

Hazardous Waste Sites, Industrial Facilities, and Adverse Pregnancy Outcomes in Dallas, Denton, and Tarrant Counties, 1997 - 2000

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Background

- In 2003, 1.6 billion pounds of materials released into the air by Toxic Release Inventory (TRI) facilities in U.S.
- By 2006, 1558 hazardous waste sites placed on the National Priorities List (NPL)
 - 1 in 4 Americans live within 3 miles of Superfund Site



Previous findings regarding maternal residential proximity to hazardous waste sites and congenital anomalies

First author and year	Defect(s)	Associations found
Geschwind, 1992	Nervous system Chromosomal anomalies	Metals (OR 1.34) Solvents (OR 1.24) Plastics (OR 1.46)
Shaw, 1992	Heart/circulatory	Residence in census tract with waste site (OR 1.5)
Marshall, 1997	Central nervous system	No association with metals or solvents at sites
Shaw, 1997	Neural tube defects (NTDS) Conotruncal heart Oral clefts	NPL sites (OR 1.4) NPL sites (OR 1.8) NPL sites (OR 1.0)
Dolk, 1998	Neural tube defects Cardiac anomalies	< 3 Km (OR 1.86) < 3 Km (OR 1.49, 1.81)
Vrijheid, 2002	Chromosomal anomalies	< 3 km (OR 1.41)

Previous findings regarding maternal residential proximity to industrial facilities and congenital anomalies

First author and year	Defect(s)	Associations found
Marshall, 1997	Central nervous system defects	Solvents (OR 1.3) Metals (OR 1.4)
Bhopal, 1999	"Fetal abnormality"	No trend in prevalence with increasing distance from steel or petrochemical facilities
Dummer, 2003	Spina bifida Heart defects Anencephaly	Incinerators (continuous ORs) Incinerators (continuous ORs) Crematoriums (continuous ORs)
Yauck, 2004	Congenital heart disease	Point sources of trichloroethylene - OR elevated for offspring of women 38+ years
Tango, 2004	Fetal and infant deaths from congenital anomalies	Peak decline in risk with distance from municipal solid waste (MSW) incinerators
Cordier, 2004	Facial clefts Renal dysplasia	Increased risk if mother lived in vicinity of MSW incinerators

Previous findings regarding maternal residential proximity to waste sites and industrial facilities and congenital anomalies – Texas Studies

First author and year	Defect(s)	Associations found
Malik, 2004	Congenital heart disease	Within 1 mile of waste sites (OR 1.2)
Brender, 2006	Oral clefts (isolated, cleft lip with & without cleft palate, cleft palate)	No association noted with residence within 1 mile of waste sites or industrial facilities; among women 35+ years, residence within 1 mile associated with oral clefts (OR 2.4, 95% CI 1.3, 4.2)
Suarez, 2007	Neural tube defects	No association with proximity to waste sites; modest risk with proximity to industrial facilities (OR 1.2) that was much stronger among births to older women (OR 2.7, 95% CI 1.4, 5.0)
Brender, 2008	Chromosomal anomalies	No association with waste sites except for Klinefelter variants; residence within 1 mile of industrial facilities associated with chromosomal anomalies among births to older women

Project objectives

- To examine relation between maternal residential proximity to waste sites and industrial facilities and
 - Selected birth defects (neural tube defects, oral clefts, conotruncal heart defects, and chromosomal anomalies)
 - Low birth weight and preterm births
 - Maternal characteristics

Study Population

- Three-county area in PHR 3
 - Dallas, Denton, and Tarrant counties
 - Births occurring during 1997 – 2000
 - Compared with Public Health Region 3 and Public Health Regions other than 3

Methods

Design and study population

- Case-control study
 - Cases - Texas Birth Defects Registry
 - Selected congenital anomalies (1997—2000)
 - Chromosomal anomalies
 - Neural tube defects
 - Conotruncal heart defects
 - Oral cleft defects
 - Linked to respective live birth or fetal death records
 - Controls – random sample of 4965 births without birth defects
 - Selected from computerized birth certificate files
 - Frequency-matched to case-births
 - Public health region of maternal residence
 - Year of birth

