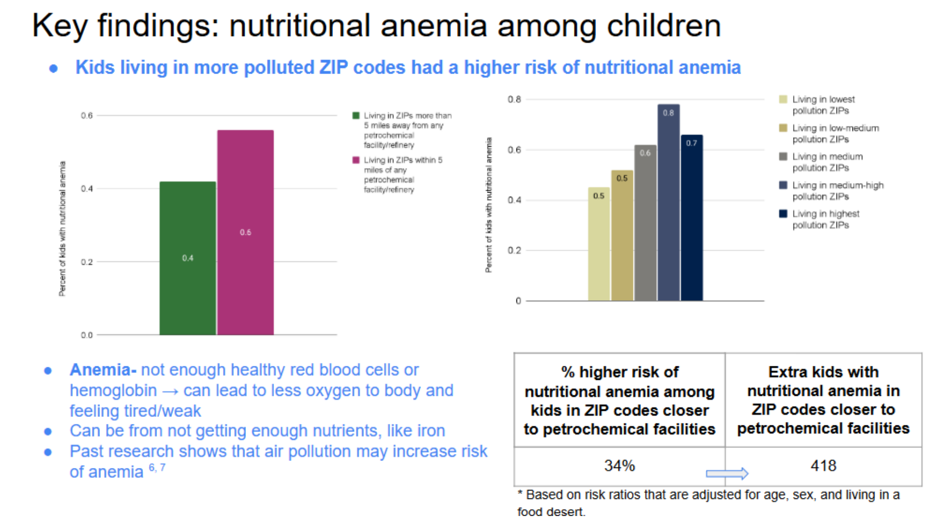


Figure 6. Example of data presentation in community focus groups.

Prior to participation, individuals were informed of the purpose of the focus group, procedures for maintaining confidentiality, and expectations for respectful dialogue. Informed consent was obtained from all participants in accordance with approved human subjects research protocols. Across both formats, the research team presented visual summaries of preliminary findings and explained analytic methods in clear, non-technical language. Discussions were facilitated using a semi-structured approach to ensure consistency across sessions while allowing participants to guide conversation toward issues they viewed as most relevant. Residents were encouraged to ask questions, reflect on whether findings aligned with their experiences, challenge interpretations, and suggest additional analyses, geographic comparisons, or outcomes for further exploration. Focus group conversations were typically ~60 minutes long. As a token of appreciation, participants received either a $25 gift card incentive (e.g., Visa, Amazon).

Figure 7. Baker, LA, August 2025.

The CoDA study recorded all focus groups to ensure that community perspectives were captured accurately for qualitative analysis. For virtual sessions, Zoom's built-in transcription feature was used to generate initial text, which was then reviewed and corrected by a research assistant while listening back to the audio recording. For in-person focus groups, a secure digital recording device and an IRB-approved Zoom transcription tool was used, followed by human review to correct any errors and redact any potentially identifying information to protect participant anonymity. Focus group transcripts were subsequently coded and analyzed to identify themes using Taguette, an open-source qualitative data analysis tool. From this, we then identified illustrative quotes for inclusion in this report.

Figure 8. Baton Rouge, LA, July 2025.

Results

Demographics of Medicaid sample

Table 9 shows how our analytic sample of Louisianans who were enrolled in Medicaid at any point in 2017, 2018, and/or 2019 compares to Louisianans statewide, using data from the US Census, the American Communities Survey, and the Louisiana Department of Health. Importantly, ~38% of all Louisianans are enrolled in Medicaid. Of note, while some individuals 65 and older are enrolled in both Medicaid and Medicare, we excluded those individuals from our sample because the Medicaid records did not include all of their health experiences (some of their health experiences were included in Medicare records, which we did not have access to). Overall, our study sample was younger and had more women, which was expected given Medicaid eligibility criteria and our study inclusion criteria.[66] We only had race/ethnicity (which is based on Medicaid enrollment data, and is not required for enrollment) for two-thirds of our sample, and the CMS Data Quality Atlas deemed the race/ethnicity data for Louisiana to be of "high concern" with regards to accuracy.[67] Nevertheless, among Medicaid beneficiaries in the sample who had documented race/ethnicity, non-Hispanic White and non-Hispanic Black were the most common race/ethnicity, similar to statewide data.[68] People in our sample had smaller household size than in the general population.[69] Tobacco use in the Medicaid sample was similar to statewide data for Louisiana; however, for the purposes of our analyses, we excluded people who used tobacco from our analyses.

About 36% of people in our sample lived in ZIP codes within 5 miles of petrochemical facilities or refineries. Available data suggest that hundreds of thousands of residents, particularly along the industrial corridor in Cancer Alley, live within 3-5 miles of petrochemical facilities and oil refineries, although a precise statewide estimate has not been reported.[70,71] In parishes in Cancer Alley, the percentage of residents residing within 5km (about 3 miles) of highly polluting petrochemical facilities ranged from 19% in East Baton Rouge Parish to 63% in St. Bernard Parish.[70]

Table 9. Demographics of study population compared to Louisiana statewide data.

	Analytic sample of Medicaid recipients in Louisiana, 2017-2019			All Louisianans, 2017
	Eligible for study inclusion (n= 1,615,089)	Lived in ZIP codes within 5 mi of petrochemical facility /refinery (n= 591,310)	Lived in ZIP codes > 5 mi away from petrochemical facility/refinery (n= 1,023,779)	Percent in Louisiana (n= 4,663,461)[1]
Eligible for Medicaid[2]	100	100	100	38.3
Age[1,3]				
Under 5 years	14.2	14.3	14.2	6.7
5 to 9 years	13.9	14.0	13.8	6.7

10 to 14 years	14.1	14.0	14.1	6.6
15 to 17 years	7.6	7.5	7.7	3.9
18 to 24 years	13.8	13.7	13.9	9.8
25 to 39 years	18.8	19.2	18.6	20.7
40 to 49 years	7.6	7.6	7.6	12.0
50 to 64 years	9.9	9.6	10.1	19.4
65+ years	0	0	0	14.0
Sex[1]				
Female	55.1	55.4	54.9	51.1
Male	44.9	44.6	45.1	48.9
Race / ethnicity[4]				
White, non-Hispanic	27.4	19.2	32.1	55.2
Black, non-Hispanic	32.5	38.7	28.9	30.2
Hispanic, all races	7.1	7.9	6.7	7.8
Other[5]	0.6	0.5	0.7	6.9
Missing	32.4	33.7	31.7	0
Household size[1]				
1 person	41.0	41.5	40.7	29.9
2 people	16.4	16.5	16.4	33.3
3 people	17.6	17.7	17.6	16.5
4 people or more	25.0	24.4	25.3	20.3
(1) Statewide comparison data from US Census Bureau American Communities Survey 2017 5-year estimates.[69,72]				
(2) Statewide comparison data from Louisiana Department of Health.[51]				
(3) Age in the study data is the age in the first year in which a beneficiary met eligibility criteria (i.e., may be from 2017, 2018, or 2019).				
(4) Statewide comparison data from US Census Bureau American Communities Survey 2017 1-year estimates.[68]				
(5) "Other" race/ethnicity category includes: Asian, non-Hispanic; American Indian and Alaska Native (AIAN), non-Hispanic; Hawaiian/Pacific Islander; non-Hispanic. Statewide comparison data includes these categories, and additionally "Some other race alone"; and "Two or more races".				

Overview of Health Findings

We conducted quantitative analyses to look at associations between residential exposure to industrial pollution and a wide variety of health outcomes among Medicaid recipients in Louisiana in response to residents' questions about different health issues of potential concern, and we complemented these analyses with discussions with residents in focus groups. Given the multitude of findings, we organize this report into the following sections. First, we share findings where there were consistently statistically significant associations between residential exposure to industrial pollution and health, regardless of how exactly we measured industrial pollution exposure. We separate the findings into children's health outcomes, women's health outcomes, and health outcomes among non-smoking adults. Second, we share where findings were mixed: either findings varied by how residential exposure to industrial pollution was measured, and/or findings varied between quantitative analyses and residents' lived experiences. In some of these instances, the quantitative analyses had no statistically significant different risk of health problems by industrial pollution exposure even when residents observed links; this could be because of limitations of the quantitative data. We want to make clear that because a health problem does not appear statistically significant in our Medicaid data, does not mean that the problem residents are experiencing does not exist. In the "Discussion" section, we suggest numerous explanations for this. Third, we share additional findings from the focus group conversations.

Primary Health Findings: Links Between Residential Exposure to Industrial Pollution and Health

Among children enrolled in Medicaid, higher residential exposure to industrial pollution was associated with increased risk of being diagnosed with nutritional anemia, learning disabilities, and dermatitis/eczema. Additionally, among children who were girls, higher residential exposure to industrial pollution was associated with an increased risk of early puberty. Among non-smoking adult women, higher exposure to industrial pollution was associated with increased risk of uterine fibroids and breast cancer. Among non-smoking women who had experienced pregnancy, living in more polluted areas was associated with an elevated risk of preeclampsia or eclampsia, miscarriage, and ectopic pregnancy. Among adults who did not use tobacco, higher exposure to industrial pollution was associated with increased risks of nutritional anemia and other acquired anemias.

Quantitative findings were complemented and contextualized through fourteen virtual and eight in-person focus groups conducted across industrial regions of Louisiana. Participants reviewed preliminary results, shared lived experiences related to environmental exposures and health, and provided feedback that informed interpretation, communication priorities, and subsequent analyses. Community discussions frequently reinforced the plausibility of observed patterns, highlighted cumulative and intergenerational health concerns, and emphasized the need for accessible, transparent presentation of findings.

Children's health

Nutritional anemia

Anemia is a condition characterized by low levels of healthy red blood cells, which can lead to symptoms like fatigue and weakness; nutritional anemia is when anemia is caused by not having enough nutrients (like iron or B12) to support having a healthy number of red blood cells. Among children, living in an area with higher exposure to industrial pollution was associated with increased likelihood of being diagnosed with nutritional anemia, even after adjusting for age, sex, and proportion of the ZIP code that was categorized by USDA as being a food desert. Children who lived in ZIP codes closer to petrochemical plants and petroleum refineries were 34% more likely to be diagnosed with nutritional anemia than children who lived in ZIP codes more than 5 miles away (RR: 1.34, 95% CI: 1.13-1.59). For every ten-fold increase in the concentration of ZIP code-level toxic air pollution, children's risk of being diagnosed with nutritional anemia increased by 16% (RR: 1.16, 95% CI: 1.09-1.23). Controlling for food access did not affect these results (risk ratios and 95% CIs remained the same).

Table 10 shows the estimated percent increase in risk and additional cases of nutritional anemia among children living near (within 5 miles of) petrochemical facilities and petroleum refineries. Although this finding cannot be interpreted as definitively causal, if we were to assume that our results represent the true causal association between residential exposure to industrial pollution and nutritional anemia among children, approximately 418 more cases of nutritional anemia among children occurred in ZIP codes closest to petrochemical facilities and petroleum refineries that may not have occurred if these individuals had lived in ZIP codes farther away.

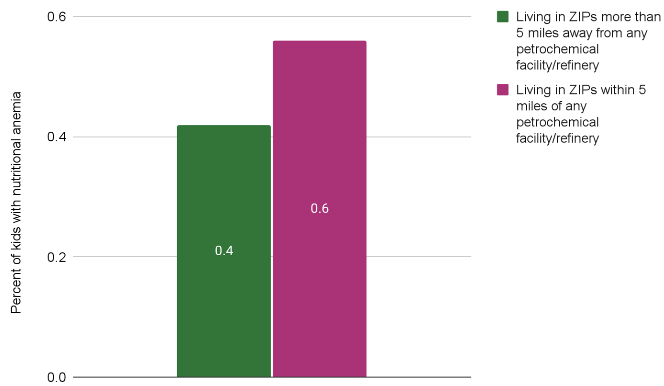


Figure 9. Percentage of children diagnosed with nutritional anemia by distance to the 40 selected petrochemical facilities and petroleum refineries. ZIP codes more than 5 miles away from a facility are shown in green (left), and ZIP codes within 5 miles are shown in red/purple (right).

