

Congenital malformations, coal-related exposure, and reproductive health

Kuzbass and the international body of evidence

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The involvement of AI is part of the Experiment project.

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Publication principle. The web article tells the author's story; this independent investigation provides the basis for verification, confirmation, or refutation. The reader draws the conclusion.

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Natalia Alexandrovna Zubkova.

From the author

I have two daughters with congenital kidney malformations. During both pregnancies, I lived in Kiselyovsk — a city of open-pit coal mines. My son was born in another country, in another city, and he is healthy.

This is my family's story. On its own, it does not prove that industrial pollution caused my

daughters' conditions. But it gives me reason to ask questions whose answers I would have wanted before my children were born.

During my first pregnancy, in 2003–2004, I was given no information about the air I was breathing or the exposures I faced. The same was true during my second pregnancy, in 2011–2012. I did not know which pollutants were present around me, at what concentrations, or what they might mean for pregnancy and a child's development. I had no data with which to assess the risk and make a decision.

I cannot go back and change the conditions in which I carried my daughters. But I want to understand what is known today about congenital malformations in Kuzbass — and what is being done for the women and men who live there and plan to become parents.

What follows is an account of what we know, what we still do not know, and who should have ensured that this knowledge existed.

ABOUT THIS EVIDENCE REVIEW

Abstract and scope

Review version 1.0**Evidence cut-off date: 8 October 2026**

This independent study contains definitions of indicators, complete numerical series, statistical re-examination, positive and null findings, limitations, a design for the research that is still needed, and sources accessible to the reader.

Publication principle:

The article tells the story. The PDF provides the grounds for confirmation or refutation. The reader draws the conclusion.

The study does not establish the cause of Natalia Zubkova's children's medical conditions, determine that the legal elements of ecocide are present, or replace a systematic review or individual medical advice.

Children with congenital conditions are no less valuable and no less deserving of treatment, support, and a full life. The purpose of this study is not to value a human life through a diagnosis, but to provide a basis for examining possible preventable harm and the duties owed to families.

1. How to read the evidence

1.1. Different indicators cannot be added together

The materials include:

- registered diagnoses per 1,000 children in their first year of life;
- the number of notifications concerning a child with a congenital malformation;
- congenital malformations per 1,000 births or newborns;
- a particular malformation as a share of all congenital malformations;
- pregnancy terminations per 100,000 women of reproductive age;
- odds ratios (OR) and prevalence ratios (PRR / PR);
- illnesses among children aged 0–14.

These have different numerators, denominators, and outcomes. The number of diagnoses does not necessarily equal the number of children. Live births do not include all terminations, miscarriages, and stillbirths. The proportion of one malformation within the overall structure is not the same as the risk per pregnancy.

Abbreviations used in the international evidence: PAHs — polycyclic aromatic hydrocarbons; NTD — neural tube defect; CHD — congenital heart defect; NBDPS — National Birth Defects Prevention Study; AOR — adjusted odds ratio; AHR — aryl hydrocarbon receptor; *WT1* — Wilms tumour 1 gene; BDNF — brain-derived neurotrophic factor. In this report, CHD is used only for congenital heart defects, not for congenital malformations as a whole.

1.2. Levels of inference

Level	What can be established	What it does not establish
Presence of a source	an open-pit mine, boiler house, power plant, transport route, or other facility exists	a particular person's dose
Environmental concentration	a substance was measured in air, water, soil, or dust	a woman's internal dose
Area-level association	pollution and an outcome differ between places or years	individual causation

Level	What can be established	What it does not establish
Individual exposure	an address, dispersion model, or personal monitor provides an exposure estimate	automatically, a biologically effective dose
Biomarker	a substance, metabolite, or molecular trace was detected in the body	the source, without source apportionment
Mechanism	a plausible pathway disrupting development was demonstrated	how often the effect occurs in people at real-world doses
Intervention	a biomarker or outcome changed after exposure was reduced	that the result applies to all congenital malformations

1.3. The language of causation

Supported:

Pollutants are recorded in Kuzbass for which the international literature contains human associations with particular congenital malformations and experimental mechanisms capable of disrupting embryonic development.

Not supported by the assembled materials:

Coal or benzo[a]pyrene caused a particular malformation in a particular child.

An individual causal conclusion requires exposure resolved accurately in time, source apportionment, complete ascertainment of outcomes, and consideration of alternative causes.

2. The official series for congenital malformations among children in their first year of life

The category in the reports is “congenital anomalies (malformations), deformations and chromosomal abnormalities.”

The principal indicator is registered diagnoses per 1,000 children in their first year of life. It is not a proven count of unique children with congenital malformations and not the prevalence of congenital malformations per 1,000 newborns.

Data year	Registered diagnoses	Per 1,000 children in their first year of life	Share	Report	Table	PDF page / printed page
2017	absent from the table	144.6	4.9%	2018	110	141 / 141
2018	5,170	183.7	5.8%	2019	107	147 / 146
2019	2,945	111.5	4.6%	2020	107	136 / 135
2020	3,302	138.4	5.9%	2021	98	128 / 127
2021	3,546	157.7	5.9%	2022	105	135 / 134
2022	2,837	132.0	6.1%	2023	107	142 / 141
2023	3,023	153.7	6.3%	2024	93	128 / 127

Verification: the entry for each year was located in the original report and checked against both the text layer and the rendered page. The report year, table number, and physical/printed page are given above. A [machine-readable series is published with the study](#), and the original reports are available from the [state reports page of the Rospotrebnadzor Office for Kemerovo Region–Kuzbass](#).