Outcomes – Low Birth Weight and Preterm Birth

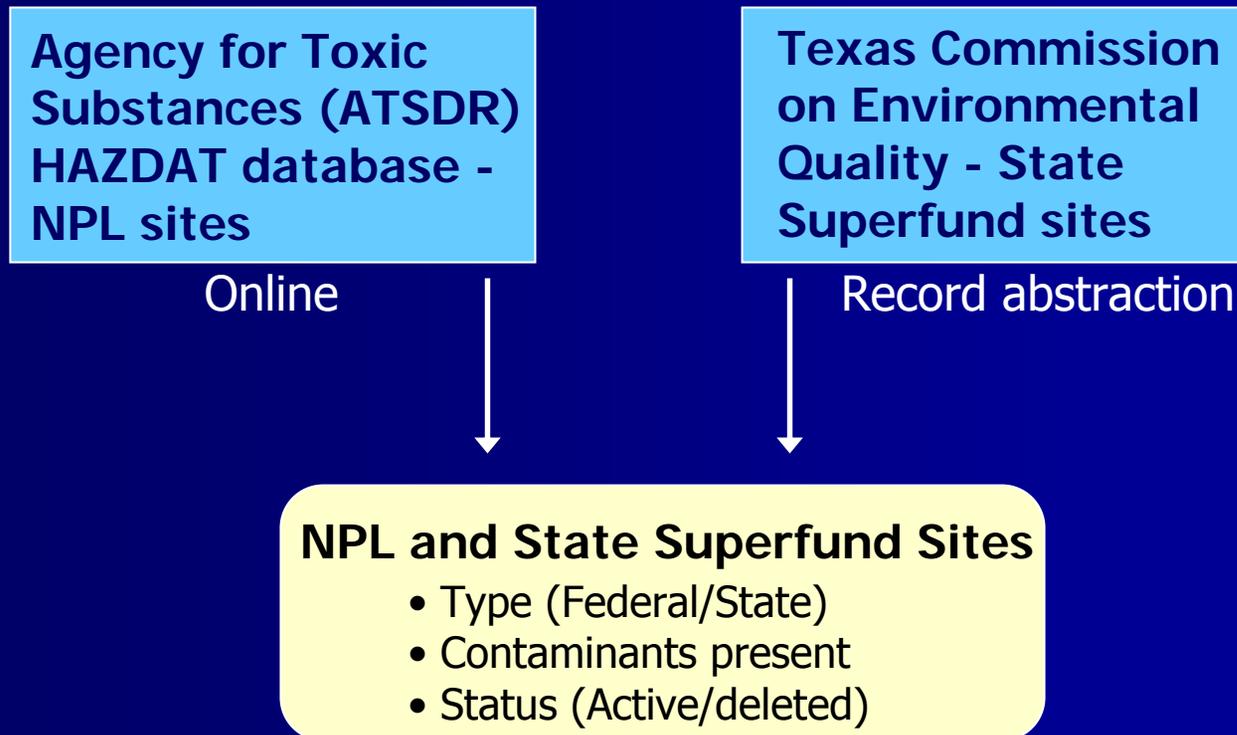
- Source of cases
 - Controls (without major birth defects who met case-definition of outcomes)
- Definition of low birth weight
 - Birth weight of less than 2500 grams
- Definition of preterm birth
 - Gestation of less than 37 weeks

Covariates available on vital records and categorization

- Maternal age
 - Five year intervals
- Maternal race/ethnicity
 - Non-Hispanic white, Hispanic, African-American, Other
- Maternal education
 - <9, 9-11, 12, 13-15, 16+ years
- Other