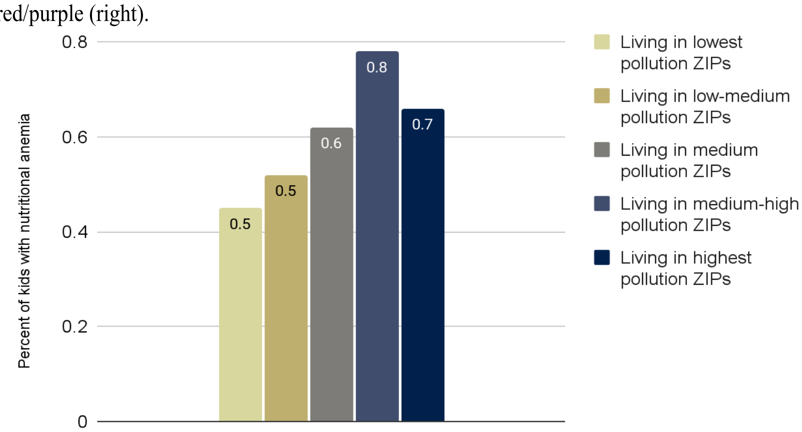


Figure 10. Percentage of children diagnosed with nutritional anemia by residential exposure to air pollution (specifically, ZIP code level of estimated toxicity-weighted chemical air pollution). ZIP codes with the lowest pollution estimates are in light tan (left), and ZIP codes with the highest air pollution estimates are in darkest blue (right).

% higher risk of nutritional anemia among kids in ZIP codes closer to petrochemical facilities	Extra children with nutritional anemia in ZIP codes closer to petrochemical facilities
34%	418

Table 10. Estimated increase in nutritional anemia risk (%) and additional cases among children living near (within 5 miles of) petrochemical facilities and petroleum refineries.

Focus group participants had experience with anemia in their families and communities, and questions about its origin:

"Hypertension and asthma and seasonal allergies and autism, and all of that stuff. ***But diabetes, anemia; that's what we hear all the time.*** *We also hear about headaches, migraines and chronic headaches."*
-Focus Group Participant, Virtual, October 2025

Learning disabilities

The types of learning disabilities measured in our data included various speech disorders, auditory processing disorders, motor control issues, and problems with reading (including dyslexia) and/or doing math. Among children, living in an area with higher exposure to industrial pollution was associated with increased likelihood of being diagnosed with a learning disability. Kids who lived in ZIP codes within 5 miles of petrochemical plants and petroleum refineries were 20% more likely to be diagnosed with a learning disability than children who lived in ZIP codes that were further away (RR: 1.20, 95% CI: 1.05-1.37). For every ten-fold increase in the concentration of ZIP code-level toxic air pollution, children's risk of being diagnosed with a learning disability increased by 12% (RR: 1.12, 95% CI: 1.06-1.18).

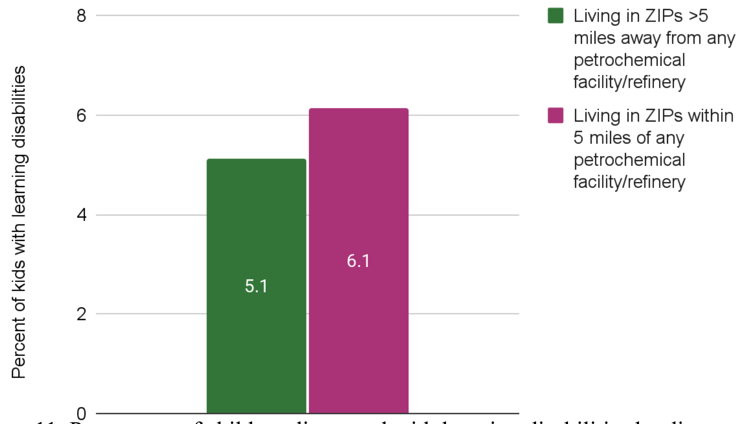


Figure 11. Percentage of children diagnosed with learning disabilities by distance to the 40 selected petrochemical facilities and petroleum refineries. ZIP codes more than 5 miles away from a facility are shown in green (left), and ZIP codes within 5 miles are shown in red/purple (right).

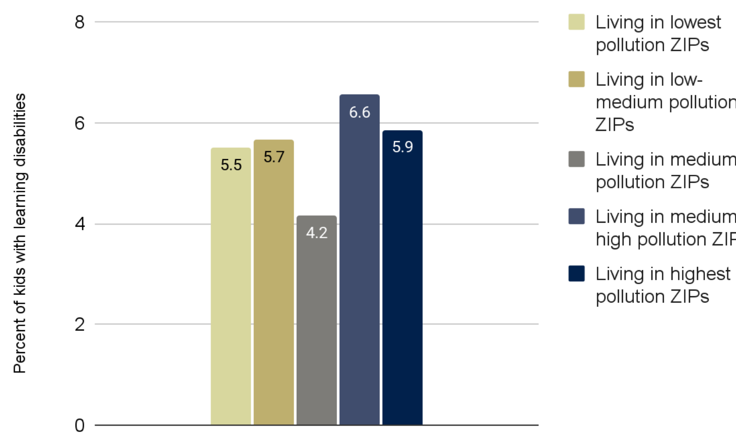


Figure 12. Percentage of children diagnosed with learning disabilities by residential exposure to air pollution (specifically, ZIP code level of estimated toxicity-weighted chemical air pollution). ZIP codes with the lowest pollution estimates are in light tan (left), and ZIP codes with the highest air pollution estimates are in darkest blue (right).

Table 11 shows the estimated percent increase in risk and additional cases of learning disability among children living near (within 5 miles of) petrochemical facilities and petroleum refineries. Although this finding is not definitively causal, if we were to assume that our results represent the true causal association between residential exposure to industrial pollution and learning disability among children, approximately 3,009 more cases of learning disability among children occurred in ZIP codes closest to petrochemical facilities and petroleum refineries that may not have occurred if these individuals had lived in ZIP codes farther away.

% higher risk of learning disabilities in ZIP codes closer to petrochemical facilities	**Extra children with learning disabilities in ZIP codes closer to petrochemical facilities**
20%	3,009

Table 11. Estimated increase in learning disability risk (%) and additional cases among children living near (within 5 miles of) petrochemical facilities and petroleum refineries.

These findings aligned with many focus group participants' own observations about children struggling in school. For example, a participant in one of our October 2025 virtual focus groups shared, *"I volunteer a lot at some of the local schools. And I see now it's* ***a lot of children that have learning disabilities, especially with reading and math****, and I've also noticed* ***a lot of speech delays from the children*** *that I currently work with as well."*

Other participants reported noticing links between residential pollution exposures and learning disabilities. A July 2025 Baton Rouge focus group participant noted, *"****I have great-grandkids, and now both of them have learning disabilities****. And they are right there, less than 5 miles from the red zone [ZIP codes within 5 miles of a petrochemical facility or refinery]."*

Other focus group participants discussed the implications of the attributable risk findings:*"So I'm just here to say we understand that extra* ***kids are diagnosed with learning disability. It may not be nothing to you, but it's something to me [because] the kids are labeled. The kids are labeled as bad kids, as slow kids,*** *right here in St James . . . the disciplinary rate was horrible. All it took was some people to come in and start saying, Okay, there's a chemical imbalance. That's environmental destruction [and] they don't have nobody fighting for them. All the kids are doing is getting a label put on. . . a diagnosis they don't know how to act."* -Focus Group Participant, St. James, August 2025

"I grew up in Belle Chasse which has quite a few plants. We have Chevron, we have Alliance, we used to have Philips 66 as well. So I grew up in an area that has a lot of plants, and then I came back to teach in that same area. I graduated from high school 10 years ago, but in the last… couple of years in our area, we have seen an increasing amount of kids with ADHD. We have a lot of kids with high-functioning autism, and our district is a very high-performing district, but ***just to see the number of special education students rise over the years is quite alarming*** *and so looking at you guys' results, I do see some correlations with that because we have kids that are 5 years old, that have delayed speech, and they're coming to us with a lot of disabilities now, so I definitely think that that's a correlation."* -Focus Group Participant, Virtual, October 2025

Dermatitis and eczema

Dermatitis and eczema are skin conditions characterized by itchiness, redness, and rash. Among children, living in an area with higher exposure to industrial pollution was associated with increased likelihood of being diagnosed with dermatitis and/or eczema. Kids who lived in ZIP codes within 5 miles of petrochemical plants and petroleum refineries were 10% more likely to be diagnosed with dermatitis and/or eczema than children who lived in ZIP codes that were further away (RR: 1.10, 95% CI:

1.01-1.20). For every ten-fold increase in the concentration of ZIP code-level air pollution, children's risk of being diagnosed with dermatitis and/or eczema increased by 6% (RR: 1.06, 95% CI: 1.03-1.08).

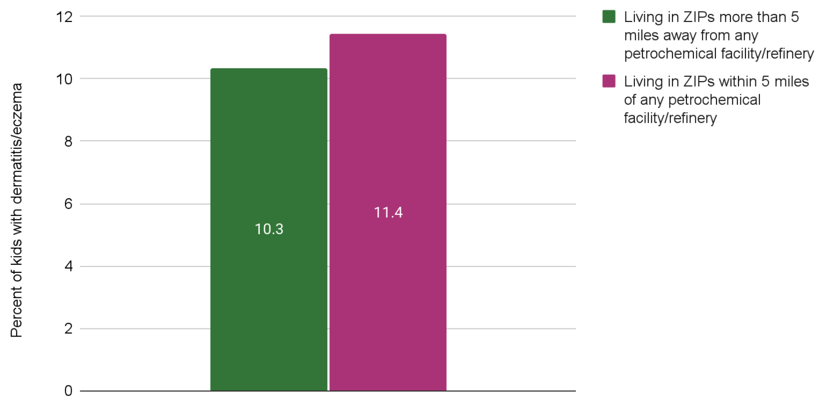


Figure 13. Percentage of children diagnosed with dermatitis and eczema by distance to the 40 selected petrochemical facilities and petroleum refineries. ZIP codes more than 5 miles away from a facility are shown in green (left), and ZIP codes within 5 miles are shown in red/purple (right).

Table 12 shows the estimated percent increase in risk and additional cases of dermatitis/eczema among children living near (within 5 miles of) petrochemical facilities and petroleum refineries. Although this finding cannot be interpreted as definitively causal, if we were to assume that our results represent the true causal association between residential exposure to industrial pollution and dermatitis/eczema among children, approximately 3,058 more cases of dermatitis/eczema among children occurred in ZIP codes closest to petrochemical facilities and petroleum refineries that may not have occurred if these individuals had lived in ZIP codes farther away.

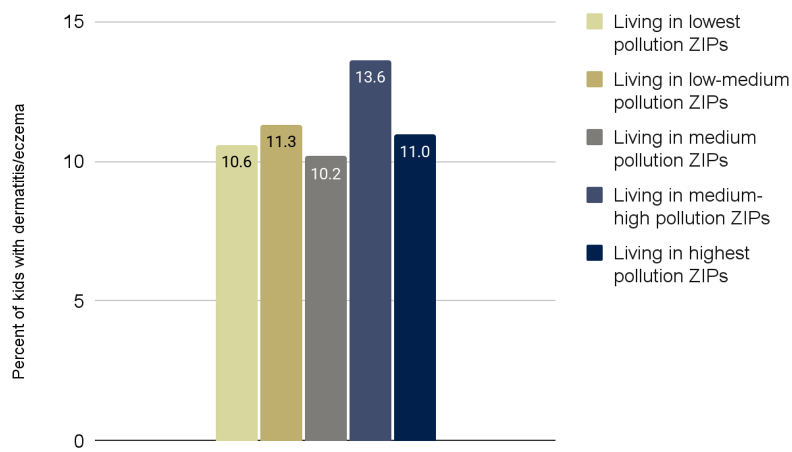


Figure 14. Percentage of children diagnosed with dermatitis and eczema by residential exposure to air pollution (specifically, ZIP code level of estimated toxicity-weighted chemical air pollution). ZIP codes with the lowest pollution estimates are in light tan (left), and ZIP codes with the highest air pollution estimates are in darkest blue (right).

