# Linking Environmental Hazards and Birth Defects Data

JEAN D. BRENDER, PHD, F. BENJAMIN ZHAN, PHD, LUCINA SUAREZ, PHD, PETER LANGLOIS, PHD, ZUNERA GILANI, MPH, IONARA DELIMA, MAG, KAREN MOODY, MS

The authors describe methods for linking birth certificate and birth defect registry data to potential environmental hazards and assess potential confounding factors. Cases of selected birth defects from the Texas Birth Defects Registry were linked to their respective birth/fetal death records. Comparison births were randomly selected from the 1996–2000 Texas birth records. Maternal addresses were related through a geographic information system to boundaries of hazardous waste sites and point locations of industries. Approximately 89% of maternal addresses of case births and 88% of comparison births were successfully related in distance to these sites and industries. Maternal characteristics associated with living within one mile of these sites included belonging to any group besides non-Hispanic white and having lower education attainment (< 16 years) or a residence within the city limits. In linking environmental and health outcome databases, researchers should be aware of factors that may confound associations between exposure and outcomes.
*Key words*: birth defects; hazardous waste sites; industrial emissions; environmental public health tracking.

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For decades, public health surveillance has been recognized as essential to understanding the geographic distribution of adverse health conditions, for generating hypotheses regarding geographic differences in incidence, and in evaluating prevention and control measures.[1] Environmental monitoring has also played a critical role in identifying public health hazards, detecting changes in air, water, and other environmental quality measures over time, and assuring compliance with regulatory standards set to safeguard the public from harm. There have been recent suggestions that the linkage of environmental monitoring data with public health surveillance data might help us better understand whether low levels of chemical toxicants in the environment pose a hazard to human health. Environmental public health tracking—the linkage of environmental hazard, exposure, and health effect data—can help bridge current data gaps and improve community health through appropriate public health activities.[2] Interpretation of these linkages, however, can be limited by issues related to human exposure pathways and the appropriate temporal sequences.

One of the more promising areas of such tracking is linking prenatal environmental exposures with health outcomes in offspring. Recent estimates indicate that 70,000 different chemicals are available on the market today,[3] and that children are at risk of exposure to nearly 15,000 high-production-volume synthetic chemicals, many of which are widely dispersed in the environment.[4] Knowledge is limited on whether levels of these chemicals found in the environment pose a hazard to children's health. Surveillance data collected on infants and children can be linked to their respective birth records. These data can in turn be linked to time-appropriate environmental data to understand the relation between prenatal environmental exposures and health conditions in children, such as birth defects.

A positive relation between maternal residence near hazardous waste sites or landfills and birth defects has been found in several studies conducted in the United States and Europe.[5–10] The effect of maternal residential proximity to industrial facilities on risk for birth defects in offspring has also been examined, with mixed results.[11–13] As part of a case–control study of maternal residential proximity to hazardous waste sites and industrial facilities and risk of selected birth defects in children, we developed record linkages between residential addresses of mothers of births with and without congenital malformations and these sites and facilities. This paper describes, in detail, the methods used to achieve these linkages. We also examined the maternal characteristics associated with living near hazardous waste sites

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Address correspondence and reprint requests to: Jean Brender, PhD, Department of Epidemiology and Biostatistics, Texas A&M School of Rural Public Health, Mail Stop 1266, University Drive and Adrionic Road, College Station, TX 77843-1266, U.S.A.; e-mail: <jdbrender@srph.tamhsc.edu>.

and industrial facilities, which could potentially confound the exposure–outcome relation.

## METHODS

### *Birth Data*

Birth defect data for births occurring in 1996–2000 were obtained from the Texas Birth Defects Registry (TBDR) at the Texas Department of State Health Services (DSHS). The Registry uses active surveillance in which trained staff regularly survey medical facilities' discharge lists, log books, and other records for births with congenital malformations

The Registry uses the Centers for Disease Control modification of the British Paediatric Association (BPA) codes for birth defects, a modification of the International Classification of Diseases 9th revision (ICD-9) codes. Only cases in which the defect was diagnosed prenatally or within one year after delivery are included. During the years 1999–2000, affected births occurring to all mothers residing in Texas at time of delivery were included. During 1996–1998, only selected geographic regions (known as public health regions) were included in the surveillance system. Registry cases were matched to birth certificates and fetal death certificates. To link Registry cases with their respective birth or fetal death records, staff used a series of queries with Microsoft Access to do deterministic linkages using demographic variables.