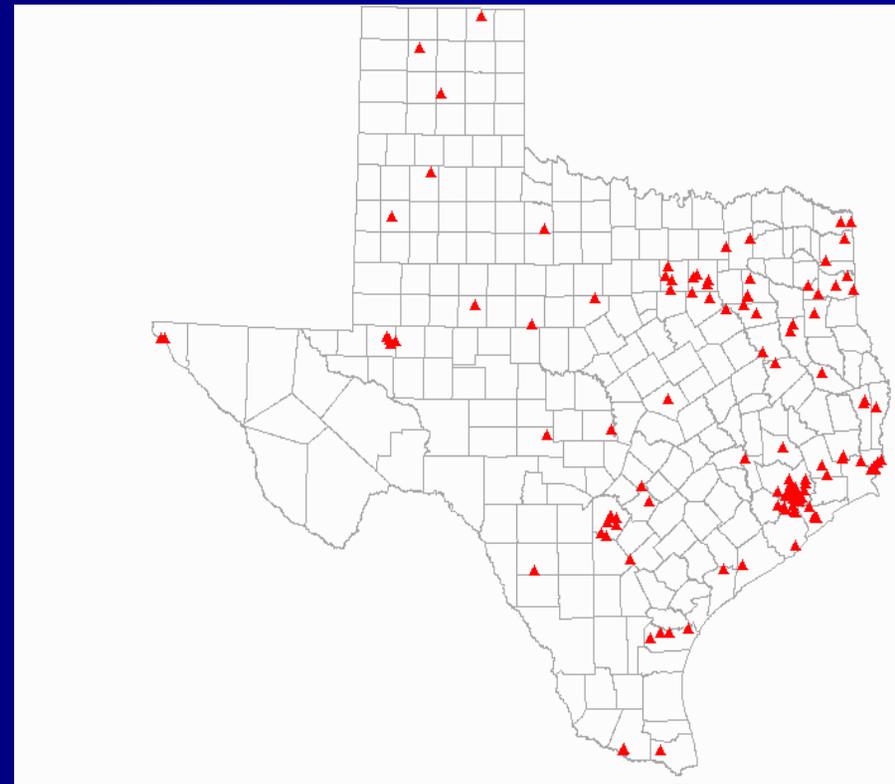
Types and sources of environmental data

Hazardous Waste Sites



National Priority List (NPL) and State Superfund Sites in Texas

- Sites - Statewide
 - 49 NPL Sites
 - 73 State Superfund sites
 - 113 sites active at the beginning of the study period



Types and sources of environmental data

Industrial Facilities - Statewide

USEPA Toxic Release
Inventory (TRI) databases
1996 - 2000

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graph TD; A[USEPA Toxic Release Inventory (TRI) databases 1996 - 2000] --> B[Facilities with reported air emissions (n=1,648)]; B --> C[• Year of report]; B --> D[• Industry (SIC code)]; B --> E[• Chemicals released];
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Facilities with reported air emissions (n=1,648)

- Year of report
- Industry (SIC code)
- Chemicals released

Development of geographic information system (GIS)

**Hazardous waste sites -
boundaries digitized**

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**Industrial facility
addresses geocoded**

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**Maternal addresses
geocoded with Centrus
Geo-coder**

Development of geographic information system (GIS)

Hazardous waste sites -
boundaries digitized

Industrial facility
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GIS - EpiLink

Maternal addresses
geocoded with Centrus
Geo-coder

Residential proximity to sites - Definition

- Maternal residential address (at time of index birth) within 1 mile and other distances from a hazardous waste site or TRI industrial facility
 - Type of facility
 - Chemical groups
 - Metals
 - Solvents
 - PAHs

Data analyses

- Reference group for distances within 1 or 2 miles of waste sites or TRI facilities
 - 1 or more miles from **any** active hazardous waste site or TRI facility included in study
 - 2 or more miles from **any** active hazardous waste site or TRI facility included in study
- Logistic regression
 - Odds ratios adjusted for maternal race/ethnicity and education *
 - Exact logistic regression used for sparse data

*Odds ratios adjusted if > 1.0 and 95% confidence intervals excluded 1.0)

Results – Pregnancy Outcomes Available for Study

Outcome	County (n)		
	Dallas	Denton	Tarrant
Neural tube defects	94	18	57
Oral clefts	160	21	88
Conotruncal heart defects	162	22	118
Chromosomal anomalies	341	43	185
Low birth weight	250	26	128
Preterm birth	210	23	165

Percent Geocoded by Case (Birth Defects) and Control Status

County	% Geocoded	
	Cases (%)	Controls (%)
Dallas	784 (98.9)	663 (96.9)
Denton	104 (96.3)	103 (97.2)
Tarrant	459 (98.5)	361 (98.1)

Proximity of maternal residences to waste sites and industrial facilities – three county area

Residential characteristic	Cases N (%)	Controls N (%)
Within 1 mile of waste site	12 (0.9)	3 (0.3)
Within 2 miles of waste site	35 (2.6)	24 (2.1)
Within 1 mile of industrial facility	308 (22.9)	227 (20.1)
Within 2 miles of industrial facility	776 (57.6)	616 (54.7)

Findings – Hazardous Waste Sites

- Three counties combined
 - Residence within 1 mile of waste site
 - Associated with isolated oral clefts
 - OR 5.7 (95% CI 1.3, 25.8)
- Separate county analyses
 - Residence within 2 miles of waste site – Tarrant County
 - Associated with Non-Down syndrome chromosomal anomalies
 - OR 4.0 (95% CI 1.3, 12.4)