% higher risk of dermatitis/eczema in kids in ZIP codes closer to petrochemical facilities	Extra kids with dermatitis/eczema in ZIP codes closer to petrochemical facilities
10%	3,058

Table 12. Estimated increase in dermatitis/eczema risk (%) and additional cases among children living near (within 5 miles of) petrochemical facilities and petroleum refineries.

*"**Growing up in New Orleans, most of us had dermatitis in some shape or form**, not to mention all the other things that were mentioned. So, thank you guys for doing this."* -Focus Group Participant, Virtual, October 2025

Early puberty among girls

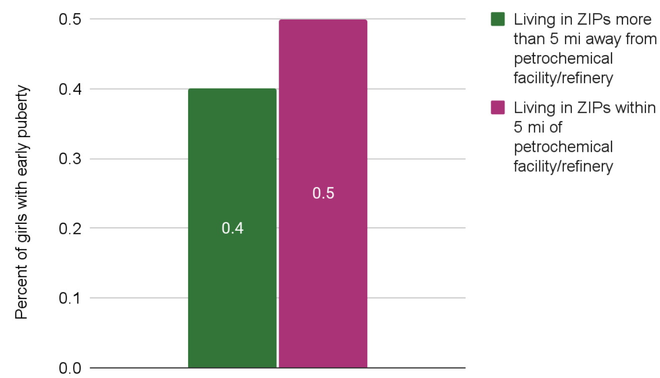


Figure 15. Percentage of children who are girls diagnosed with early puberty by distance to the 40 selected petrochemical facilities and petroleum refineries. ZIP codes more than 5 miles away from a facility are shown in green (left), and ZIP codes within 5 miles are shown in red/purple (right).

Early ("precocious") puberty in girls is typically defined as having the first menstrual period, breast development, and/or other signs of puberty before age 8. Among children who were girls, living in an area with higher exposure to industrial pollution was associated with increased likelihood of being diagnosed with early puberty, after adjusting for age. Girls who lived in ZIP codes closer to petrochemical plants and petroleum refineries were 24% more likely to be diagnosed with early puberty than girls who lived in ZIP codes more than 5 miles away (RR: 1.24, 95% CI: 1.10-1.41). For every ten-fold increase in the concentration of ZIP code-level toxic air pollution, girls' risk of being diagnosed with early puberty increased by 9% (RR: 1.09, 95% CI: 1.04-1.16).

Table 13 shows the estimated percent increase in risk and additional cases of early puberty among girls living near (within 5 miles of) petrochemical facilities and petroleum refineries. Although this finding cannot be interpreted as definitively causal, if we were to assume that our results represent the true causal association between residential exposure to industrial pollution and early puberty among girls, approximately 147 more cases of early puberty among girls who have been pregnant occurred in ZIP codes closest to petrochemical facilities and petroleum refineries that may not have occurred if these individuals had lived in ZIP codes farther away.

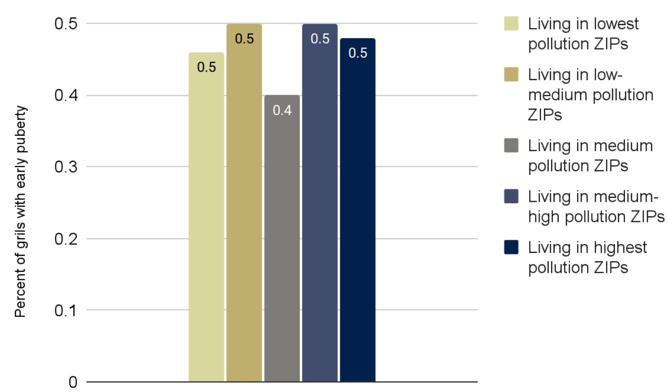


Figure 16. Percentage of girls diagnosed with early puberty by residential exposure to air pollution (specifically, ZIP code level of estimated toxicity-weighted chemical air pollution). ZIP codes with the lowest pollution estimates are in light tan (left), and ZIP codes with the highest air pollution estimates are in darkest blue (right).

% higher risk of early puberty in girls in ZIP codes closer to petrochemical facilities	Extra girls with early puberty in ZIP codes closer to petrochemical facilities
24%	147

Table 13. Estimated increase in early puberty risk (%) and additional cases among girls living near (within 5 miles of) petrochemical facilities and petroleum refineries.

Focus group participants spoke of their experience with early puberty among girls in their communities. According to one participant: ***I know several kids in the area who I know who had early puberty… who got their periods at age 8.*** *I thought that was… well, I don't have any kids, so I thought that was, like, strange, because I didn't get my cycle until I was 11. So, just to hear parents or grandparents tell me their grandbabies had their cycles at 8. I thought, what's happening that kids are getting it? I thought that was really early. This finding is interesting.* -Focus Group Participant, Virtual, April 2026

Table 14. Key findings of multivariate analysis of children's health outcomes (risk ratios and 95% confidence intervals), among all children aged 0-17 years (n=804,357).		
Health outcome	**Distance model RR (95% CI)**	**Air pollution model RR (95% CI)**
Nutritional anemia	1.34 (1.13-1.59)	1.16 (1.09-1.23)
Learning disabilities	1.20 (1.05-1.37)	1.12 (1.06-1.18)
Dermatitis and eczema	1.10 (1.01-1.20)	1.06 (1.03-1.08)
Early puberty (among girls only)	1.24 (1.10-1.41)	1.09 (1.04-1.16)

Women's Health

Uterine fibroids

Uterine fibroids are non-cancerous growths in the uterus that can cause heavy periods, pain, anemia, and sometimes fertility or pregnancy problems. Among women, living in an area with higher exposure to industrial pollution was associated with increased likelihood of being diagnosed with uterine fibroids. Women who lived in ZIP codes closer to petrochemical plants and petroleum refineries were 16% more likely to be diagnosed with fibroids than women who lived in ZIP codes more than 5 miles away (RR: 1.16, 95% CI: 1.05-1.28). For every ten-fold increase in ZIP code toxic air pollution levels, women's risk of being diagnosed with fibroids increased by 6% (RR: 1.06, 95% CI: 1.03-1.10).

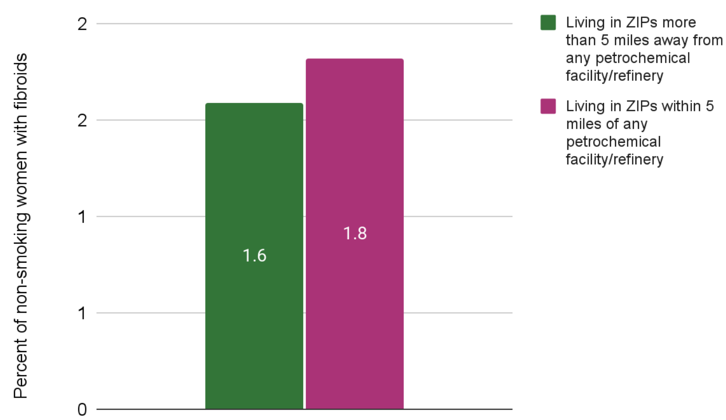


Figure 17. Percentage of non-smoking adult (18 years of age and older) women diagnosed with uterine fibroids by distance to the 40 selected petrochemical facilities and petroleum refineries. Prevalence of fibroids among women living in ZIP codes more than 5 miles away from a facility are shown in green (left), and ZIP codes within 5 miles are shown in red/purple (right).

Table 15 shows the estimated percent increase in risk and additional cases of uterine fibroids among non-smoking women living near (within 5 miles of) petrochemical facilities and petroleum refineries. Although this finding cannot be interpreted as definitively causal, if we were to assume that our results represent the true causal association between residential exposure to industrial pollution and uterine fibroids, approximately 458 more cases of uterine fibroids among non-smoking women who have been pregnant occurred in ZIP codes closest to petrochemical facilities and petroleum refineries that may not have occurred if these individuals had lived in ZIP codes farther away.

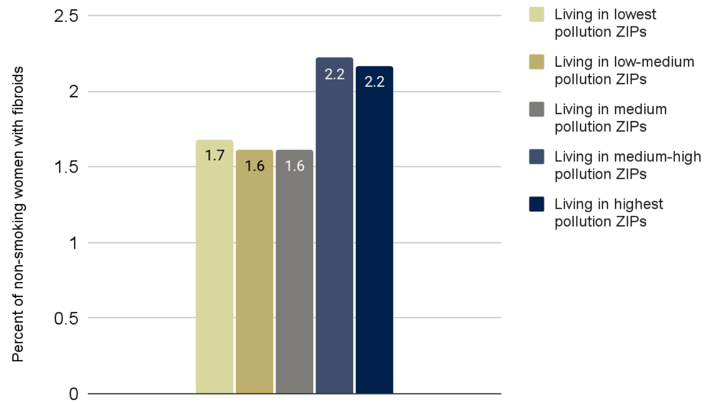


Figure 18. Percentage of non-smoking adult (18 years of age and older) women diagnosed with uterine fibroids by residential exposure to air pollution (specifically, ZIP code level of estimated toxicity-weighted chemical air pollution). ZIP codes with the lowest pollution estimates are in light tan (left), and ZIP codes with the highest air pollution estimates are in darkest blue (right).

% higher risk of uterine fibroids in ZIP codes closer to petrochemical facilities	**Extra women with uterine fibroids in ZIP codes closer to petrochemical facilities**
16%	458

Table 15. Estimated increase in uterine fibroid risk (%) and additional cases among non-smoking women living near (within 5 miles of) petrochemical facilities and petroleum refineries."

Many women who participated in the focus groups spoke about living with uterine fibroids:
"I just found that, especially with fibroids, ***I've had so many girlfriends, who have had fibroids and have had them removed.****"* -Focus Group Participant, Virtual, October 2025

"I know that ***my mom had fibroids. My sister had fibroids,*** *but we never even considered that an issue. So, this new information still just fits right in."* -Focus Group Participant, Virtual, October 2025

"I'm familiar with a few people who have been affected. In the neighborhood that I live in, I'm near the Denka, DuPont plant. I remember… a lot of my neighbors in the area have cancer, but at any rate, fibroids was there too. . . So I'm… ***I'm familiar with a couple of people who said that they had major issues with fibroids, and I ended up having to have hysterectomies, because of the fibroids****."* -Focus Group Participant, Virtual, October 2025

"I know of at least one person who, before they moved to the area, they were told they had…quarter size [fibroids]. . . And then when they moved into the area. . . and had their annual exam by their gynecologist, and they had grown. [They were] much bigger, and within 2 years, ***the doctor was telling her it had gone from the size of a bubble gum to a grapefruit. . .And she ended up having to have a hysterectomy because they were so big****. Wow. [they] had gotten so big, and the only thing that had changed in her life*

was that she moved in the neighborhood. . . and moved closer to… to the plant." -Focus Group Participant, Virtual, October 2025

Breast cancer

Breast cancer is a disease in which abnormal cells in the breast grow uncontrollably, and can be life-threatening. Among women without a documented history of smoking, living in an area with higher exposure to industrial pollution was associated with increased likelihood of being diagnosed with breast cancer. Women who lived in ZIP codes closer to petrochemical plants and petroleum refineries were 10% more likely to be diagnosed with breast cancer than women who lived in ZIP codes more than 5 miles away (RR: 1.10, 95% CI: 1.02-1.19). For every ten-fold increase in the concentration of ZIP code-level toxic air pollution, women's risk of being diagnosed with breast cancer increased by 6% (RR: 1.06, 95% CI: 1.03-1.09).

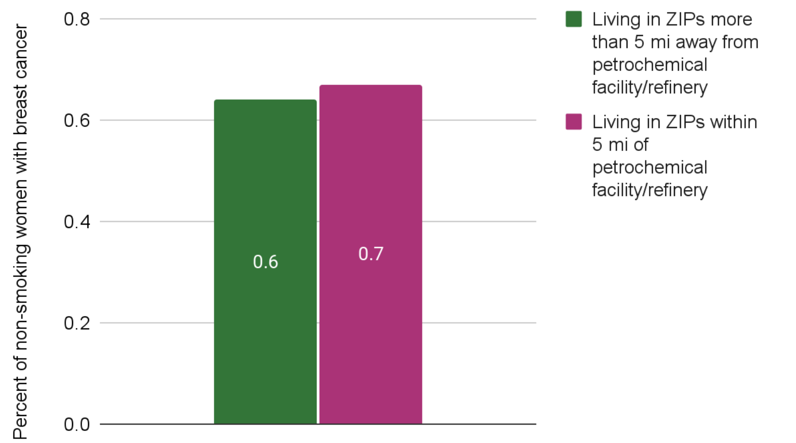


Figure 19. Percentage of non-smoking adult (18 years of age and older) women diagnosed with breast cancer by proximity to the 40 selected petrochemical facilities and petroleum refineries. ZIP codes more than 5 miles away from a facility are shown in green (left), and ZIP codes within 5 miles are shown in red/purple (right).