Birth defects selected for this study included neural tube defects (BPA codes 740.000–742.090); conotruncal heart defects (BPA codes 745.000–745.010; 745.100–745.190; 745.200–745.210; 747.215; 747.230; 747.250; 746.000–746.090 with 745.480 or 745.490, then scanned to exclude muscular ventricular septal defects; 746.995 with 745.480 or 745.490, then scanned to exclude muscular ventricular septal defects; 747.310, 746.840); oral clefts (BPA codes 749.000–749.220); and all chromosomal malformations (BPA codes 758.000–758.990).

Comparison births were randomly selected and frequency matched to case births by year of birth (1996–2000) and public health region of maternal residence as recorded on the birth certificate (11 regions in Texas). Prior to selection of this random sample, we removed all births that had been identified by the Birth Defect Registry as having a birth defect. Case births with the congenital malformation of interest were linked to their respective birth and fetal death records, and these data were merged with the comparison birth file to form the complete data set for case and control births. Maternal addresses of cases were taken from vital records unless missing, and then addresses from medical records were used. The only addresses available for controls were from those on vital records. Maternal addresses were geocoded with the geocoding tool ArcGIS 8.3 Centrus GeoCoder for ArcGIS plug-in with its accompanying reference street database[14] and completed without knowledge of case or control status. The Texas Department of State Health Services and the Texas State University Institutional Review Boards approved the study protocol.

We used the Standard Occupational Classification system (SOC)[15] to code parental occupations and the North American Industrial Classification System (NAICS)[16] to code the respective industries of parental employment. Occupations were further classified into those with probable exposures to solvents, heavy metals, and polycyclic aromatic hydrocarbons from information available in the Agency for Toxic Substances and Disease Registry (ATSDR) Toxicological Profiles, National Institute for Occupational Safety and Health (NIOSH) criteria documents, and the National Library of Medicine Haz-Map.[17]

Because addresses on birth and fetal death certificates reflect maternal residences at delivery, and some women are known to change residences between the time of conception and delivery, we also examined the association between maternal residential proximity to hazardous waste sites and industrial facilities and birth defects among Texas case and control births who were part of the National Birth Defects Prevention Study (NBDPS, 30 target defects). The methods of the NBDPS are described in detail elsewhere.[18] As part of the telephone interview in NBDPS, women are asked about residential addresses during the period of three months prior to the estimated date of conception to the address at delivery of the index child. We reviewed the Texas case- and control-women's addresses and selected those addresses for further geocoding that corresponded to the periconceptional period (three months prior to three months after the estimated date of conception). In addition to residential data, data were also obtained from the Texas portion of NBDPS on maternal demographic characteristics, folic acid use, and cigarette smoking.

### *Environmental Data*

Environmental data were obtained from three sources. Data regarding National Priority List (NPL) superfund sites were downloaded from the ATSDR online Hazardous Substances Release/Health Effects Database (HazDat),[19] including information about site characteristics and contaminants present by environmental media and maximum concentrations found. The Texas Commission on Environmental Quality (TCEQ) online superfund database[20] provided information regarding site status (active/deleted) and geographic coordinates (point locations). Because the ATSDR HazDat database did not contain information about state superfund sites, we abstracted environmental data for these waste sites from paper and microfilmed files stored at TCEQ in Austin, Texas. Downloaded NPL and abstracted state superfund data were merged into one file that contained site- and chemical-specific information for hazardous waste sites in Texas.

Land areas of hazardous waste sites in Texas ranged from less than 2 to 760 acres. To account for varying land areas and reduce misclassification of proximity that would have been introduced by using point locations, we digitized the boundaries of these sites from Digital Orthophoto Quarter Quads (DOQQ) images with a 1-meter resolution. These images were obtained from the Texas Natural Resources Information System (TNRIS).