Maternal residence within 1 mile of **any** industrial facility with air emissions of chemicals and birth defects in residents of Dallas, Denton, and Tarrant Counties (Combined)

Birth Defect	Cases N (%)	Controls N (%)	OR (95% CI)
Neural tube defects	56 (34.1)	227 (20.1)	2.1 (1.4, 2.9)
Anencephaly	19 (38.0)	227 (20.1)	2.4 (1.3, 4.4)
Spina bifida	31 (33.3)	227 (20.1)	2.0 (1.3, 3.1)

Maternal residence within 1 mile of **any** industrial facility with air emissions of chemicals and NTDs in residents of Dallas, Denton, and Tarrant Counties

County	Cases N (%)	Controls N (%)	OR (95% CI)
Dallas	35 (37.2)	159 (24.0)	1.9 (1.2, 3.0)
Denton	3 (17.6)	4 (3.9)	6.9* (0.69, 92.3)
Tarrant	18 (34.0)	64 (17.1)	1.9* (0.95, 3.8)

*Adjusted for maternal race/ethnicity and education

Maternal residence within 1 mile of a **chemical manufacturing** facility and birth defects in residents of Dallas, Denton, and Tarrant Counties (Combined)

Birth Defect	Cases N (%)	Controls N (%)	OR (95% CI)
Neural tube defects	20 (15.6)	86 (8.7)	1.9 (1.1, 3.3)
Anencephaly	5 (13.9)	86 (8.7)	1.7 (0.64, 4.5)
Spina bifida	14 (18.4)	86 (8.7)	2.4 (1.3, 4.4)

Maternal residence within 1 mile of a **chemical manufacturing** facility with air emissions of chemicals and NTDs in residents of Dallas, Denton, and Tarrant Counties

County	Cases N (%)	Controls N (%)	OR (95% CI)
Dallas	16 (21.3)	69 (12.0)	2.0 (1.1, 3.6)
Denton	2 (12.5)	1 (1.0)	10.9* (0.53, 684.2)
Tarrant	2 (5.4)	16 (5.1)	1.1 (0.23, 4.8)

*Adjusted for maternal race/ethnicity and education

Maternal residence within 1 mile of a facility with **heavy metals emissions** and birth defects in residents of Dallas, Denton, and Tarrant Counties (Combined)

Birth Defect	Cases N (%)	Controls N (%)	OR (95% CI)
Neural tube defects	26 (19.4)	95 (9.5)	2.3 (1.4, 3.7)
Anencephaly	10 (24.4)	95 (9.5)	3.1 (1.5, 6.4)
Spina bifida	14 (18.4)	95 (9.5)	2.1 (1.2, 4.0)

Maternal residence within 1 mile of a facility with **heavy metal emissions** and NTDs in residents of Dallas, Denton, and Tarrant Counties

County	Cases N (%)	Controls N (%)	OR (95% CI)
Dallas	14 (19.2)	60 (0.6)	2.0 (1.1, 3.8)
Denton	1 (6.7)	0 (0.0)	—
Tarrant	11 (23.9)	35 (10.5)	2.2* (0.88, 5.0)

*Adjusted for maternal race/ethnicity and education

Maternal residence within 1 mile of a facility with **emissions of solvents** and birth defects in residents of Dallas, Denton, and Tarrant Counties (Combined)

Birth Defect	Cases N (%)	Controls N (%)	OR (95% CI)
Neural tube defects	38 (26.0)	151 (14.4)	2.1 (1.4, 3.2)
Anencephaly	12 (27.9)	151 (14.4)	2.3 (1.2, 4.6)
Spina bifida	23 (27.1)	151 (14.4)	2.2 (1.3, 3.7)

Maternal residence within 1 mile of a facility with **emissions of solvents** and NTDs in residents of Dallas, Denton, and Tarrant Counties

County	Cases N (%)	Controls N (%)	OR (95% CI)
Dallas	26 (30.6)	111 (18.0)	2.0 (1.2, 3.3)
Denton	3 (17.6)	4 (3.9)	6.3* (0.65, 82.5)
Tarrant	9 (20.5)	36 (10.8)	2.1 (0.94, 4.9)

*Adjusted for maternal race/ethnicity and education

Hazardous wastes sites, low birth weight, and preterm births

- Within one mile of a hazardous waste site
 - No preterm or low birth weight births among control mothers
- Within two miles of a hazardous waste site
 - 2 (3.1%) of women with LBW births, 22 (2.1%) with normal weight births
 - 2 (2.4%) with preterm births, 18 (2.0%) with term births