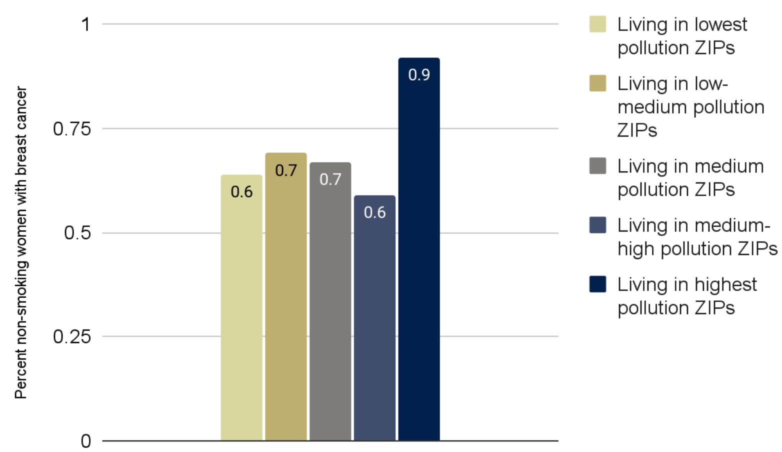


Figure 20. Percentage of non-smoking adult (18 years of age and older) women diagnosed with breast cancer by residential exposure to air pollution (specifically, ZIP code level of estimated toxicity-weighted chemical air pollution). ZIP codes with the lowest pollution estimates are in light tan (left), and ZIP codes with the highest air pollution estimates are in darkest blue (right).

Table 16 shows the estimated percent increase in risk and additional cases of breast cancer among non-smoking women living near (within 5 miles of) petrochemical facilities and petroleum refineries. Although this finding cannot be interpreted as definitively causal, if we were to assume that our results represent the true causal association between residential exposure to industrial pollution and breast cancer, approximately 111 more cases of breast cancer among non-smoking women who have been pregnant occurred in ZIP codes closest to petrochemical facilities and petroleum refineries that may not have occurred if these individuals had lived in ZIP codes farther away.

% higher risk of breast cancer in ZIP codes closer to petrochemical facilities	Extra women with breast cancer in ZIP codes closer to petrochemical facilities
10%	111

Table 16. Estimated increase in breast cancer risk (%) and additional cases among non-smoking women living near (within 5 miles of) petrochemical facilities and petroleum refineries.

Focus group participants voiced observations and concerns about breast cancer in their communities. One described extensive family history of breast cancer among family members who lived in the same place: *"I'm a third-generation… family member with breast cancer. My grandmother died of breast cancer, my mother died. My sister's a 17-year survivor…* ***My sister, my mother, and myself had genetics testing at Ochsner…to see if we had the cancer gene*** *in our, you know, DNA, and* ***it was determined it was environmental… We always thought it was just in the family, but it's not. It's just environmental****. . . I'm from St. John Parish, but across the river from LaPlace, where I grew up. The plant is directly across the river from…where I grew up."* -Focus Group Participant, Virtual, October 2025

Another described cases among neighbors: *"****Just on my street, I may know. . . about 7 or 8 women [with breast cancer]. And that's way too many.*** *And there's a whole lot more people that I know just in my neighborhood with other forms of cancer."* -Focus Group Participant, Virtual, October 2025

Another highlighted diagnoses among women with younger ages: *"Definitely think there's a serious correlation with breast cancer, especially with the increased diagnosis in that area… I have…* ***a portion of my family where the girls that were all first cousins were all diagnosed with breast cancer by the time they were in their 20s.*** *So, it's… I know there's a genetic component of it, um, but, you know, I'm wondering how much the environment has to do with it as well. One of my little cousins, she passed… she actually passed about a year and a half ago at the age of 38, and one of them just had a mastectomy, and she's 29."* -Focus Group Participant, Virtual, October 2025

Table 17. Key findings of multivariate analysis of women's health outcomes (risk ratios and 95% confidence intervals), among all non-smoking women aged 18 years and older (n= 494,920).

Health outcome	Distance model RR (95% CI)	Air pollution model RR (95% CI)
Uterine fibroids	1.16 (1.05-1.28)	1.06 (1.03-1.10)
Breast cancer	1.10 (1.02-1.19)	1.06 (1.03-1.09)

Women's Health: Pregnancy-related health outcomes

Ectopic pregnancy

Ectopic pregnancy occurs when a fertilized egg implants outside the uterus, most commonly in the fallopian tube, and can be life-threatening if not treated promptly. Among women who experienced pregnancy, living in an area with higher exposure to industrial pollution was associated with increased risk of ectopic pregnancy. Non-smoking women with history of pregnancy who lived in ZIP codes closer to petrochemical plants and petroleum refineries were 18% more likely to be diagnosed with ectopic pregnancy than those who lived in ZIP codes more than 5 miles away (RR: 1.18, 95% CI: 1.02-1.37). For every ten-fold increase in the concentration of ZIP code-level toxic air pollution, non-smoking women with a history of pregnancy had a 9% increase in risk of being diagnosed with ectopic pregnancy (RR: 1.09, 95% CI: 1.02-1.16).

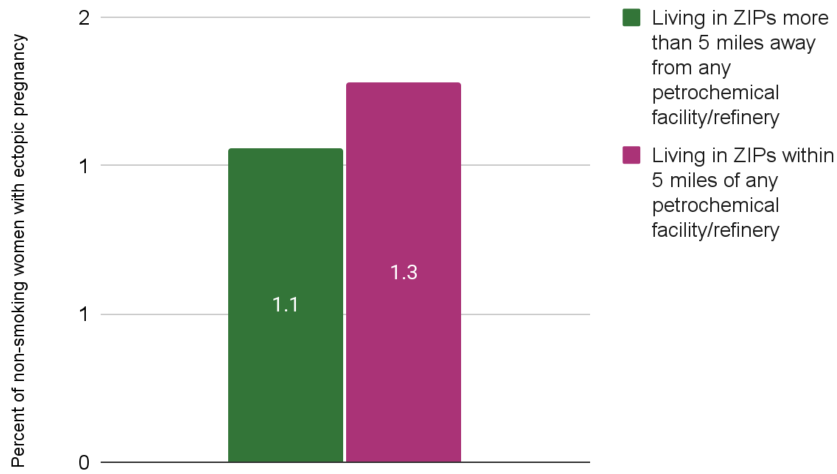


Figure 21. Percentage of non-smoking adult (18+ years of age) women who experienced pregnancy who were diagnosed with ectopic pregnancy by distance to the 40 selected petrochemical facilities and petroleum refineries. ZIP codes more than 5 miles away from a facility are shown in green (left), and ZIP codes within 5 miles are shown in red/purple (right).

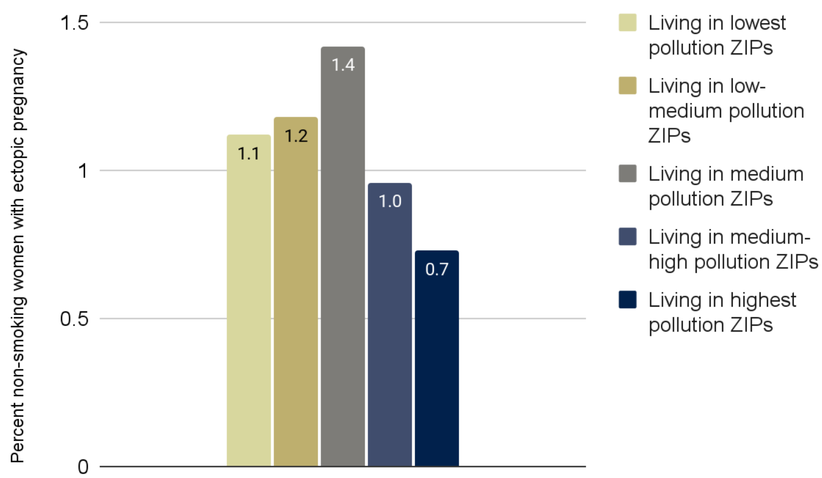


Figure 22. Percentage of non-smoking adult (18 years of age and older) women who experienced pregnancy diagnosed with ectopic pregnancy by residential exposure to air pollution (specifically, ZIP code level of estimated toxicity-weighted chemical air pollution). ZIP codes with the lowest pollution estimates are in light tan (left), and ZIP codes with the highest air pollution estimates are in darkest blue (right).

Table 18 shows the estimated percent increase in risk and additional cases of miscarriage among non-smoking women who have been pregnant living near (within 5 miles of) petrochemical facilities and petroleum refineries. Although this finding cannot be interpreted as definitively causal, if we were to assume that our results represent the true causal association between residential exposure to industrial pollution and miscarriage, approximately 179 more cases of miscarriage among non-smoking women who have been pregnant occurred in ZIP codes closest to petrochemical facilities and petroleum refineries that may not have occurred if these individuals had lived in ZIP codes farther away.

% higher risk of ectopic pregnancy in ZIP codes closer to petrochemical facilities	Extra women with ectopic pregnancy in ZIP codes closer to petrochemical facilities
18%	70

Table 18. Estimated increase in ectopic pregnancy risk (%) and additional cases among non-smoking women who have been pregnant living near (within 5 miles of) petrochemical facilities and petroleum refineries.

Miscarriage

Miscarriage, or spontaneous pregnancy loss before 20 weeks of pregnancy, can occur when fetal development, implantation, or placental formation is disrupted. Among women who experienced pregnancy, living in an area with higher exposure to industrial pollution was associated with increased likelihood of miscarriage. Non-smoking women with history of pregnancy who lived in ZIP codes closer to petrochemical plants and petroleum refineries were 11% more likely to be diagnosed with miscarriage than those who lived in ZIP codes more than 5 miles away (RR: 1.11, 95% CI: 1.02-1.21). For every ten-fold increase in the concentration of ZIP code-level toxic air pollution, non-smoking women with a history of pregnancy had a 5% increase in risk of being diagnosed with miscarriage (RR: 1.05, 95% CI: 1.01-1.08).

Table 19 shows the estimated percent increase in risk and additional cases of miscarriage among non-smoking women who have been pregnant living near (within 5 miles of) petrochemical facilities and petroleum refineries. Although this finding cannot be interpreted as definitively causal, if we were to assume that our results

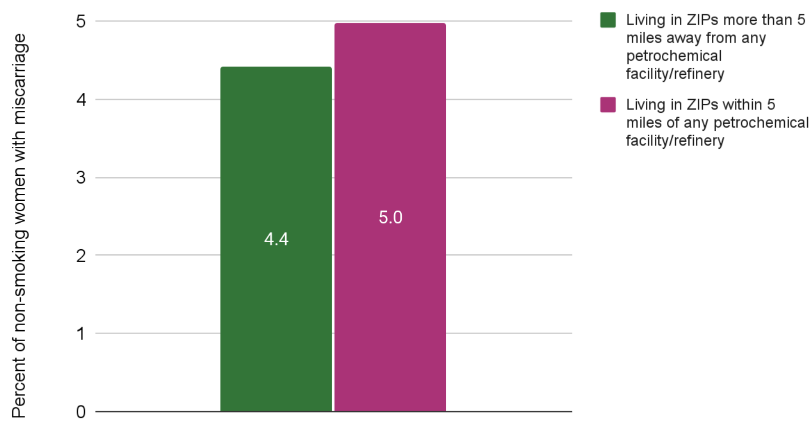


Figure 23. Percentage of non-smoking adult (ages 18+) women who experienced pregnancy diagnosed with miscarriage by distance to the 40 selected petrochemical facilities and petroleum refineries. ZIP codes more than 5 miles away from a facility are shown in green (left), and ZIP codes within 5 miles are shown in red/purple (right).