Data regarding Texas industries with air emissions of chemicals were obtained from the United States Environmental Protection Agency (EPA) Toxic Release Inventory (TRI) program.[21] Section 313 of the Emergency Planning and Community Right-to-Know Act (EPCRA) mandates reports from certain businesses each year on the amounts of EPCRA Section 313 chemicals that these facilities release into the environment.[22] A company is required to report as part of the TRI if it is included in a covered standard industrial code (SIC), has ten or more employees, and manufactures, imports, processes, or otherwise uses any of the 650+ EPCRA Section 313 chemicals in amounts greater than the threshold quantities specified. These databases contain information about each reporting facility for location (address, latitude and longitude), year of report, chemicals released (name, CAS number, amount released in pounds, environmental media), and type of industry (SIC code). These industries were further classified by whether they were petroleum refineries (SIC Major Group 29: Petroleum Refining and Related Industries), primary metals or smelter facilities (SIC Major Group 33: Primary Metal Industries), or chemical industries (SIC Major Group 28: Chemicals and Allied Products).

We examined the company-reported locational information and found several errors, such as addresses in Texas assigned geographic coordinates outside of the state. For example, 52 (3.6%) of the reported latitudes and longitudes among the 1,438 Texas facilities with air emissions in 2000 fell outside the state. Second, some of the latitudes and longitudes in geographic decimal degrees were rounded to the nearest degree in the TRI databases and were considered too imprecise for calculating distances. Therefore, addresses of industrial facilities were geocoded by the study team to increase the degree of positional accuracy and reduce misclassification of distances between maternal residences and these facilities.

Site contaminants at hazardous waste sites and air releases from industries were further classified by whether heavy metals, polycyclic aromatic hydrocarbons, or solvents were involved. Solvents were also specified by structural categories (e.g., alcohols, aromatic hydrocarbons, alkyl halides) based on Sullivan's classification of these compounds.[23]

### *Data Linkage and Analysis*

All related databases were combined to create a comprehensive geographic information system (GIS) within the ArcGIS environment. We also developed a query tool—called GIS-EpiLink—that provided functions to support a variety of queries to link environmental data and cases and controls based on different combinations of chemicals, types of birth defects, and the distance between a maternal residence location and a hazardous waste site or industrial facility. Different queries were performed between industrial facilities and hazardous waste site databases and the maternal residential files to identify women who had any periconceptional (1997–2001 Texas NBDPS cases and controls) or birth addresses (1996–2000 cases with selected birth defects and birth certificate controls) within 10 miles of these sites or facilities. Actual distances within 10 miles were incorporated into the maternal residential files. This large buffer area with distances in miles as output was chosen to allow for flexibility in developing smaller buffer zones of various sizes and to allow for comparisons with other published studies. Maternal addresses were related to the boundaries of those hazardous waste sites that were still active (undergoing clean-up) during the periconceptional period (Texas NDBPS cases and controls) or year of the index birth (1996–2000 birth defects cases and birth certificate controls). Street addresses of industrial facilities were related by year to the corresponding year(s) of maternal addresses during the periconceptional period or year of the index birth.

We examined the relation between maternal characteristics of comparison women and a periconceptional address or address at delivery within one mile and two miles of a hazardous waste site or industrial facility. This portion of the study was restricted to comparison births because they represented normal births (without documented birth defects) during the study period.

The following maternal characteristics were studied among the Texas NBDPS controls: maternal age (< 20, 20–29, > 29 years), race/ethnicity (non-Hispanic white, African American, Hispanic, other), education (< 12, 12, >12 years); birthplace (U.S. versus other); folic acid use one month prior to one month postconception (yes/no), prenatal care (yes/no), and smoking one month prior to three months postconception (yes/no). Among the birth certificate controls, we examined maternal age (five categories ranging from less than 20 years to 35 years or older); maternal race/ethnicity (non-Hispanic white, African American, Hispanic, other); maternal education (0–8, 9–11, 12, 13–15, 16+ years), residence within the city limits (yes/no), Medicaid status (on Medicaid or not), prenatal care (yes/no), and tobacco use during pregnancy (yes/no). Crude prevalence odds ratios (OR) and 95% confidence intervals (CI) for living within one mile of one or more industrial sites or hazardous waste sites were calculated for each of the maternal characteristics. Logistic regression (SPSS 12.0, Chicago, Illinois) was used to obtain prevalence odds ratios adjusted for maternal age, race/ethnicity, and education.