What can be seen without a causal interpretation

- The series is not monotonic: its minimum is 111.5 in 2019 and its maximum 183.7 in 2018.
- Between 2017 and 2023, the rate rose by 9.1 points, or approximately 6.3%. Two endpoints do not prove a sustained trend.
- The share increased from 4.9 to 6.3%, but depends on the total number of diagnoses across all disease classes.
- The absolute number for 2017 is absent from the primary table and cannot be reconstructed by calculation.
- Fluctuations may reflect diagnosis, registration, demography, access to care, and the pandemic period.

The reader can therefore repeat the check using three coordinates: report year, table number, and page of the original. The absolute number for 2017 was deliberately not reconstructed because it is not present in the primary table.

3. Anna Bachina's dissertation and related publications

3.1. Boundary of the accessible material

Full dissertation:

Bachina, A. V. *Hygienic Diagnosis and a Regional Model for Monitoring Congenital Malformations: Candidate of Medical Sciences Dissertation, speciality 14.02.01.* Kemerovo, 2015. 150 pp.

- [Russian State Library record](#);
- identifier `rs101005099557`;
- access to the full text is limited to the Russian State Library's reading rooms and virtual reading rooms.

Dissertation abstract:

- [Russian State Library record](#);
- 23 printed pages, 24 digital frames;
- the official text layer has been preserved locally.

The statement “the dissertation did not measure” is therefore replaced with the more precise formulation:

The available dissertation abstract and the publications examined contain no information about individual measurement of a woman's exposure during the critical weeks of pregnancy.

Until lawful access to the full volume is obtained, it cannot be claimed that it contains no additional table or methodological detail. An individual pregnancy cohort, however, is not evident in the stated design, principal results, or the later 2017 article.

3.2. Design according to the accessible sources

- 34 administrative territories: 16 urban districts and 18 municipal districts.

- 6,813 registered newborns with congenital malformations.
- The dissertation abstract gives the medical dataset period as 2000–2012; the 2017 article assigns the same 6,813 cases to 2005–2012. The discrepancy cannot be resolved without the full text.
- 391,912 ambient-air samples, 35,980 soil samples, and 40,430 drinking-water samples; 468,322 in total.
- Nineteen EUROCAT model forms and ICD-10 classes.
- Time series, non-parametric tests, correlation, regression, cluster analysis, and GIS mapping.

3.3. Principal published findings

- The congenital-malformation indicator among children in their first year of life was 65.8 per 1,000 in 2005 and 134.2 in 2012.
- The long-term average was 113.03 per 1,000.
- Congenital malformations accounted for 25.6% of infant mortality.
- ICD-10 block distribution: circulatory system, 40.2%; musculoskeletal system, 26.2%; genital organs, 10.9%.
- Areas with a high prevalence of congenital malformations overlapped by 60.8% with areas of high and very high combined anthropogenic and industrial pressure.
- Benzo[a]pyrene, nitrogen dioxide, formaldehyde, and suspended particulate matter were identified as priority pollutants.

The dissertation abstract reports the following correlations:

Comparison	Published result
Congenital malformations and average mass of industrial emissions	$r = 0.41$; $p = 0.00037$
Emissions from enterprises extracting fuel and energy minerals	$r = 0.89$; $p = 0.0068$ and $r = 0.964$; $p = 0.00045$
Total emissions from stationary sources	$r = 0.89$; $p = 0.00681$
Hydrocarbons	$r = 0.96$; $p = 0.0005$
Methane	$r = 0.96$; $p = 0.00045$
Xylene	$r = 0.77$; $p = 0.00018$
Toluene	$r = 0.76$; $p = 0.00215$
Soot	$r = 0.88$; $p = 0.00037$

These are the authors' aggregate results, not relative risks for a particular pregnancy.

3.4. Re-examination of the 2014 article

The study of Kemerovo used 3,421 notifications from 1993–2012. Its correlation graph for benzo[a]pyrene and particular congenital malformations covers eight annual observations, 2005–2012.

Published values:

- congenital heart defects and benzo[a]pyrene: $r_s = 0.77$;
- hypospadias and benzo[a]pyrene: $r_s = 0.59$;
- multiple congenital malformations and benzo[a]pyrene: $r_s = 0.13$.

The text calls the first two associations significant and prints $p < 0.5$, probably in place of $p < 0.05$.

Neither the eight underlying pairs of values nor information about tied ranks is published. The exercise below is therefore not a reanalysis of the original data but an **illustrative conditional calculation**. It makes two assumptions: there are no tied ranks; and, in place of the original data, it uses the nearest Spearman coefficient possible at $n = 8$ to the reported rounded coefficient. Under these assumptions, complete enumeration of $8! = 40,320$ rank permutations gave:

Published	Conditionally selected r_s at $n = 8$ with no tied ranks	Two-sided p for the conditional coefficient
0.77	0.7619	0.0368
0.59	0.5952	0.1323
0.13	0.1190	0.7930

The value 0.7619 rounds to 0.76, and 0.5952 to 0.60; these conditional coefficients therefore do not reproduce the published rounded values 0.77 and 0.59.