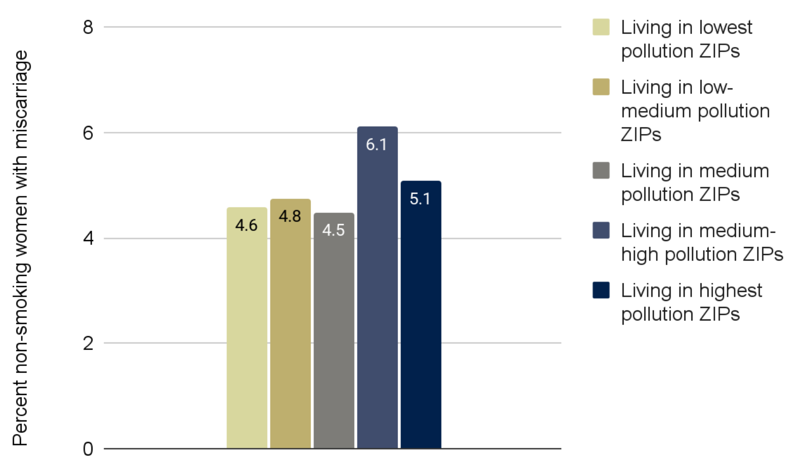


Figure 24. Percentage of non-smoking adult (18 years of age and older) women who experienced pregnancy diagnosed with miscarriage by residential exposure to air pollution (specifically, ZIP code level of estimated toxicity-weighted chemical air pollution). ZIP codes with the lowest pollution estimates are in light tan (left), and ZIP codes with the highest air pollution estimates are in darkest blue (right).

represent the true causal association between residential exposure to industrial pollution and miscarriage, approximately 179 more cases of miscarriage among non-smoking women who have been pregnant occurred in ZIP codes closest to petrochemical facilities and petroleum refineries that may not have occurred if these individuals had lived in ZIP codes farther away.

% higher risk of miscarriage in ZIP codes closer to petrochemical facilities	Extra women with miscarriage in ZIP codes closer to petrochemical facilities
11%	179

Table 19. Estimated increase in miscarriage risk (%) and additional cases among non-smoking women who have been pregnant living near (within 5 miles of) petrochemical facilities and petroleum refineries.

In focus group discussions a participant spoke about their experience with miscarriage:
*"**I know a couple of people who had multiple miscarriages and it was difficult for at least one or two people to get pregnant** and so at least one of the people that I'm thinking about grew up all of their lives pretty much across the street, like across the field from what's now [plant name]."* -Focus Group Participant, Virtual, April 2026

Preeclampsia and eclampsia

Preeclampsia is high blood pressure during pregnancy, which can harm the mother's organs and slow the baby's growth. Eclampsia is the more rare, severe form of preeclampsia that often involves seizures and is acutely dangerous for the life of both the mother and the baby. Among women who experienced pregnancy, living in an area with higher exposure to industrial pollution was associated with increased likelihood of being diagnosed with preeclampsia and/or eclampsia. Non-smoking women with history of pregnancy who lived in ZIP codes closer to petrochemical plants and petroleum refineries were 24% more likely to be diagnosed with preeclampsia and/or eclampsia than those who lived in ZIP codes more than 5 miles away (RR: 1.24, 95% CI: 1.14-1.35). For every ten-fold increase in the concentration of ZIP code-level toxic air pollution, non-smoking women with a history of pregnancy had an 8% increase in risk of being diagnosed with preeclampsia and/or eclampsia (RR: 1.08, 95% CI: 1.05-1.12).

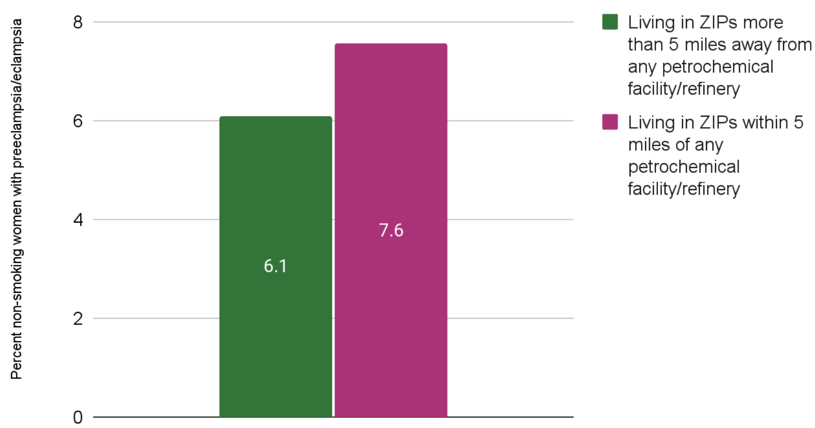


Figure 25. Percentage of non-smoking adult women who experienced pregnancy diagnosed with preeclampsia or eclampsia by distance to the 40 selected petrochemical facilities and petroleum refineries. ZIP codes more than 5 miles away from a facility are shown in green (left), and ZIP codes within 5 miles are shown in red/purple (right).

Table 20 shows the estimated percent increase in risk and additional cases of preeclampsia/eclampsia among non-smoking women who have been pregnant living near (within 5 miles of) petrochemical facilities and petroleum refineries. Although this finding cannot be interpreted as definitively causal, if we were to assume that our results represent the true causal association between residential exposure to industrial pollution and preeclampsia/eclampsia, approximately 531 more cases of preeclampsia/eclampsia among non-smoking women who have been pregnant occurred in ZIP codes closest to petrochemical facilities and petroleum refineries that may not have occurred if these individuals had lived in ZIP codes farther away.

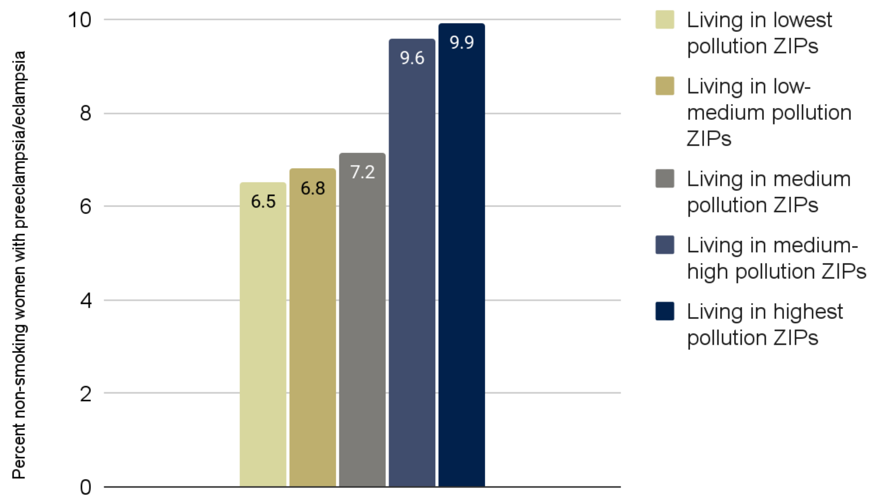


Figure 26. Percentage of non-smoking adult women who experienced pregnancy diagnosed with preeclampsia or eclampsia by residential exposure to air pollution (specifically, ZIP code level of estimated toxicity-weighted chemical air pollution). ZIP codes with the lowest pollution estimates are in light tan (left), and ZIP codes with the highest air pollution estimates are in darkest blue (right).

% higher risk of preeclampsia/eclampsia in ZIP codes closer to petrochemical facilities	Extra women with preeclampsia or eclampsia in ZIP codes closer to petrochemical facilities
24%	531

Table 20. Estimated increase in preeclampsia/eclampsia risk (%) and additional cases among non-smoking women who have been pregnant living near (within 5 miles of) petrochemical facilities and petroleum refineries.

In focus group discussions some participants spoke about the experience with preeclampsia and eclampsia:

"I just think it's interesting to see, like, fibroids can affect you if you can become pregnant or not, and then see on the other end that ***you can also be preeclampsia or have eclampsia****, which is something that you can only experience while you're pregnant. So it's like you're [impacted] on both ends of the spectrum. Just being introduced to pollution. . . "* -Focus Group Participant, Virtual, October 2025

*“**I know a relative**…in the red zone [area of Louisiana exposed to higher industrial pollution; highlighted on a map in red] **[who] had preeclampsia and then a stillbirth**. But I never connected it to …address or zip code.”* -Focus Group Participant, Baton Rouge, July 2025

“So my daughter had preeclampsia , and she ended up having some babies like 6 weeks early which meant they had low birth weight.” -Focus Group Participant, Reserve, July 2025

*“**My ex daughter in-law had preeclampsia**…[The birth] was an emergency surgery. . .and this was my first time even having the experience of even knowing what it was. … You always think about what causes that, because she didn't have any of those issues prior to [pregnancy], you know?”* -Focus Group Participant, Baton Rouge, July 2025

Table 21. Key findings of multivariate analysis of pregnancy-related health outcomes (risk ratios and 95% confidence intervals), among non-smoking women who have been pregnant (n=96,482).

Health outcome	Distance model RR (95% CI)	Air pollution model RR (95% CI)
Ectopic pregnancy	1.18 (1.02-1.37)	1.09 (1.02-1.16)
Miscarriage	1.11 (1.02-1.21)	1.05 (1.01-1.08)
Preeclampsia / eclampsia	1.24 (1.14-1.35)	1.08 (1.05-1.12)

Adult Health Findings

Anemia

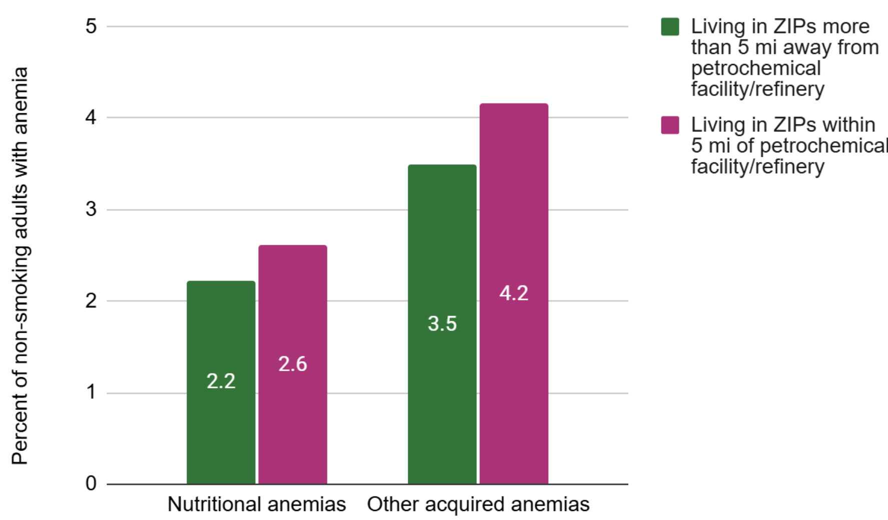


Figure 27. Percentage of non-smoking adults (18 years of age and older) diagnosed with nutritional anemia (left) and other acquired types of anemia (right) by proximity to the 40 selected petrochemical facilities and petroleum refineries. ZIP codes more than 5 miles away from a facility are shown in green (left), and ZIP codes within 5 miles are shown in red/purple (right).

Among non-smoking adults, living in an area with higher exposure to industrial pollution was associated with increased likelihood of being diagnosed with nutritional anemia as well as other types of acquired (not genetic, not secondary to other health conditions, not medication-induced) anemia. After adjusting for age, sex, and living in a food desert, non-smoking adults in our sample who lived in ZIP codes closer to petrochemical plants and petroleum refineries were 15% more likely to be diagnosed with nutritional anemia and 18% more likely to be diagnosed with other types of acquired than those who lived in ZIP codes more than 5 miles away (nutritional anemia RR: 1.15, 95% CI: 1.08-1.23; other acquired anemia RR: 1.18, 95% CI: 1.10-1.26). For every ten-fold increase in the concentration of ZIP code-level toxic air pollution, non-smoking adults' risk of being diagnosed with nutritional or other acquired anemias increased by 6 and 7%, respectively (nutritional RR: 1.06, 95% CI: 1.04-1.09; other acquired RR: 1.07, 95% CI: 1.05-1.10).