## RESULTS

A total of 6,048 case births were linked to their respective Texas birth or fetal death certificates for 1996–2000, including 764 births with a neural-tube defect, 1,390 births with conotruncal heart defects, 2,013 births with oral clefts, 1,341 births with Down's syndrome, and 2,334 births with any chromosomal anomaly. A total of 453 births had more than one of these defects, and cases with neural-tube defects, conotruncal heart defects, or oral clefts were excluded from the respective counts of these defects if they also had a chromosomal anomaly. A total of 4,965 births without documented birth defects were selected from the birth certificate files as controls. In the Texas portion of the NBDPS, 1404 case mothers and 454 control mothers of 1997–2001 deliveries were interviewed.

Forty-three NPL sites and 70 state superfund sites were active during 1996–2001. All of these sites' boundaries were digitized, and the respective environmental data were combined with site locational data. Of the 8,215 Texas industries that reported air releases under the TRI during 1996–2001, 7,197 (87.6%) were successfully geocoded.

The proportions of maternal residences geocoded varied between the vital records study and the NBDPS. Approximately 84% of the Texas NBDPS cases and controls had one or more periconceptional addresses successfully geocoded, compared with 89% of maternal addresses at delivery in the other study. However, proportions of case and control addresses geocoded were not materially different from one another in each study sample. Table 1 shows the proportions of case and control addresses geocoded for both studies. Approximately 26% of the Texas NBDPS cases and 24% of the NBDPS controls reported more than one address during the periconceptional period. Maternal addresses were linked in distance to the locations of 113 active hazardous waste sites by type of site (NPL or state superfund) and contaminants present (heavy metals, polycyclic aromatic hydrocarbons, or solvents). Maternal addresses were linked to the locations of the 7,197 industries reporting air emissions during the study period by type of facility (chemical, petroleum refining, primary metals/smelter) and air emissions (heavy metals, polycyclic aromatic hydrocarbons, or solvents).

Residential proximity to hazardous waste sites varied by several maternal characteristics (Table 2). With adjustment for age and education, control women (identified from Texas live-birth certificates) who were African American, Hispanic, or of other racial/ethnic categories were two or more times more likely than non-Hispanic white women to have a residential address at delivery within one mile of a hazardous waste site. Maternal educational attainment was strongly associated with living near hazardous waste sites. Relative to women with 16 or more years of education, the prevalence odds ratio for women with less than nine years of education was 8.9 (95% CI: 2.3–34.1) for living within one mile of a waste site. Other factors related to residential proximity to these sites included a residence within the city limits (adjusted OR 7.2) and reported tobacco use during pregnancy (adjusted OR 2.2). Women with fewer years of education and of a racial/ethnic group other than non-Hispanic white were also more likely to live within a mile of industrial facilities with air emissions (Table 3). Women with a residence within the city limits were 2.4 times more likely (95% CI: 1.5–3.9) to live near these facilities than women with residences outside the city limits.

We also examined various maternal characteristics by residence within two miles of industrial facilities and waste sites. Although the differences were not as marked for women living between one and two miles of these sites as those noted for women living within a mile, similar trends and patterns were observed by race/ethnicity and maternal education among women living slightly further away (data not shown). Women who were less educated or belonging to any group besides non-Hispanic white were more likely to live one to two miles from waste sites or facilities than women who were more educated or non-Hispanic white.