This is an illustrative calculation for nearby conditional coefficients at $n = 8$ and with no tied ranks. It does not recover the authors' p values and cannot confirm or refute the significance of the published associations.

In the same article, the congenital heart defect series is labelled as a rate per 10,000 births. A linear increase of 7.01 is described in the text as an increase “by 7 per mille.” If the unit on the graph is correct, this is approximately 7 per 10,000, or 0.7 per mille. The appropriate formulation is: **a probable tenfold inconsistency in the units**, because the underlying statistical file is unavailable.

Source and basis for verification: [full text of the article](#); every assumption, the enumeration, and the results of the conditional check are stated directly in this section.

3.5. Limitations

The available materials do not show:

- personal exposure during the first weeks of pregnancy;
- a complete address history and movements;
- complete ascertainment of early losses, stillbirths, and terminations;
- individual adjustment for parental age, smoking, diabetes, infections, medication, folate, occupation, heredity, and social position;
- apportionment of contributions from coal, metallurgy, chemical industry, energy production, and transport;
- adjustment for multiple testing or a complete list of null associations;
- an open de-identified dataset and analysis code.

3.6. Professional trajectory after the dissertation

- 2015: defence of the dissertation on congenital malformations and monitoring.
- 2016: co-authorship of a study on children's health under combined environmental exposure in the coal and chemical industrial centres of Kuzbass.
- 2017: article on the regional monitoring model, submitted in 2016 and using the earlier 2005–2012 dataset.
- 2022–2026: public sources identify Bachina as chief physician of the Centre for Hygiene and Epidemiology in Kemerovo Region–Kuzbass and an instructor in the Department of Hygiene at Kemerovo State Medical University.
- 2025: participation in an evaluation of the Clean Air project.

No continuation of this research line was identified in the public sources examined. The reason has not been established. The hypothesis that the work was prohibited or restricted requires a document, participant testimony, a project record, or evidence of denied funding or data access.

3.7. Reconstructed corpus of seventeen publications

The dissertation abstract lists seventeen works connected with the dissertation. These are not seventeen independent studies of congenital malformations: some repeat the same dataset, some address risk assessment and the organisation of social and hygienic monitoring, and some survive only as bibliographic records. This map prevents selective use of only the strongest coefficients and makes the inaccessibility of primary sources visible.

No.	Publication	Availability and subject	Contribution
1	Bachina, Gromov, Glebova. Monitoring congenital malformations as an indicator, 2013	bibliography and subject identified from the abstract; full text not found	early version of the central research line
2	Glebova et al. Children's health in Prokopyevsk, 2013	<u>complete official issue</u>	ten annual morbidity values; emissions and congenital malformations with a one-year lag
3	Shabaldin et al. Fetal congenital malformations in Kemerovo, 2014	<u>full text</u>	3,421 notifications, district series for 1993–2012, benzo[a]pyrene and particular forms
4	Bachina et al. Environmental and hygienic aspects of congenital malformations in Kuzbass, 2015	full text checked	principal synthesis of the dissertation's territorial correlations
5	Monitoring congenital malformations among newborns in the region, 2008	full text not found	probable early baseline series and registry history
6	Risk from emissions of the Salair Chemical Plant, 2012	bibliography established	risk assessment; not a study of pregnancies or congenital malformations
7	Health risk in the industrial centres of Kuzbass, 2012/2013	journal record: <i>Sanitary Doctor</i> . 2013;(7):61–63; full text unavailable	general pollution risk, not individual pregnancies
8	Integrated assessment of drinking water, 2012	old internet source unavailable	methodology for a composite index; indirect relevance
9	Salair Chemical Plant, 2012	old internet source unavailable	repeats the subject of No. 6
10	Monitoring an indicator of environmental influence, 2013	old internet source unavailable	probable predecessor to No. 1
11	Environmental and hygienic problems of the region, 2013	old internet source unavailable	broad context; findings repeated elsewhere
12	Airborne risk in ferrosilicomanganese production, 2013	bibliography established; proceedings not found	risk methodology, not congenital malformations

No.	Publication	Availability and subject	Contribution
13	Environmental and hygienic problems of the region, 2013	journal record: <i>Environmental Protection and Nature Management</i> . 2013;(2):42–45	regional context
14	Glebova, Bachina, Koskina. Priorities for social and hygienic monitoring, 2013	<u>official Rospotrebnadzor proceedings</u>	key correlations and explicit acknowledgement that standard monitoring was incomplete
15	Social and hygienic monitoring in municipal hygiene, 2013	bibliography established; related 2016 versions appear in the Kemerovo State Medical University catalogue	organisational method, not a new congenital-malformation study
16	Social and hygienic monitoring in food hygiene, 2013	bibliography established	indirect relevance
17	Selection of priority air-pollution indicators, 2013	bibliography established; a related 2016 method appears in the Kemerovo State Medical University catalogue	explains pollutant selection but does not replace raw data

3.8. Prokopyevsk: children's health and short time series

The 2013 article describes Prokopyevsk as a major centre for coking-coal extraction. Mining accounted for 48.9% of shipped goods and 66.4% of industrial production; ambient air accounted for 75.6% of combined anthropogenic and industrial pressure. Annual mean concentrations exceeded limits: nitrogen dioxide by 1.7–3 times, benzo[a]pyrene by 2.4–4.1 times, and suspended particulate matter by 1.3–2.2 times. The authors classified the carcinogenic risk from soot, 1.6×10^{-4} , as unacceptable.