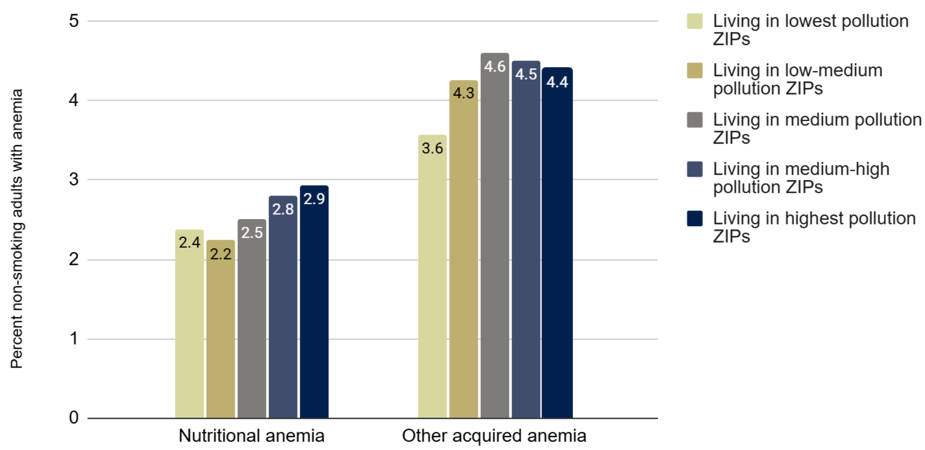


Figure 28. Percentage of non-smoking adults (18 years of age and older) who did not use tobacco who were diagnosed with nutritional anemia and other acquired anemias by residential exposure to air pollution (specifically, ZIP code level of estimated toxicity-weighted chemical air pollution). ZIP codes with the lowest pollution estimates are in light tan (left), and ZIP codes with the highest air pollution estimates are in darkest blue (right).

Table 22 shows the estimated percent increase in risk of nutritional and other acquired anemias and additional cases of these outcomes among non-smoking adults living near (within 5 miles of) petrochemical facilities and petroleum refineries. Although these findings cannot be interpreted as definitively causal, if we were to assume that our results represent the true causal association between residential exposure to industrial pollution and nutritional anemia and other acquired anemias, approximately 1,010 more cases of nutritional anemia and 1,886 cases of other acquired anemias among non-smoking adults occurred in ZIP codes closest to petrochemical facilities and petroleum refineries that may not have occurred if these individuals had lived in ZIP codes farther away.

Type of anemia	% higher risk of anemia in ZIP codes closer to petrochemical facilities	Extra adults with anemia in ZIP codes closer to petrochemical facilities
Nutritional	15%	1,010
Other acquired	18%	1,886

Table 22. Estimated increase in anemia risk (%) and additional cases among non-smoking adults living near (within 5 miles of) petrochemical facilities and petroleum refineries.

Many focus groups participants either lived with or knew people that were living with anemia:

*“**My daughter is 23 now, she's dealing with anemia, and I'm like, where'd that come from?** It's just a lot of different stuff that's popping up, and I'm like… We never had none of these diagnoses, we never had none of these medical problems. . . . But when I moved out here, it just seems like the health is… I don't want to say the word declining, because it’s negative, but… Something is absolutely going on.”* –Focus Group Participant, Destrahan, August 2025

*“**My sister lives across the street from me. . . and she suffers with anemia really, really bad. She stays tired and weak…** doctor. gave her some kind of vitamin to take. She's taking something prescribed. But then she's about 68 years old. She's trying to take care of her granddaughter, who suffers with seasonal allergies and ADHD. . . [with] a combination of all of that put together, she stays tired.”* –Focus Group Participant, Virtual, October 2025

*“**I'm a registered nurse right now, and I see a lot of patients coming in with low oxygen and low red blood cells**…living in South Louisiana, I definitely see a lot of patients with anemia, and I think that does correlate, especially with the air pollution that we're breathing in right now.”* –Focus Group Participant, Virtual, November 2025

Table 23. Results of multivariate analysis of non-smoking adult health outcomes (risk ratios and 95% confidence intervals), among non-smoking adults aged 18 years and older (n=810,732).

Health outcome	Distance model RR (95% CI)	Air pollution model RR (95% CI)
Nutritional anemia	1.15 (1.08-1.23)	1.06 (1.04-1.09)
Other acquired anemia	1.18 (1.10-1.26)	1.07 (1.05-1.10)

Mixed findings

Across a number of child and adult health outcomes examined, findings were mixed and did not show a consistent pattern across the two ways we measured residential exposure to industrial pollution (distance from facilities and amount of air pollution exposure). Some conditions showed associations in one model but not the other, and in a few cases the direction of association differed between models. Given this heterogeneity and the lack of a clear, coherent pattern, we advise these results be interpreted with caution.

Figure 29. St. James, LA, August 2025.

For other health outcomes– especially health outcomes that were rarer– despite other studies suggesting worse health outcomes among individuals exposed to industrial pollution in Louisiana and/or elsewhere, our quantitative analyses were not statistically significant. However, in several cases, this may be because our analysis was statistically underpowered to detect a difference in disease risk between exposure groups for many of these outcomes. Full risk ratio and 95% confidence interval estimates for all outcomes and results of power calculations are provided in Appendices E and I, respectively, for readers who would like additional detail.

Health conditions with mixed findings in the quantitative study that were frequently mentioned in focus groups included cancers and respiratory health issues like asthma and COPD (chronic obstructive pulmonary disease).

Many people identified anecdotally higher incidences of cancer in different industrialized regions of Louisiana. For example:
"In these areas that have lots of industry… I can't tell you how many times I've been at somebody's house, and they say, there's such and such over there [who] died of cancer last year… I mean, I lived here for 25 years, but ***I grew up here, and two of my best friends from high school died in their 20s of cancer****... I've lived in a lot of different places, and… no other place on Earth like this one, where it's like, people die young from cancer."* -Focus Group Participant, Lake Charles, July 2025

Others shared personal experiences with asthma being underdiagnosed:
*"****I felt like it was asthma from the beginning…They will say upper respiratory problems****. They had a special name for it, I don't remember. My baby is 28, but there was a special name for it, and it was straight-up asthma, wheezing and everything. So that means early on, they don't really report it. And I don't know what the criteria is that would make them not diagnose asthma for what it is."* -Focus Group Participant, Virtual, October 2025

Figure 30. Reserve, LA, July 2025.

Many attributed asthma to industrial pollution exposures:
"So my grandma, she passed away last year. She is from New York, born and raised. But she moved out of there, and ***she moved out here for about 30, 40 years. She acquired asthma before she died of heart failure****. Mind you, she never had asthma living in New York, an already, you know, over industrialized city, but once she moved down to the parish. And spent the rest of her time here, and between that high blood pressure and dying of heart failure…"* -Focus Group Participant, Lake Charles, July 2025

"Because I feel like these areas are triggering a lot of these. Comorbidities, as they would call it. Um, yeah, we may have had asthma, but we have been controlling our asthma, we've been taking our medications. ***We have been doing the right thing, and then we all of a sudden have these exacerbations of asthma attacks, of breathing problems, of sinus infections because of the area****."* -Focus Group Participant, Destrehan, September 2025

"So, I'm from Pointe à la Hache, Louisiana, which is on the East Bank side of Plaquemines Parish, and in our area, we have a plant called Electric Coal, and then right across the river from us, which is really not that much when you really think about it, there's a new refinery that they just started, and I'm wondering, like, ***I know my brother suffers with asthma from a child, but my great-grandmother, she didn't get diagnosed with asthma until she was, like in her 30s****."* -Focus Group Participant, Destrehan, September 2025

Others talked about the presence of multiple co-morbidities:
*"Uh, h****ypertension and asthma and seasonal allergies and autism****, and all of that stuff. . . that's what we hear all the time. Uh, we also hear about* ***headaches, migraine and chronic headaches****. Matter of fact, I suffer from headaches."* -Focus Group Participant, Virtual, October 2025

"I've seen it all. . . I myself struggle with anemia. It's not as bad as trying to keep it under control, but at the same time, it's still there, right? It's still present and there's diabetes. ***I lost a husband to diabetes…and he was 36 years old****, so imagine, very young. And then we just had a* ***recent client at 40. He's currently right now in a nursing home with stroke****. You know, healthy young male… One day, he was up working, and the next day, it was… it was done. Stroked out."* -Focus Group Participant, Baton Rouge, July 2025

Discussion

Overview of quantitative and qualitative findings

After adjusting for age and sex, children on Medicaid living in areas with more industrial pollution exposure had significantly higher risk of nutritional anemia (even after adjusting for food access), early puberty among girls, learning disabilities, and dermatitis than children who lived in areas with less industrial pollution exposure. After adjusting for age, among non-smoking women under 65 on Medicaid, those who lived in areas with more industrial pollution exposure had significantly higher risk of fibroids and breast cancer than those who lived in less polluted areas. Among non-smoking women who had experienced pregnancy, those who lived in areas with more industrial pollution exposure had a higher risk of preeclampsia/eclampsia, miscarriage, and ectopic pregnancy than those who lived in areas with less industrial pollution exposure. After adjusting for age, sex, and food access, among adults under age 65 on Medicaid, those who lived in areas with more industrial pollution exposure had a higher risk of nutritional anemia and other types of acquired anemia than those who lived in areas with less industrial pollution exposure. Qualitative findings supported quantitative findings, with residents sharing personal experiences of the health issues identified and in some cases connecting these issues to pollution exposure. Qualitative findings also highlighted other health conditions of concern to residents as well as future directions for research, policy and practice.

Key findings

Anemia in children and adults

In our analysis of Louisianans enrolled in Medicaid, residential exposure to industrial pollution was associated with a statistically significantly higher risk of nutritional anemia for both children and non-smoking adults. Underdiagnosis of anemia has been documented, with diagnostic delays estimated from months to years, largely because early symptoms like fatigue are common and non-specific.[73,74] Even in a study of cancer patients receiving consistent healthcare, nearly three-quarter of those tested for iron deficiency anemia met criteria, yet only 5% received a formal diagnosis and 12% were treated.[73] Untreated, severe anemia can lead to significant health complications, including immune suppression, postoperative complications, cardiovascular strain, adverse pregnancy outcomes, and neurological effects.[75–78] Among children, prolonged anemia increases risk of tachycardia, poor capillary refill, and irreversible neurodevelopmental/cognitive deficits.[77,78] Longitudinal studies have shown that iron-deficiency in infancy is associated with persistently lower cognitive performance, with deficits still evident at at ages 11 to 14, even after treatment. In adults, anemia may also present with tachycardia and is associated with increased risk of cardiovascular and cerebrovascular complications, including worsening heart failure and stroke; in pregnancy, it is linked to outcomes such as miscarriage, preterm birth, and maternal mortality.[75,78–80] Nutritional anemia is driven by nutritional deficiencies, such as low levels of iron, vitamin B12, and folate. However, a recent systematic review has linked environmental pollutants, including heavy metals and indoor and outdoor air pollution, to lower red blood cell count and higher prevalence of iron-deficiency anemia.[81] Certain industrial chemicals, including benzene, may interfere with the growth and functioning of red blood cells.[82,83] While we have not identified prior studies conducted in Louisiana that have found associations between industrial pollution and anemia in childhood or adulthood, a recent global scoping review reviewed 11 studies of outdoor air pollution exposure (including particulate matter of various sizes, NO_2, SO_2, and CO) and anemia risk and found that all reviewed studies showed a positive association, providing further support for the theory that air pollution may be an important risk factor for anemia across age groups and geographies.[81,84] The association between nutritional anemia among children and both nutritional anemia and other acquired anemias among adults remained statistically significant and did not greatly change in magnitude after controlling for food access, indicating that this relationship is independent of nutritional deficiencies caused by living in an area with low access to grocery stores.