Although there were too few controls in the Texas portion of the NBDPS study ($n$ = 380) to perform the same analyses as in the 1996–2000 vital record study, risk-factor distributions for living near superfund sites or industrial facilities during the periconceptional period were comparable to those found for addresses at delivery near these sites. A higher proportion of women who were less educated or who were African American, Hispanic, or other racial/ethnic categories than women

**TABLE 1 Proportions of Maternal Addresses Georeferenced, by Study Sample and Case–Control Status**

| Study Case–Control Status | Georeferenced No. (%) |
|---|---|
| Texas portion of National Birth Defects Prevention Study | |
| Cases | 1,174 (83.6) |
| Controls | 380 (83.7) |
| Registry cases linked to vital records and birth certificate controls | |
| Cases | 5,385 (89.0) |
| Controls | 4,368 (88.0) |

**TABLE 2 Maternal Characteristics by Residential Proximity to Hazardous Waste Sites, 1996–2000 Texas Births without Documented Congenital Malformations***

| | Residence within One Mile of Hazardous Waste Site | | Unadjusted Odds Ratio (95% CI) | Adjusted† Odds Ratio (95% CI) |
|---|---|---|---|---|
| | N (%) | Total | | |
| Age (years) | | | | |
| < 20 | 26 (3.6) | 720 | 1.3 (0.75–2.3) | 1.1 (0.65–2.0) |
| 20-24 | 34 (2.8) | 1,220 | 1.0 (referent) | 1.0 (referent) |
| 25-29 | 26 (2.3) | 1,152 | 0.81 (0.47–1.4) | 1.1 (0.62–1.8) |
| 30-34 | 20 (2.4) | 824 | 0.87 (0.48–1.6) | 1.2 (0.63–2.1) |
| 35+ | 11 (2.4) | 452 | 0.87 (0.41–1.8) | 1.2 (0.60–2.6) |
| Race/ethnicity | | | | |
| Non-Hispanic white | 18 (1.0) | 1,720 | 1.0 (referent) | 1.0 (referent) |
| African American | 12 (2.6) | 470 | 2.5 (1.1–5.5) | 2.0 (0.92–4.2) |
| Hispanic | 84 (4.1) | 2,038 | 4.1 (2.4–7.0) | 2.8 (1.6–4.8) |
| Other | 3 (2.2) | 138 | 2.1 (0.49–7.7) | 2.4 (0.66–8.9) |
| Education (years) | | | | |
| 0–8 | 25 (5.4) | 466 | 7.5 (2.9–20.4) | 8.9 (2.3–34.1) |
| 9–11 | 37 (3.8) | 981 | 5.2 (2.1–13.6) | 3.5 (1.2–10.6) |
| 12 | 38 (2.9) | 1,318 | 3.9 (1.6–10.3) | 2.3 (0.87–6.0) |
| 13–15 | 9 (1.2) | 743 | 1.6 (0.52–5.1) | 1.3 (0.42–4.1) |
| 16+ | 6 (0.8) | 794 | 1.0 (referent) | 1.0 (referent) |
| Residence within city limits | | | | |
| Yes | 116 (2.9) | 4,000 | 10.5 (1.8–419) | 7.2 (1.0–52.3) |
| No | 1 (0.3) | 353 | 1.0 (referent) | 1.0 (referent) |
| Medicaid status | | | | |
| On Medicaid | 41 (3.8) | 1,091 | 1.6 (1.1–2.5) | 1.4 (0.94–2.1) |
| Not on Medicaid | 76 (2.3) | 3,275 | 1.0 (referent) | 1.0 (referent) |
| Prenatal care | | | | |
| None | 5 (6.0) | 83 | 2.4 (0.84–6.3) | 1.6 (0.64–4.2) |
| Yes | 112 (2.6) | 4,285 | 1.0 (referent) | 1.0 (referent) |
| Tobacco use during pregnancy | | | | |
| Yes | 11 (3.8) | 293 | 1.5 (0.73–2.8) | 2.2 (1.1–4.4) |
| No | 106 (2.6) | 4,040 | 1.0 (referent) | 1.0 (referent) |

*Random sample of 4,368 births from Texas live-birth certificates.
†Adjusted for maternal age, race/ethnicity, and education (age, race/ethnicity, and education adjusted for each other in logistic model).

who were more educated or non-Hispanic white lived within a mile of either a hazardous waste site or industrial facility during the periconceptional period.