The mean rate of congenital anomalies among children aged 0–14 was 15.52 ± 3.1 per 1,000 in Prokopyevsk and 16.70 ± 1.6 in the region; the difference was not significant ($p = 0.76$). This null comparison of means must not be omitted. At the same time, the authors reported a higher growth rate in the city, 19.14% versus 7.97%, and one-year-lagged correlations: liquid and gaseous emissions with congenital malformations $r = 0.96$; $p = 0.0004$, and suspended particulate matter with congenital malformations $r = 0.87$; $p = 0.0025$.

The basis was ten annual morbidity values for 2003–2012 and emissions data for 2003–2011. The article does not publish the annual underlying congenital-malformation counts and denominators, a common-trend test, sensitivity to the selected lag, adjustment for multiple comparisons, or individual family factors. This is a strong ecological signal, not an estimate of risk for a particular pregnancy.

3.9. Kemerovo: 3,421 notifications and analysis of particular malformations

The 2014 publication analysed 3,421 notifications concerning children with congenital malformations in 1993–2012. The overall rate reached 83.4 per 1,000 births in 2008 and 92.8 in 2009, then was 44.1 in 2010, 56.2 in 2011, and 51.8 in 2012. Particularly high values were published for Zavodsky District: 123.69 and 205.52 per 1,000 in 2008–2009. No district-level exposure model was presented that could separate an industrial source from diagnosis and record-keeping.

For 2005–2012 — eight annual observations — the authors reported rank correlations between benzo[a]pyrene and congenital heart defects $r_s = 0.77$, hypospadias $r_s = 0.59$, and multiple congenital malformations $r_s = 0.13$. The conditional permutation exercise appears in section 3.4: assuming no tied ranks and using the nearest possible coefficients at $n = 8$, it gives two-sided $p = 0.0368$, 0.1323 , and 0.7930 . The first signal is therefore compatible with the 0.05 threshold, while the second and third are not. This is not a reconstruction of the original analysis because the underlying data and exact rank structure are unavailable.

In the same article, the graph labels the congenital-heart-defect frequency per 10,000 births, while the linear trend of 7.01 is described in the text as an increase “by 7 per mille.” If the graph label is correct, the value is approximately 0.7 per mille. We describe this as a probable tenfold inconsistency in units, not a conclusively proven error.

3.10. What the monitoring authors themselves acknowledged

The official 2013 proceedings repeat strong territorial associations between congenital malformations and extraction of fuel and energy minerals ($r = 0.964$; $p = 0.00045$), stationary sources ($r = 0.89$; $p = 0.00681$), gaseous and liquid emissions ($r = 0.89$; $p = 0.0068$), hydrocarbons ($r = 0.96$; $p = 0.0005$), and methane ($r = 0.96$; $p = 0.00045$). Elevated or high risk was noted for Novokuznetsk, Prokopyevsk, Kiselyovsk, Kemerovo, Beryozovsky, Yurga, and Tashtagol District.

At the same time, the authors stated that standard indicators did not provide a true picture of the real hazard of chemical pollution. They called for the full spectrum of substances, sources, and their contributions to be considered, and for better laboratory and instrumental monitoring. This is an important internal limitation of the corpus: specialists themselves published the warning signal and also acknowledged that the measurement system was inadequate.

3.11. What remained inaccessible

We did not obtain the full dissertation, the early 2008 publication on the registry, the full text of the principal 2013 journal article, or the original statistical output for the 2014 paper. The study therefore does not attribute to the closed dissertation material absent from the abstract and accessible articles. Nor does it claim that further work was prohibited: what is established is a transition to other professional activity and the absence, in the public corpus found, of an individual pregnancy study continuing this research line.

4. Pregnancy terminations due to congenital malformations in Novokuznetsk

Source: P. E. Saltykova, S. V. Shramko, E. A. Chubar, and A. E. Vlasenko. “Frequency and structure of congenital malformations in the city of Novokuznetsk, 2012–2021”. *Mother and Child in Kuzbass*. 2024;1(96):32–39. DOI [10.24412/2686-7338-2024-1-32-39](https://doi.org/10.24412/2686-7338-2024-1-32-39).

Design

- Archive of the gynaecology department at Novokuznetsk City Clinical Hospital No. 1.
- Terminations before 22 weeks following detection of a congenital malformation in prenatal screening.
- 494 medical records.
- Women aged 16–47.
- Study period: 2012–2021.
- Measures: absolute number, share within the structure, and pregnancy termination rate per 100,000 women of reproductive age.

Findings

- The pregnancy termination rate due to fetal congenital malformations was 24.9 per 100,000 women of reproductive age in 2012 and 29.3 in 2021; the 2019 peak was 42.4.
- The overall measure had no significant trend: $p = 0.72$.
- Across the full structure: multiple malformations, 59.1%; the authors’ category “genetic mutations in cases with karyotyping,” 18.4%; central nervous system malformations, 13.6%.