Learning disabilities among children

We observed an association among children between industrial/petrochemical pollution exposure and increased risk of being diagnosed with a learning disability among children. Past research shows that air pollution exposure may affect how children's brains develop and is associated with cognitive delays.[85–87] For example, a systematic review found that exposures to $PM_{2.5}$, NO_2, and polycyclic aromatic hydrocarbons were associated with worse global intellective functioning, attention/executive functioning, and memory/learning in preschool- and school-aged children.[86] Exposure to air pollutants during prenatal and early childhood periods has been linked to adverse neurodevelopmental outcomes. Known or highly suspected developmental neurotoxic compounds include nitric oxide (NO), which is often present in air pollution, as well as several industrial byproducts, including lead, methylmercury, arsenic, polychlorinated biphenyls, polycyclic aromatic hydrocarbons, and toluene.[87] Children chronically exposed to high levels of pollution have been observed to have brain structures that were similar to adults with neurodegenerative diseases like Alzheimer's.[85] Infants exposed to higher levels of polycyclic aromatic hydrocarbons showed greater cognitive impairment and lower IQ at age 5 than those with less exposure.[87] A study in East Baton Rouge Parish found that average rates of child disability, a combined measure of asthma and neurodevelopmental disorders, was 1.39 times higher in the two most polluted ZIP codes (where 18 of the 24 TRI-reporting facilities in the parish were located in 2002), compared to all other ZIP codes in the parish.[88] Two additional studies in Louisiana showed an association between higher industrial pollution exposure and lower school performance scores, which could be a proxy for learning disabilities.[15,89]

Dermatitis and eczema among children

Among children in our sample, those with more residential exposure to industrial pollution had a significantly higher risk of being diagnosed with dermatitis and/or eczema. Air pollution exposure may cause or worsen these conditions through several biological mechanisms. Some components of air pollution, such as polycyclic aromatic hydrocarbons (PAHs), activate the aryl hydrocarbon receptor in skin cells, which leads to increased expression of certain genes involved in detoxification and inflammation, including cytochrome P450. Activation of this pathway contributes to inflammatory responses implicated in conditions such as atopic dermatitis.[90] Air pollutants like ozone and PAHs also generate reactive oxygen species through interactions with fats and proteins in the outer layer of the skin, resulting in oxidative stress that overwhelms the skin's normal antioxidant defenses.[90] Skin biopsies from people with atopic dermatitis showed increased chemical markers of damage from oxidation.[91] Air pollution can also cause skin cells to release more inflammatory cytokines and alter cellular pathways, which can contribute to dermatitis symptoms.[90] Epidemiologic evidence also largely supports the association between air pollution exposure and dermatitis/eczema. Longitudinal studies among infants and children have shown that increased exposure to air pollution components, including particulate matter, NO_2, and ozone, increases the risk of diagnosis with dermatitis and exacerbates symptoms. Maternal exposures to air pollutants during pregnancy have also been associated with increased risk of children developing dermatitis in early life.[90] In a study in Colfax, Louisiana in 2018, residents who lived close to or in the path of emissions from a hazardous waste thermal treatment facility reported frequent skin irritation.[8] Another study conducted in Colfax in 2020 interviewed residents living near the facility, who again reported skin issues, among other health conditions.[32] In Freetown, Louisiana, a community surrounded by a dense concentration of petrochemical plants and industrial infrastructure, residents interviewed in 2016-2018 similarly reported experiencing several health conditions, including skin irritation, which they attributed to the chemical pollution from the many surrounding petrochemical plants.[4]

Early puberty among girls

We found that residential exposure to industrial pollution was associated with statistically significantly higher risk of early puberty among children who were girls. Early puberty can have implications for health outcomes across the lifespan, including increased risk of cardiovascular disease, metabolic disorders like obesity and type 2 diabetes), cancer (particularly breast cancer), and worse mental health.[92,93] Early puberty has also been linked to lower educational attainment[93] which has negative impacts on health and quality of life.[94] Research suggests that exposure to air pollution is associated with disrupted pubertal development, including early puberty among girls.[95–97] In a review paper, four out of six studies conducted elsewhere showed that air pollution exposure accelerates pubertal development and promotes early puberty, with one study having null findings and another suggesting pollution exposure might actually delay development of breast tissue.[97] Exposure to endocrine-disrupting chemicals, which can disrupt natural hormones,[92,93,98] may increase the risk of early puberty.[99] Known EDCs that can be found in industrial air pollution include bisphenol A,[98] polycyclic aromatic hydrocarbons (PAHs), and heavy metals.[100,101] To the best of our knowledge, there are no other studies conducted in Louisiana to assess links between residential industrial/air pollution exposure and pubertal timing.

Uterine fibroids among women

Exposure to industrial chemicals and air pollution may promote fibroid growth by disrupting hormones and increasing inflammation.[102–105] Early life exposure to endocrine disrupting chemicals (EDCs), some of which can be found in industrial air pollution, can alter programming of uterine stem cells, leading to changes in gene expression that cause the uterus to be more susceptible to fibroid development later in life.[102–104] Adult exposure to EDCs can also promote fibroid growth. Industrial chemicals like phthalates and PFAS may bind or otherwise dysregulate estrogen or progesterone hormone receptors, which can gene expression and signaling pathways that may accelerate fibroid growth.[102,103] Higher phthalate exposure is associated with higher risk of fibroids and with larger fibroids.[106,107] Pollution-induced systemic inflammation and oxidative stress also promote fibroid development. Air pollution and other industrial chemicals elevate circulating cytokines, activating pathways such as MAPK/ERK, NF-κB, TGF-β, and YAP/TAZ, which drive cell proliferation, excess extracellular matrix deposition, reduced apoptosis, and chronic inflammatory signals.[102,104,106,108] Because fibroids are characterized by thick, disorganized extracellular matrices and increased uterine stiffness,[109] this mechanism is biologically plausible. We have not identified prior studies conducted in Louisiana that assessed associations between residential exposure to industrial pollution and risk of uterine fibroids.

Breast cancer among women

We observed an association between higher industrial/petrochemical pollution exposure and increased risk of breast cancer diagnosis. Long-term exposure to outdoor air pollution, including fine particulate matter, nitrogen dioxide, and other combustion-related pollutants, is linked to higher breast cancer risk, possibly because these pollutants damage DNA and interfere with hormones.[110] There is also research finding links between industrial pollution and breast cancer in Louisiana, including among residents of New Orleans' Agriculture Street neighborhood, which includes a polluted site.[111] An analysis of data from Louisianan women with breast cancer found that women who lived in parishes characterized by lower median income and/or geographic proximity to the Mississippi River corridor (including, but not limited to, parishes within Cancer Alley) and the Red River had shorter survival times than other women with breast cancer in the state. The areas of the state with worse survival also had significantly high emissions of ammonia and particulate matter, likely reflecting contributions from nearby industrial and agricultural activities.[10] In a study among the NIH-AARP cohort, which included Louisianans, long-term exposure to fine particulate air pollution (PM2.5; levels estimated using EPA data and spatiotemporal prediction models) was associated with incident breast cancer among the entire cohort.[112]

Ectopic pregnancy among pregnant women

In our analysis, women living in areas with higher industrial pollution exposure had an increased likelihood of ectopic pregnancy. Few studies have examined the relationship between ambient air pollution and ectopic pregnancy directly, and there are no prior studies in Louisiana. However, environmental toxicants may affect early embryo transport and implantation processes that determine where a pregnancy develops. A systematic review of 5 studies that assessed the association between air pollution exposure and outcomes of in-vitro fertilization found that exposure to particulate matter, nitrogen dioxide (NO_2), and carbon monoxide (CO) were associated with increased risk of ectopic pregnancy.[113] This evidence suggests that exposure to petrochemical and refinery emissions could plausibly contribute to ectopic pregnancy risk.

Miscarriage among pregnant women

In our sample of women in Louisiana who had been pregnant and did not use tobacco, higher residential exposure to petrochemical/industrial pollution was associated with increased risk of miscarriage. A growing body of research links exposure to outdoor air pollution, including particulate matter, nitrogen dioxide (NO_2), carbon monoxide (CO), ozone (O_3), and sulfate compounds (SO_x), to increased risk of pregnancy loss.[114] Several systematic reviews of the research literature have been conducted and have found associations between air pollutants exposure and miscarriage.[115–119] Industrial facilities and petrochemical refineries are major sources of many of these pollutants, as well as volatile organic compounds (VOCs) and polycyclic aromatic hydrocarbons (PAHs). Many of these chemicals can cause oxidative stress, inflammation, and DNA damage, which may interfere with embryonic/fetal growth and development. Air pollutants have been shown to be present in umbilical cord blood, suggesting that they are transferred across the placenta.[120,121] One prior study has been conducted on this in Louisiana: in 1996, residents of New Orleans' Agriculture Street neighborhood, which had a history of hazardous waste contamination,[122] reported significantly higher rates of miscarriage compared with communities located further away from the site.[111]

Preeclampsia/eclampsia among pregnant women

Preeclampsia and eclampsia can have lasting health impacts across the life course for both the mother and baby.[123–125] Exposure to air pollution, toxic metals, and PFAS has been suggested to increase the risk of preeclampsia and eclampsia, likely by disrupting blood vessel development in the placenta.[126,127] Cadmium, a metal used in manufacturing, has the strongest evidence of an association with preeclampsia, while nitrogen dioxide (NO_2) and fine particulate matter ($PM_{2.5}$), both common components of industrial air pollution, also show likely associations with preeclampsia.[126] PFAS have also been evaluated in epidemiologic studies for associations with preeclampsia and other hypertensive disorders, with mixed results.[127] We have not identified prior studies conducted in Louisiana that assessed associations between community industrial pollution exposure and risk of preeclampsia/eclampsia.

Mixed findings

Several health outcomes that we examined in the Medicaid data showed inconsistent or null findings. For example, among both children and adults, we did not observe an association between industrial pollution and asthma diagnosis, despite the many personal accounts of respiratory illness shared in our focus groups. We observed unusual findings for COPD among adults, but the challenge is that the median age of COPD diagnosis is when people are in their 60s or even 70s,[128] and so are unlikely to have been included in our sample. Therefore, these findings should be interpreted cautiously, especially given the substantial body of biological and epidemiological evidence linking pollution to these outcomes (including studies in Louisiana).[129–134]One possible explanation for these findings could be underdiagnosis of these conditions in areas with more industrial activity due to more limited access to good quality healthcare or specialty care, resulting in fewer diagnoses; one community member spoke to this as a possibility in our focus groups. Prior studies have largely focused on exacerbations and disease severity among individuals already diagnosed with COPD or asthma, which are outcomes that may be more sensitive to short-term changes in air pollution exposure.[130,131,133,134] In contrast, our study examined diagnoses over a three-year period, rather than disease severity. These differences in outcome definition could have attenuated observed associations toward the null. Several studies have shown that there are often barriers to diagnosis of asthma and COPD in primary care settings, with estimates of undiagnosed cases of COPD ranging from 65% to 80%.[135–137] Alternatively, people may move from a more polluted area to a less polluted area because of their respiratory health issues;[138] because we only know where they live for a certain small period of time, we are unable to quantitatively assess if this occurred. If this did occur, this could also bias our findings towards being null. There may also be other phenomena that could explain these findings.

