SPA Policy Brief

Prenatal Industrial Pollution and Lifelong Economic Harm

EXECUTIVE SUMMARY

Industrial facilities that report to the Toxics Release Inventory (TRI), an EPA-managed dataset, emit a broad mix of hazardous air pollutants in residential areas. New research by **SPA Professor Claudia Persico** indicates that children who gestate within about one mile of an operating TRI facility face lasting harms to learning, health, and earnings that increase the risk of adult poverty. The evidence uses sibling comparisons and ZIP-level event studies that exploit plant openings and closings to isolate prenatal exposure effects. Key mechanisms include neurodevelopmental injury and reduced schooling; harms concentrate very near sites and grow with cumulative exposure.

BACKGROUND

Many TRI facilities are sited in populated neighborhoods. The EPA estimates that roughly 19% of the U.S. population lived within one mile of an operating TRI site in 2014. Toxicants emitted by TRI facilities include heavy metals, volatile organic compounds, and polycyclic aromatic hydrocarbons that are neurotoxic in early life.

Prenatal insults can program lifelong brain and health trajectories, so exposures during gestation can convert neighborhood pollution into persistent social costs. Measured local increases in PM2.5 near new industrial activity are consistent with acute local exposure increases.

STUDY DESIGN

Persico's research combined detailed family survey data with precise location data for TRI sites. It compared sibling outcomes when one gestated during the operation of a nearby TRI site and another did not—plus a stacked difference-in-differences comparison, at the ZIP level, that compares births before and after plant openings or closings. These approaches reduce bias from family background and neighborhood selection. Ambient PM2.5 and other pollutants are substantially higher very close to TRI sites, supporting the exposure assumptions underlying the analysis.

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KEY OUTCOMES

Children gestated within one mile of an operating TRI site experience large, persistent setbacks across education, earnings, and health compared to unexposed siblings, including:

- 0.760 fewer years of schooling
- 23.2% lower wages in adulthood.
- 32% increase in the likelihood of adult receipt of public assistance
- Huge increases in the incidence of disability and cognitive disability

A standardized outcomes index combining income, schooling, employment, and disability falls by roughly 0.4–0.57 standard deviations for prenatally exposed children in family-fixed-effects estimates.

- Effects concentrate within about one mile of TRI sites and decline rapidly with distance.
- Cumulative exposure matters: children with longer postnatal exposure (e.g., ≥7 years) show larger
- long-run harms.

In distributional implications, low-income and minority children are more likely to live near TRI sites, so local pollution reinforces inequality and reduces intergenerational mobility. Effects are robust to specifications (sibling comparisons, ZIP-level stacked D-in-D), unexplained by measured parental behavior changes between births, and similar when limiting to less-polluting TRI sites.

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INTERPRETATION AND MECHANISMS

The pattern of results points to neurodevelopmental injury during gestation as a core mechanism. Toxicants emitted by many TRI facilities (e.g., lead, mercury, PAHs, certain VOCs) are known to impair fetal brain development and later cognitive function. The study's mediation analysis indicates that cognitive disability and reduced schooling explain a substantial fraction of the long-run outcome gap, with reduced employment and income explaining additional portions. Because effects are largest for children living closest to sources and where exposure accumulates over years, both prenatal and early-childhood pathways plausibly operate.

POLICY RECOMMENDATIONS

Strengthen exposure prevention for fence-line communities:

- Prioritize more stringent emission controls, modern pollution-control technologies, and continuous monitoring for TRI facilities located within ~1 mile of residential areas.
- Require facility permitting to include cumulative impact assessments and explicit consideration of prenatal and early-childhood exposures.

Improve surveillance and data quality:

- Enhance TRI reporting accuracy and require higher-frequency, chemical-specific ambient monitoring in neighborhoods close to facilities.
- Fund biomonitoring and birth-cohort tracking to better tie specific chemicals and exposure levels to developmental outcomes.

Target mitigation and social supports in affected communities:

- Expand early childhood screening and intervention, special education resources, and workforce supports for cohorts born near high-emitting facilities.
- Direct remediation, relocation assistance, or community investments (e.g., housing remediation, school supports) where scientific and community assessments indicate high prenatal exposure risk.

Integrate long-run human capital impacts into regulatory benefit–cost analysis:

- Update EPA and interagency regulatory guidance so rulemakings for HAPs and TRI-related standards value cognitive and educational losses and lifetime earnings impacts, not only short-term health endpoints.

Prioritize environmental justice:

- Use equity-weighted analyses when siting, permitting, or authorizing expansions so that historic burdens on low-income and minority neighborhoods are addressed.

COSTS AND BENEFITS

A conservative back-of-the-envelope calculation estimates an added annual public-assistance cost of roughly $2.1 billion per birth cohort attributable to TRI-proximate prenatal exposure, using national spending and population shares. That figure excludes lifetime earnings losses, health care costs, special education, and criminal justice impacts, so it understates total societal cost. Preventive controls and targeted remediation thus have the potential for large net benefits if they reduce prenatal and early-life exposures.

Implementation Notes for Federal Action

Begin with prioritized monitoring and mitigation in ZIP codes with TRI sites within 1 mile of residential populations (identify using current TRI and census data).

Fund pilot programs pairing enhanced air monitoring, maternal and child biomonitoring, and early-childhood supports in high-exposure communities to evaluate intervention effectiveness.

Require updated benefit–cost frameworks in HAP rulemaking to monetize long-run cognitive and earnings impacts, drawing on longitudinal evidence.

Limitations and Research Gaps

TRI emissions are a mixed treatment; current analyses cannot isolate which individual chemicals drive the largest long-run harms, so targeted toxicant-level research is needed. Historical ambient monitoring is sparse in many places; investing in modern, near-source monitoring will reduce exposure misclassification. Finally, impacts vary by local emission mixes, meteorology, and sociodemographic context; localized assessments will be necessary to prioritize interventions.

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CONCLUSION

A consistent body of quasi-experimental evidence shows that prenatal exposure to industrial emissions near TRI sites produces meaningful and persistent reductions in education and earnings and increases in adult assistance dependence and cognitive disability. Policies that prevent prenatal exposure, improve monitoring and TRI reporting, and invest in early-life remediation and supports in affected communities should be prioritized because they can reduce intergenerational harm and advance environmental justice.