- Share of central nervous system malformations: 10.8% in 2012 and 25.0% in 2021; a 2.3-fold increase, $p = 0.001$.
- The pregnancy termination rate due to central nervous system malformations was 2.7 per 100,000 women of reproductive age in 2012 and 7.3 in 2021; a 2.7-fold increase, $p = 0.032$.
- The authors called for in-depth systematic analysis.

Indicator	2012	2021	Reported trend
Pregnancy terminations due to fetal congenital malformations, per 100,000 women of reproductive age	24.9 (95% CI 17.5–34.3)	29.3 (95% CI 20.9–39.9)	No statistically significant trend, $p = 0.72$
Central nervous system malformations as a share of these terminations	10.8% (95% CI 3.0–25.4)	25.0% (95% CI 12.7–41.2)	Increase, $p = 0.001$
Pregnancy terminations due to central nervous system malformations, per 100,000 women of reproductive age	2.7 (95% CI 0.7–6.9)	7.3 (95% CI 3.5–13.5)	Increase, $p = 0.032$

All six 95% confidence intervals were reported by the authors and were not calculated by this project. The methods on page 33 state that the intervals were calculated using the Clopper–Pearson method. The overall rates and intervals appear in the text and Figure 1 on page 34; the central nervous system shares appear in Table 1 on page 34; and the pregnancy termination rates due to central nervous system malformations appear in Table 2 and the accompanying text on page 36.

Limitations

- This is one specialist hospital, not a demonstrably complete city registry of every outcome.
- The denominator is all women of reproductive age, not pregnancies or screened pregnant women.
- Changes in diagnosis, referrals, karyotyping, and clinical decisions can change the observed structure.
- Pollution, address, occupation, and individual dose were not analysed.
- The increase in the central nervous system share and the increase in the rate per 100,000 women are consistent with each other but do not establish a cause.

Authorship and scientific network

O. N. Gulyaeva is not listed as an author and is not mentioned in the acknowledgements. In October 2025, S. V. Shramko was officially named as supervisor of P. E. Saltykova's candidate-level research topic on genes and congenital malformations: <https://info.ngiuv.ru/2025/10/>.

Gulyaeva and Shramko co-authored related studies of xenobiotics and pregnancy. This confirms a shared scientific and clinical network, but it does not justify attributing supervision of the article on 494 terminations to Gulyaeva.

5. Olga Gulyaeva's research line

Thirty-one works from 2014–2026 were verified, fourteen of them concerning pregnancy, congenital malformations, fetal growth restriction, or early losses. For independent verification, the [bibliographic register](#) and a [table of principal claims, samples, and limitations](#) have been published; links to the key articles also appear in section 16.

5.1. Foundational congenital-malformation sample

The 2018 study examined 53 women:

- 26 had given birth to children with congenital malformations;
- 27 had given birth to children without congenital malformations and had no spontaneous miscarriages.

Findings:

- AA CYP1A2*1F : OR 3.23; 95% CI 1.04–10.07 ;
- GSTM1 deletion: OR 6.8; 95% CI 1.64–28.55 ;
- in a subgroup of nine women with antenatal death associated with placental insufficiency, OR 16 was reported for the GSTM1 deletion.

Source: [DOI](#).

5.2. The 2021 study: matching group sizes

The study again reports a structure of 26 cases and 27 controls:

- AA CYP1A2 + GSTM1 deletion : OR 5.56; 95% CI 1.05–29.32 ;

- CA CYP1A2 + GSTM1 normal : OR 0.11; 95% CI 0.03–0.40 .

The matching group sizes and effect estimates suggest that the samples may overlap, but the available information does not establish the exact extent. Without additional documentary confirmation, this work can be treated neither as an independent replication nor as an established reanalysis of the same participants.

A separate screening analysis covered 1,426 women in eight cities of southern Kuzbass. Kiselyovsk had the highest proportion assigned to the congenital-malformation risk group: 13 of 67, or 19.4%. This is a **screening risk group**, not thirteen confirmed cases among newborns.

Source: DOI.

5.3. The 2022 null finding

Fifty-five women: 26 with a congenital malformation in the child, 11 with fetal growth restriction, and 18 controls.

- The association of HIF-1A rs11549465 with congenital malformations was not confirmed: for CT, OR 1.42; p = 0.782 .
- For the group of eleven women with fetal growth restriction, OR 9.71 was reported; the study was described as a pilot.

Source: DOI.

5.4. Early losses: potentially overlapping pools

Year	Outcome	Cases	Controls	Interpretation
2023	embryonic demise	28	35	early sample; CYP1A2
2024	embryonic demise	33	53	GSTM1/GSTT1; enlarged control group
2024	embryonic demise	33	27	CYP1A2/GSTM1 combinations; possible overlap with the 33-case group
2024	early loss	49	53	molecular stage; original clinical pool 172 + 186

Year	Outcome	Cases	Controls	Interpretation
2025	missed miscarriage	49	part of 80	OR 3.67 and 16.86 recur

The matching group sizes and effect estimates suggest sample overlap, but the available information does not establish its exact extent.

5.5. What these studies do and do not provide

They provide:

- pilot associations between genetic susceptibility and congenital malformations or other adverse outcomes;
- a biologically plausible model of unequal susceptibility;
- grounds for a large independent replication.

They do not provide:

- an individual pollutant dose;
- an address-level link to a particular open-pit mine or other source;
- apportionment of the coal contribution;
- a representative estimate of risk for all women in a city;
- several independent confirmations where samples may overlap.