We also had many null associations between industrial pollution exposure and risk of most types of cancer (other than breast cancer), despite substantial reports of individuals' lived experiences with cancer in our focus groups. There are a few possible explanations for these findings. First, our sample only includes people ages 64 and younger, and cancer is more common among older adults.[139] Therefore, we are only capturing a subset of the full cancer burden experienced in this population. Second, our measures of environmental exposures may not be nuanced enough to detect associations that may truly exist. For example, residential ZIP code at a certain point in time may not reflect the longer-term or earlier-life exposures that may be more relevant for cancer development, particularly if individuals have moved over the course of their lives.[140,141]

Finally, many residents were curious about whether industrial pollution exposure led to worse birth outcomes, including low birth weight, preterm birth, and birth defects. While the prevalences of low birth weight and preterm birth were higher in ZIP codes closer to petrochemical facilities and refineries, we did not find statistically significant differences in the risks of low birth weight or preterm birth. Power calculations showed that our study was statistically underpowered (there were not enough people with certain combinations of exposures and outcomes) to detect differences in risk for these outcomes. However, other studies that did have adequate statistical power have found that residential industrial pollution exposure was associated with worse birth outcomes in Louisiana.[16]

Strengths of approach

To the best of our knowledge, our study is the first to combine quantitative analysis of government health and environmental data with community-engaged research methods to assess associations between industrial/petrochemical pollution exposure and health in Louisiana. Of note, one strength of our study is that we have a large population of children and women, who are often more vulnerable populations. Ours is also the first study in Louisiana to our knowledge with quantitative findings for associations between industrial pollution exposure and anemia among children and adults, early puberty among girls, and uterine fibroids, ectopic pregnancy, and preeclampsia/eclampsia among women in Louisiana. Our study adds support to previous findings in Louisiana for associations between pollution exposure and childhood learning disabilities, skin problems (dermatitis/eczema), as well as miscarriage and breast cancer among women.[8,10,88,111]

Our approach has many strengths. Our scientific approach was designed to be as rigorous and reproducible as possible. We engaged with community members at all steps of the research process, using a community-based participatory research approach; community-based participatory research has been found to lead to more rigorous science and higher-quality epidemiological evidence.[44,142] This made sure that we were answering research questions of interest to community members, and doing our analyses in a trustworthy way. Our quantitative data came from government sources, including the federal government's Medicaid database, the federal government's Environmental Protection Agency, and the Louisiana Department of Environmental Quality. These government data sources have extensive documentation and are widely used; because they are publicly available, it is also makes it easier to replicate our analytic approach in other contexts (e.g., other industrialized regions) and/or in other time periods (e.g., a follow-up study in 10 years). When we conducted our quantitative analyses, we took the most scientifically conservative approach, including adjusting for potential confounding and prioritizing reporting on findings that appeared to be robust to how environmental exposures were measured. Our quantitative and qualitative approaches were also complementary: community focus groups supported co-interpret research findings with residents, providing important insights into additional analyses of interest and relevance to the community. The approach additionally allowed us to synthesize lived experiences with statistical analyses to create a more holistic understanding of the relationship between pollution and health in this region.

Limitations of approach

Despite the many strengths of our project, our approach also has limitations. First, we took as scientifically conservative of an approach to our analyses as possible in order to prioritize being as rigorous as possible in our methods. However, this might have been overly conservative. This approach almost certainly does not capture the full extent of the associations between industrial petrochemical pollution exposure and health. However, this suggests that, while the magnitude of the associations may differ, the associations we did find are likely to be true associations. However, there are likely also other true associations between residential exposure to industrial pollution and other health outcomes that our modeling failed to detect.

Second, a limitation of using the Medicaid data is that not all health outcomes of interest are comprehensively documented in health care claims data. Healthcare claims data is primarily used for medical billing purposes, so some health outcomes that are not billable– in addition to health outcomes for which people may not regularly seek medical treatment– may not be consistently documented in these records. For example, community members were interested in early onset of menopause; however, this has been shown previously to be underreported in claims data.[143]

Third, our use of the CCW Chronic Conditions and Other Chronic and Disabling Conditions rules for number and type of health care claims with diagnostic codes may have reduced the number of cases of our health conditions of interest that we were able to identify (i.e., reduced sensitivity), particularly if certain health conditions were only diagnosed in a single outpatient visit (where the rules required two), or if some beneficiaries were only enrolled for a short period of time or did not seek care for their condition/symptoms. However, most of the health conditions we assessed were chronic and would likely have required medical management during multiple healthcare encounters. We also compared our findings using the CCW rules to a less restrictive version of the case definition that used the same diagnostic codes (i.e., only one diagnosis code required on any claim of any type) and found many of the same associations.

Fourth, there are limitations of the Medicaid data. For example, we did not have data for people over age 65, because health services that they receive that are paid for by Medicare are not included in the Medicaid dataset, even if they are also eligible for Medicaid. Additionally, due to the privacy restrictions of the Medicaid data used in this study, we did not have exact residential addresses of Medicaid recipients, and had to assess exposure at the level of residential ZIP code or groupings of ZIP codes. This may lead to possible misclassification of level of pollution exposure. However, we expect potential misclassification due to use of ZIP codes to bias results towards the null - i.e., there may be a higher chance that we are unable to identify associations between petrochemical pollution exposure that may truly exist.

Fifth, the environmental pollution data we used may not entirely reflect the multitude of environmental exposures that residents face. We have not measured exposures through water, food, or other potential exposure routes, and our exposure data is self reported by industrial facilities, so may be subject to reporting bias. Importantly, the air pollution dataset that we used focused on industrial emissions of chemicals, but did not include particulate matter, the type of air pollution that has been the most strongly and consistently associated with poor health outcomes in the scientific literature. As a focus group participant from Dehestran stated in September 2025, "*You're gonna digest, in some form or fashion, you're gonna have introduction to pollution whether it's through water, through soil, through crops…my family owns property that they drill oil on…And then we still plant, you know, in the next general area. So, it's hard to say, okay, you know, let's look at this, or let's look at that… because of the way the body is, and the way that pollution works, and the way that cancer works, or any other disease process… it's a multitude of factors that can contribute to all of it"*. The RSEI estimates are also not specifically limited to emissions from petrochemical facilities and petroleum refineries, and include reported emissions from other TRI reporting facilities in Louisiana, such as mining operations and commercial hazardous waste treatment plants; however, many of these may also support petroleum industry activities.

Directions for future policy and practice

Community members across the state who participated in our focus groups had several specific recommendations for taking action based on our findings.

Residents had ideas for increased environmental regulations and monitoring, including strengthening state and federal policies governing industrial emissions and improving transparency and frequency of chemical reporting from petrochemical facilities. One recommendation was that new industrial facility permits, facility expansion permits, and permit renewals should have a specific section that focuses on the implications of health. Some residents also expressed interest in stopping further growth of industrial facilities in order to protect human health. Residents also recognized that new types of industrial activities, including data centers, are emerging and were not yet present during the time period for which we have data, but that some of these same recommendations might apply. Policies and practices that can protect children from industrial exposure was also of interest, as a form of prevention and/or early intervention:

"If we look at it as a total picture and, like, actually seeing people as they develop, then we'll probably start seeing some of these other diseases start coming up, and then maybe we could start to make those changes, you know, that we want to see. As far as you know, ***recognizing the pollution and trying to do something a little bit different. . . as far as exposure.****"*

- Focus Group Participant, Destrehan, September 2025

Some participants felt that air quality data from government sources underreported pollution, a concern that has been validated in Louisiana by past research showing significant underreporting of hazardous air pollution in Cancer Alley.[14] Due to this, community members expressed interest in studies that conducted their own air and water sampling due to a lack of trust in the state authorities.

One participant spoke of wanting better monitoring practices near schools and public areas:

"I was just going to leave a comment about pipelines running to the community in front of a little elementary school. . . and you never know where the pipeline's at, because they don't come and communicate with us at all.. . and the train's leaking all the time [on the tracks]. ***There's no app monitoring****. There's no one coming to check to bring a meeting to us to say, this is what's going on. You know, they don't want us to know anyway. They don't care about killing us but we deal with all of that. . . [We] are* ***trying to get monitors in our area****."*

- Focus Group Participant, Lake Charles, July 2025

Community members also recommended that public health agencies and school districts conduct campaigns to increase awareness about health conditions that were common in industrialized areas as well as provide more health services and school services for the various elevated health conditions they were seeing. Health care providers practicing in industrialized areas may also consider monitoring for these health issues in their patient populations, including, for example, testing for anemia among patients who report fatigue, or screening for learning disabilities.

Now we have data coming in, something that we can actually look at and see and that means a lot. Maybe we can capture these kids at an early age, because some of these kids are 12, 13 years old before we find out that they're ***ADHD****, you know what I'm saying?* ***Language delay.*** *So now,* ***if we can catch that at an earlier age than that, we can help them better.***

- Focus Group Participant, Virtual, April 2026

Participants suggested that people start talking about the health issues in the CoDA study with their family, their neighbors, people they work with so that a conversation starts about health, to support, as relevant, an individual's medical diagnosis or community organizing around health. Community members also expressed wanting state legislators, local representatives and elected officials, and regulatory agencies to advocate for communities' health and wellbeing. They had many ideas for initiating and sustaining engagement:

Every representative, every politician that represents my district and any other district that I can reach out to get them aboard, bring them aboard . . . *that's work! . . . to get out and lobby for him and for bills?* ***Let's start lobbying****, let them start lobbying for, you know, what we are striving for. You know, everybody's human, everybody deserves fairness, everybody deserves life. So, I mean, if you want my vote, let's do this thing the right way. Let's do it the proper way. You know, help us, we help you. Let's save lives!"*

- Focus Group Participant, Virtual, April 2026

I would really start with the college students*, because us millennials nowadays … we're more into politics than our family was, or our moms and generations past were. So we're… kind of more… I wouldn't say advanced, but we're kind of hands-on with it, and I just think that* ***the word should be out to more schools****.*

- Focus Group Participant, Virtual, April 2026

To get it started, the proper and correct way, ***we need to reach out to politicians****, the only people who are gonna make it work. You know, they gotta make it work if they, if they want to make it work. We have some that will get aboard and the ones that's not going to get aboard,* ***we pressure them and let their colleagues pressure them. . .let their constituents from their community . . . apply a little bit of pressure.*** *But how* *can people apply pressure if people don't know [about the CoDA health report]? . . . They're gonna see the good that can come out of this, the good that's coming out of it, and then we'll pressure, you know, the ones that's being hateful and just looking out for themselves, instead of looking out for the constituents. After all, without constituents, you wouldn't have a job."*

- Focus Group Participant, Virtual, April 2026

Directions for future research

There are several directions for future research. Residents shared some ideas in the focus groups. For example, our study, like many others, focused primarily on air pollution; some residents were interested in the role of water pollution as a component of residential exposure to industrial pollution. Additionally, residents were interested in the health impacts of different types of industrial facilities that were located especially close to schools.

*"**We have sewer plants as well that's putting off very toxic waste**. Children are inhaling it on a daily basis. I passed through it a few days ago, and I see there's another sewer plant at the end of the park and it has kids out there, but it's running, but then you can still smell the waste. **I don't think that's safe**."*

- Focus Group Participant, Virtual, April 2026

Numerous participants shared concerns regarding the potential health impact of all the new data centers that are being proposed, permitted and built. These energy-intensive projects often require the construction of new power plants to power them. There was interest in knowing more about the health impacts of residential exposure to various types of power plants, including electrical substations and transmission infrastructure.

Our study was limited in only having access to three years of Medicaid data: if there were resources available to access more years of government data, it might be possible to assess the health implications of opening, expanding, and/or closing industrial facilities over time, which could help inform regulatory decision-making. Additionally, similar analyses to ours could be done with relevant Medicare data in order to understand industrial pollution exposure and health in older populations.

Conclusions

The CoDA Environmental Health Study demonstrates the value of integrating rigorous epidemiologic analysis with sustained community engagement to examine environmental health inequities in Louisiana. By combining large-scale Medicaid data with multiple measures of industrial pollution exposure and resident-guided interpretation, the project identified meaningful associations between environmental pollution and adverse health outcomes affecting children, women, and adults in higher-exposure communities. Although the study does not establish causality, the consistency of our highlighted findings across exposure metrics and alignment with existing scientific literature underscore the public health relevance of these patterns.

Equally important, the project's participatory framework strengthened the scientific process by ensuring that analyses addressed community-prioritized concerns and that results were interpreted within local social and environmental contexts. Focus group feedback not only enhanced understanding of the findings but also provided suggestions for new analyses based on residents' observations. Input from the focus groups also shaped dissemination strategies and ideas for next steps for community environmental health advocacy toward stronger policies and effective practices. Ideas for future research also emerged from discussions with community members. These results highlight persistent environmental health disparities and support the need for continued research, community-informed monitoring, and evidence-based decision-making to promote health and wellbeing in regions affected by industrial pollution.

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Appendices

Appendix A. Detailed Quantitative Methodology

Appendix B. ICD-10 Codes and Claims Algorithms Used to Define Outcomes and Eligibility Variables.

Appendix C. List of included NAICS codes, petrochemical facilities and petroleum refineries

Appendix D. Prevalence of health outcomes in Medicaid sample

Appendix E. Results of multivariate analyses

Appendix F. Maps comparing census tracts that are food deserts to our exposure maps

Appendix G. Crosstabs of case counts using CCW algorithm case counts compared to less-restrictive case definition

Appendix H. Number of diagnosis codes by individual among those with at least one diagnosis code

Appendix I. Power calculations for health outcomes with mixed findings.