Although the numbers of women available for study were small, leading to imprecise estimates of effect, approximately 3.6% of control women who denied using folic acid one month prior through one month postconception lived within a mile of a hazardous waste site, compared with 0.8% of women who reported taking folic acid during this period (OR 4.9, 95% CI 0.61–38.9). Non-users of folic acid during this period were also more likely than users to live within a mile of an industrial facility (OR 1.5, 95% CI 0.72–3.3).

## DISCUSSION

We have outlined the necessary steps to link maternal prenatal residential addresses to locations of potential environmental hazards, including hazardous waste sites and industrial facilities. While the study demonstrates feasibility of such linkages, several caveats should be discussed. First, close residential proximity to such sites and facilities should not be equated with exposure. Persons who live near industrial facilities and waste sites may be at higher risk of exposure, especially if air emissions of chemicals are occurring, than persons who do not live nearby. Studies of air dispersal of contaminants and other types of modeling might increase certainty of actual exposures, but these models also have limitations. Nevertheless, communities are often concerned about potential links between close proximity to hazardous waste sites and industrial facilities and adverse health outcomes, and the linkages described in this study provide a mechanism to address these concerns.

Based on the findings of the present study, some caution should also be exercised in using self-reported geographic coordinates. To avoid introducing inaccuracies and misclassification in environmental public health tracking, we recommend that, at minimum, investigators and public health professionals examine a

**TABLE 3 Maternal Characteristics by Residential Proximity to Toxic Release Inventory (TRI) industrial Facilities, 1996–2000 Texas Births without Documented Congenital Malformations***

| | Residence within One Mile of Hazardous Waste Site | | Unadjusted Odds Ratio (95% CI) | Adjusted† Odds Ratio (95% CI) |
|---|---|---|---|---|
| | N (%) | Total | | |
| Age (years) | | | | |
| < 20 | 121 (16.8) | 720 | 1.2 (0.94–1.6) | 1.0 (0.79–1.4) |
| 20-24 | 173 (14.2) | 1,220 | 1.0 (referent) | 1.0 (referent) |
| 25-29 | 174 (15.1) | 1,152 | 1.1 (0.85–1.4) | 1.4 (1.1–1.8) |
| 30-34 | 93 (11.3) | 824 | 0.77 (0.58–1.0) | 0.96 (0.71–1.3) |
| 35+ | 47 (10.4) | 452 | 0.70 (0.49–1.0) | 0.94 (0.65–1.4) |
| Race/ethnicity | | | | |
| Non-Hispanic white | 131 (7.6) | 1,720 | 1.0 (referent) | 1.0 (referent) |
| African American | 86 (18.3) | 470 | 2.7 (2.0–3.7) | 2.4 (1.8–3.3) |
| Hispanic | 373 (18.3) | 2,038 | 2.7 (2.2–3.4) | 2.0 (1.6–2.6) |
| Other | 18 (13.0) | 138 | 1.8 (1.0–3.2) | 1.6 (0.89–2.8) |
| Education (years) | | | | |
| 0–8 | 101 (21.7) | 466 | 3.7 (2.6–5.4) | 2.4 (1.4–4.1) |
| 9–11 | 175 (17.8) | 981 | 2.9 (2.1–4.1) | 1.9 (1.2–2.9) |
| 12 | 181 (13.7) | 1,318 | 2.1 (1.5–3.0) | 2.0 (1.4–2.8) |
| 13–15 | 81 (10.9) | 743 | 1.6 (1.1–2.4) | 1.6 (1.1–2.3) |
| 16+ | 55 (6.9) | 794 | 1.0 (referent) | 1.0 (referent) |
| Residence within city limits | | | | |
| Yes | 589 (14.7) | 4,000 | 3.2 (2.0–5.4) | 2.4 (1.5–3.9) |
| No | 18 (5.1) | 353 | 1.0 (referent) | 1.0 (referent) |
| Medicaid status | | | | |
| On Medicaid | 153 (14.0) | 1,091 | 1.0 (0.83–1.2) | 0.83 (0.67–1.0) |
| Not on Medicaid | 455 (13.9) | 3,275 | 1.0 (referent) | 1.0 (referent) |
| Prenatal care | | | | |
| None | 10 (12.0) | 83 | 0.84 (0.41–1.7) | 0.63 (0.32–1.2) |
| Yes | 598 (14.0) | 4,285 | 1.0 (referent) | 1.0 (referent) |
| Tobacco use during pregnancy | | | | |
| Yes | 29 (9.9) | 293 | 0.66 (0.44–0.99) | 0.82 (0.54–1.2) |
| No | 577 (14.3) | 4,040 | 1.0 (referent) | 1.0 (referent) |