This conclusion is based on comparison of study designs and sample sizes in sections 5.1–5.4, the published register, and the primary articles. Matching numbers are treated as evidence of possible overlap, not proof that the samples were fully identical.

5.6. All works assembled from the reproductive-health research line

The register was established using ORCID [0000-0003-2225-6923](#), affiliations, co-authors, and subject matter. This matters because OpenAlex conflates Olga Nikolaevna Gulyaeva of Novokuznetsk with another researcher who published on adipose tissue. Five such unrelated records were excluded.

The works below are analysed as one research line. Publications using identical or overlapping groups are not counted as independent replications.

Early conference papers, 2015–2017

- **2015, reproductive disorders in the Indigenous population of Mountain Shoria.** A conference abstract associated `GSTM1/GSTT1` polymorphisms with reproductive disorders. The full text is absent from the corpus; exact samples and effects cannot be checked from the bibliographic record.
- **2016, course of pregnancy and embryogenesis.** A conference paper on polymorphisms in xenobiotic-biotransformation genes is known through citations in later articles. The original proceedings were not obtained.
- **2017, fetal congenital malformations among women in an environmentally disadvantaged region.** This conference publication directly preceded the 2018 journal article; the independence of its sample has not been established.

These materials show the development of a hypothesis, but do not add three independent datasets.

2018: foundational congenital-malformation sample

The [journal article](#) compared 26 women who had given birth to children with congenital malformations with 27 women who had given birth to children without congenital malformations and had no spontaneous miscarriages. For `AA CYP1A2*1F`, the authors reported `OR 3.23`; 95% CI 1.04–10.07; for the `GSTM1` deletion, `OR 6.8`; 95% CI 1.64–28.55. In a subgroup of nine women with antenatal fetal death associated with placental insufficiency, `OR 16` was reported for the `GSTM1` deletion.

This was a small case–control study. Wide intervals reflect uncertainty; pollutants were not measured in participants' bodies. Place of residence was used as a proxy for exposure.

2021: matching group sizes and territorial screening

The [2021 study](#) again reported 26 congenital-malformation cases and 27 controls. For `AA CYP1A2 + GSTM1 deletion`, `OR 5.56`; 95% CI 1.05–29.32; `CA CYP1A2 + normal GSTM1` was described as protective, `OR 0.11`; 95% CI 0.03–0.40. The matching group sizes and effect estimates suggest overlap, but the available information does not establish its exact extent. The work is therefore treated neither as a proven independent replication nor as an established repeat analysis of the same sample.

A separate dataset covered prenatal screening of 1,426 women in eight cities of southern Kuzbass. In Kiselyovsk, 13 of 67 participants, or 19.4%, were assigned to the congenital-malformation risk group, the highest proportion among the reported territories. This is a screening result, not thirteen confirmed malformations among newborns.

A [study of fetal growth restriction among workers](#) included 39 women: fourteen cases and 25 controls. The authors reported associations involving `CYP1A2/GSTM1` combinations, but access to the full text on the official platform is restricted. Differences between workers and homemakers were not statistically significant; no personal pollutant dose was measured.

2022: an essential null finding

The [HIF-1A pilot study](#) included 55 women: 26 with congenital malformations in the child, eleven with fetal growth restriction, and eighteen controls. No association was found between congenital malformations and [CT HIF-1A rs11549465](#): OR 1.42; 95% CI 0.118–16.910; $p = 0.782$. For the eleven fetal-growth-restriction cases, the authors reported OR 9.71 but themselves called for a larger sample. The null congenital-malformation result shows that not every hypothesised genetic mechanism is confirmed.

2023–2025: early pregnancy losses

Five publications may represent progressive enlargement or analyses of fully or partly overlapping clinical pools; the accessible information does not establish the exact overlap.

- [2023, CYP1A2](#): 28 women with loss of a first pregnancy and 35 controls; OR 3.86 for genotype AA. The article combines this analysis with a separate breast-cancer study; its oncology table has an internal inconsistency of $n = 35$ although the genotype counts sum to 33.
- [2024, GSTM1/GSTT1](#): 33 cases of embryonic demise and 53 controls; OR 3.18 for GSTM1 deletion and OR 16.64 for GSTT1 deletion. The latter effect is based on eight exposed cases and one control.
- [2024, phase I and II combinations](#): 33 cases and 27 controls; OR 7.00 for CA CYP1A2 + GSTM1 deletion, OR 0.19 for CA CYP1A2 + normal GSTM1. The matching number of cases in another publication suggests overlap but does not itself prove identical participants.
- [2024, early loss of a first pregnancy](#): clinical pool of 172 cases and 186 comparisons; genotyping of 49 cases and 53 controls; GSTM1, OR 3.67; 95% CI 1.47–9.14; GSTT1, OR 16.86; 95% CI 2.10–135.41. The very wide second interval shows instability.
- [2025, major obstetric syndromes](#): 142 cases and 80 controls; cases included 39 pre-eclampsia, sixteen fetal growth restriction, 38 preterm birth, and 49 missed miscarriage outcomes. The same OR 3.67 and 16.86 are reported for the last group as in the 2024 study. This suggests an overlapping dataset, but the available information does not establish the exact participants.