Residence within 1 mile of industrial facilities and low birth weight births

Residential Characteristic	< 2500 grams N (%)	2500+ grams N (%)	OR (95% CI)
Within 1 mile	19 (29.2)	208 (19.6)	1.7 (0.97, 3.0)
Within 2 miles	41 (63.1)	575 (54.1)	1.4 (0.86, 2.4)
Within 1 mile petrochemical	2 (4.2)	5 (0.6)	6.4* (0.58, 41.6)
Within 1 mile chemical mfg	8 (14.8)	78 (8.4)	1.9 (0.87, 4.2)
Within 1 mile heavy metals	8 (14.8)	87 (9.2)	1.7 (0.78, 3.7)
Within 1 mile solvents	13 (22.0)	138 (13.9)	1.7 (0.92, 3.3)

Residence within 1 mile of industrial facilities and preterm births

Residential Characteristic	< 37 weeks N (%)	37+ weeks N (%)	OR (95% CI)
Within 1 mile	21 (25.3)	182 (19.8)	1.4 (0.82, 2.3)
Within 2 miles	50 (60.2)	498 (54.1)	1.3 (0.81, 2.0)
Within 1 mile smelter	3 (4.6)	13 (1.7)	2.8 (0.76, 9.9)

Residence within 1 mile of industrial facilities and low birth weight births – Dallas and Tarrant Counties

County	Residential characteristic	N (%) of mothers with LBW births	OR (95% CI)
Tarrant	Within 1 mile of industrial facility	9 (40.9)	3.6 (1.5, 8.8)
Dallas	Within 1 mile of petrochemical facility	2 (6.3)	6.3 (1.2, 33.9)
Tarrant	Within 1 mile of facility with emission of solvents	6 (31.6)	4.4 (1.5, 12.3)

Maternal characteristics associated with living within 1 mile of industrial facility

- With adjustment for maternal race/ethnicity and education, no association seen for maternal age, Medicaid status, or prenatal care

Maternal characteristics associated with living within 1 mile of industrial facility

Maternal race/ethnicity	Number (%) within 1 mile	OR* (95% CI)
White, non-Hispanic	140 (13.1)	1.0 (Referent)
African American	58 (15.9)	1.2 (0.82, 1.6)
Hispanic	315 (34.1)	2.3 (1.8, 3.1)
Other	22 (18.0)	1.4 (0.82, 2.3)

* Adjusted for maternal education

Maternal characteristics associated with living within 1 mile of industrial facility

Maternal education (years)	Number (%) within 1 mile	OR* (95% CI)
0 – 8	124 (42.6)	2.8 (1.5, 5.1)
9 – 11	129 (26.8)	1.5 (0.95, 2.3)
12	150 (21.6)	1.7 (1.2, 2.5)
13 – 15	60 (14.1)	1.1 (0.76, 1.7)
16+	61 (11.6)	1.0 (Referent)

*Adjusted for maternal race/ethnicity

Conclusions

- No convincing evidence that residents who lived in close proximity to hazardous waste sites more likely to have adverse pregnancy outcomes in three counties

Conclusions

- Maternal residence within a mile of industrial facilities associated with neural tube defects in offspring
 - Positive association seen for both anencephaly and spina bifida
 - Associations much weaker or nonexistent in rest of state (excluding PHR 3)

Conclusions

- Maternal residence within a mile of industrial facilities only weakly associated or not associated with other adverse pregnancy outcomes examined in study

Discussion - Limitations

- Elective terminations not included
- Maternal address at delivery
 - Change of address might have occurred
- Proximity of residence proxy for potential exposure to:
 - Waste site contaminants
 - Air releases from industrial facilities
 - Climatic conditions not considered
- Waste sites limited to those listed on Texas State Superfund or the NPL
- Small numbers of women with residential characteristics of interest for some pregnancy outcomes

Final thoughts

- Association between maternal residence near industrial facilities at birth and NTDs in offspring should be interpreted with caution
 - In light of discussed limitations
 - Texas NBDPS, 1997 – 2001
 - Control women who denied taking folic acid around conception were more likely to live near industrial facilities than women who reported taking these supplements during that period
- Methods used in study provide an objective and efficient approach in addressing concerns regarding perceived excesses of adverse health outcomes in populations living near waste sites or industrial facilities