*Random sample of 4,368 births from Texas live-birth certificates.
†Adjusted for maternal age, race/ethnicity, and education (age, race/ethnicity, and education adjusted for each other in logistic model).

sample of the available coordinates provided by different sources for positional accuracy and perform the georeferencing of addresses if necessary.

For hazardous waste sites and industrial facilities that typically exist as an area unit, misclassification may also be introduced if proximity is determined from point locations instead of boundaries of sites and facilities. In this study, distances between maternal residences and hazardous waste sites were determined from site boundaries, but distances from industrial facilities were calculated from single point locations. While industrial facilities often cover less land area than hazardous waste sites, air emissions may impact a larger area than immediately around the facility and are influenced by climatic and topographic conditions.

Results from this study clearly demonstrate the importance of taking into account maternal race/ethnicity and education and other factors such as folic acid intake when linking prenatal maternal residential locations to potential environmental hazards and adverse reproductive outcomes. Both lower maternal educational attainment and being of a racial/ethnic group other than non-Hispanic white were strongly associated with living within one mile of either a hazardous waste site or an industrial facility. Maternal education [24–26] and race/ethnicity[27–30] are also associated with a variety of congenital malformations. These observations make these fundamental characteristics important potential confounders in epidemiologic studies of proximity to environmental hazards and birth defects in offspring.

Other studies have documented racial/ethnic disparities in residential proximity to industrial emissions and air pollution. Perlin et al.[31] found that African American children five years old or younger were more likely than white children to live in close proximity to industrial sources of air pollution in three study areas located in West Virginia, Louisiana, and Maryland. In a study of air pollution during pregnancy, higher proportions of Hispanic, African American, and Asian/Pacific Islander mothers than white mothers lived in areas with higher levels of ozone, particulate matter, sulfur dioxide, nitrogen dioxide, and carbon monoxide.[32] With adjustment for maternal age, parity, marital status, and race/ethnicity, women with lower educational attainment, however, were not more likely to live in areas of higher levels of air pollution than more educated women.

In the present study, women who were non-users of folic acid one month prior through one month post-conception were more likely to live near hazardous waste sites or industrial facilities than users of folic acid during this period, although the odds ratios were consistent with unity due to the small number of control mothers available for study. Folic acid has been shown to reduce risk for neural tube defects, [33,34] and has also been associated with reduced risks for other types of birth defects.[35,36] Therefore, folic acid use might be an important confounding variable in studies of the relation between residential proximity to environmental hazards and congenital malformations. Folic acid use is not a routinely collected variable on vital records, and exposure is usually determined through interview. However, maternal education and race/ethnicity have been shown to influence the intake of folic acid during the periconceptional period.[37,38] and these variables are usually available on vital records. Adjustment for maternal education and race/ethnicity might partly account for folic acid use in such studies.

Environmental public health tracking has the potential to identify hazards to human health. This activity seems especially suitable for studying effects on children's health, since the appropriate temporal relation between environmental exposures and outcomes are more easily achieved than exposure–chronic disease relationships in adults. Availability and quality of environmental hazard/exposure data for linkage to health-effect data will vary by political units (e.g., states and countries). For example, the site-assessment and remediation of NPL superfund sites require a systematic scoring system for hazard ranking and a formal public health assessment (for which data on environmental contaminants and affected media are made available online). These consistent and systematic site assessment procedures are not available in Europe.[39] Therefore, a thorough inventory of available data, data elements, and potential variables to achieve linkages should be conducted for the geographic area of interest.

As seen from this study, linking databases to conduct environmental public health tracking demands recognition of the limitations of such data, attention to reducing misclassification errors, and adjustment for potential variables that might distort study associations. Future work should indicate whether this type of tracking is a valid research tool.

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