There is no cohort identifier spanning the publications. Matching group sizes and effect estimates suggest overlap, but its exact extent cannot be established from the accessible information.

2025: combining distinct outcomes and congenital malformations

The [CYP1A1 analysis](#) included 131 women: 39 with pre-eclampsia, sixteen with fetal growth restriction, 38 with preterm births, eleven with a congenital malformation in the child, and 27 controls. For [AG CYP1A1*2A rs4646903](#), the authors reported OR 20.22 for fetal growth restriction, 10.59 for preterm birth, 5.69 for pre-eclampsia, and 14.86 for congenital malformations. The accessible abstract gives no confidence intervals. The congenital-malformation subgroup has only eleven cases; the large estimates require independent replication.

2026: maternal anaemia and fetal growth restriction

The [HIF-1A](#) study compared two pilot samples. For maternal anaemia: 37 cases and 53 controls, OR 3.57 for CC; for fetal growth restriction in the newborn: nineteen cases and 40 controls, OR 7.71; in nineteen mother–child pairs versus 33 comparisons, OR 6.26 for the CC/CC combination. The authors describe the sets as separate pilot data, but there was no personal exposure measurement.

5.7. Complete register of 31 verified publications

The table separates the reproductive core from background studies. The latter help explain the genetic-susceptibility model but are not pregnancy studies.

ID	Year	Subject	Publication and source	Role in this study
G01	2014	anthracosilicosis among miners	official page	occupational coal exposure; not reproductive
G02	2015	population oncology	<i>Medical Genetics</i> 14(3-153):16	background genetic line
G03	2015	reproductive health of Shors	<i>Medical Genetics</i> 14(3):34–35	early reproductive abstract
G04	2016	pregnancy and embryogenesis	Novokuznetsk 2016 proceedings:31–35	early core line; primary text not obtained
G05	2017	fetal congenital malformations	Novokuznetsk 2017 proceedings:85–88	predecessor to the 2018 article
G06	2017	population genetics	<i>Human Genetics and Pathology</i> :51–52	background distribution of GSTM1/GSTT1
G07	2018	reproductive health of Shors	article	demography and genealogy; not an exposure study of congenital malformations
G08	2018	congenital malformations	DOI	foundational sample 26 + 27
G09	2019	fluoride intoxication	DOI	occupational susceptibility; not reproductive
G10	2019	dust bronchitis	DOI	miners; not reproductive

ID	Year	Subject	Publication and source	Role in this study
G11	2020	Mountain Shoria populations	DOI	345 participants; population background
G12	2021	CYP1A1/CYP1A2	DOI	population background in southern Kuzbass
G13	2021	congenital malformations and anthropogenic pressure	DOI	1,426 screenings; 26 + 27, possible overlap with early sample
G14	2021	fetal growth restriction	DOI	14 cases + 25 controls
G15	2022	miners' diseases	DOI	occupational line; not reproductive
G16	2022	congenital malformations and fetal growth restriction	DOI	null congenital-malformation result; pilot fetal-growth-restriction result
G17	2023	bronchitis among miners	DOI	occupational line
G18	2023	dust pathology among miners	DOI	occupational line
G19	2023	dust bronchitis	DOI	occupational line
G20	2023	occupational genetics	DOI	review
G21	2023	loss of a first pregnancy	DOI	28 + 35; probable early pool
G22	2024	embryonic demise	DOI	33 + 53
G23	2024	gene combinations and loss	DOI	33 cases + 27 controls; possible overlap
G24	2024	early loss	DOI	358 records; genotyping 49 + 53
G25	2025	syndromes and congenital malformations	DOI	131 women; small subgroups
G26	2025	obstetric syndromes	DOI	222 women; overlap with earlier groups
G27	2025	fluoride intoxication	DOI	not reproductive

ID	Year	Subject	Publication and source	Role in this study
G28	2025	pathology among metalworkers	DOI	not reproductive
G29	2026	anaemia and fetal growth restriction	DOI	two pilot sets
G30	2026	breast cancer	DOI	related oncology
G31	2026	air pollution and breast cancer	DOI	related oncology

5.8. Overall limit of this research line

In all principal clinical studies, a participant's address is not linked to a particular open-pit mine, underground mine, coke plant, or metallurgical source; emissions transport during the critical weeks is not modelled; and PAH adducts, metabolites, metals, or other dose biomarkers are not measured. Coal is part of a general industrial background together with metallurgy, energy production, chemical industry, and transport.

The corpus therefore confirms that unequal genetic susceptibility to an industrial environment was investigated in Kuzbass and that signals were recorded for congenital malformations, fetal growth restriction, preterm birth, pre-eclampsia, and early losses. It does not identify coal as an individually measured cause or provide a numerical risk estimate for any particular woman.

6. Kiselyovsk and access to information

6.1. Chronology

Date	Document	Established	Not established
22 April 2020	Kemerovo Hydrometeorological Centre response No. 08-10/467-1196	regular observations were not conducted in Kiselyovsk or the urban district; calculated background concentrations for cities without observations were used	an actual time series of residents' exposure
3 December 2020	sampling	samples were taken near residential and social facilities	chronic exposure or conditions in earlier years

Date	Document	Established	Not established
15 December 2020	Rospotrebnadzor response No. 3007	individual exceedances; preparation of materials for an unscheduled inspection of boiler house No. 25	the inspection result and a reduction in exposure
Archive check through 2026	public materials and personal archive	no complete public chain of “inspection — measure — follow-up measurement” was found	it cannot be concluded that no action was taken

6.2. Readings at 15 Kommunalnaya Street

- Suspended particulate matter: 0.7 mg/m³ against a maximum one-time limit of 0.5 mg/m³ — 1.4 times the limit.
- Carbon monoxide: 7.15 mg/m³ against a limit of 5 mg/m³ — 1.43 times the limit.
- Benzo[a]pyrene: the letter gives 6.6–13.3 ng/m³ and an exceedance of 6.6–13.3 times the stated 24-hour standard.

Independent verification of the regulatory comparison for benzo[a]pyrene requires the complete sampling protocols, duration, method, and detection limit. These are not present in the accessible archive. A publication should attribute the conclusion to the authority.

6.3. Supported conclusion

The available documents do not allow Natalia Zubkova’s exposure during her pregnancies in 2003–2004 and 2011–2012 to be reconstructed. The absence of a regular observation series prevents retrospective verification of dose during the critical weeks.

Unsupported:

- projecting one 2020 sample back onto earlier pregnancies;
- attributing every substance to open-pit coal mines;
- asserting that the promised inspection did not take place;
- inferring the cause of a congenital malformation from the proximity of pollution and illness.

The underlying documents, copies of agency responses, and sequence of events are published in [“The Day the Air Was Measured”](#). This study uses only conclusions that can be checked against those documents; the absence of a public resolution in the materials found is not equated with proof that no action was taken.

7. Pollutants and congenital malformations

7.1. What is recorded in Kuzbass

The 2024 state report records:

- 70,195 ambient-air tests;
- 1.95% of results outside standards;
- 3,805 benzo[a]pyrene samples, 7.04% above the limit;
- PM_{2.5}: 22.74% of samples above the limit;
- PM₁₀: 14.61%;
- more than five times the limit: benzo[a]pyrene, 80 samples; PM_{2.5}, 23; PM₁₀, 12.

These are proportions of collected samples, not proportions of days, homes, or pregnancies exposed.

The 2023 report records:

- annual mean benzo[a]pyrene in Novokuznetsk at 6.2 times the limit;
- formaldehyde at 3.9 times the limit;
- suspended particulate matter at 1.7 times the limit;
- NO₂ at 1.4 times the limit;
- annual mean benzo[a]pyrene above the limit in soil in the Kiselyovsk, Novokuznetsk, Polysaev, and Prokopyevsk urban districts and several municipal districts;
- annual mean chloroform above the limit in Kiselyovsk drinking water in 2021–2023.

Chloroform matters to the right to a safe environment, but without source apportionment it cannot be attributed to the coal industry.

7.2. PAHs and neural tube defects

A 2026 study in Shanxi included:

- 128 case–control pairs;
- 16 PAHs, 11 metabolites, and 16 DNA adducts in placenta;
- highest versus lowest tertile of total PAHs: OR 5.04; 95% CI 1.96–12.96 ;
- phenanthrene: OR 4.96 ;
- low-molecular-weight PAHs: OR 4.47 ;
- in the experiment, benzo[a]pyrene increased the frequency of neural tube defects in mice from 1.8 to 5.7%.

Limitations: samples were obtained at termination or delivery, not when the neural tube closed; the mixture was not apportioned by source. [DOI](#).

Household coal combustion in Shanxi:

- 610 neural-tube-defect cases and 837 controls;
- any questionnaire-reported exposure to pollution from coal: adjusted OR 1.6; 95% CI 1.1–2.1 .

This study is coal-specific, but it is not a study of open-pit mines. [DOI](#).

7.3. PAHs and congenital heart defects

The US National Birth Defects Prevention Study:

- 1997–2002: 1,907 congenital-heart-defect cases and 2,853 controls; no adjusted association with broad groups of heart defects was found. [PubMed](#).
- 1997–2011: 4,775 cases and 7,734 controls; highest quartile of occupational PAH exposure — conotruncal defects OR 1.41; 95% CI 1.00–2.00 , tetralogy of Fallot OR 1.83; 95% CI 1.21–2.78 ; most other comparisons were null. [PubMed](#).

7.4. Kidneys and urinary tract

An experiment with benzo[a]pyrene demonstrated AHR-dependent alteration of WT1 splicing and nephrogenesis targets; a mutant Ahr variant protected the embryonic kidney. [PubMed](#).

This establishes mechanistic plausibility, not evidence in humans for agenesis, hydronephrosis, multicystic dysplasia, or another congenital anomaly of the kidney and urinary tract (CAKUT).

7.5. Particulate matter and metals

PM_{2.5} and PM₁₀ are size fractions, not molecules. Their toxicity depends on composition.

- An Israeli cohort of 396,334 births found non-linear associations between first-trimester PM_{2.5} and anomalies of several organ systems; for cardiac anomalies, second versus first quartile OR 1.09; 95% CI 1.02–1.15, without a monotonic increase in subsequent quartiles.
- Wuhan, 70,854 pregnancies: OR 1.13–1.23 for high PM₁₀, PM_{2.5}, NO₂, and SO₂ during the first trimester.
- A Chinese study of 339 congenital-heart-defect cases and 333 controls: highest cadmium group OR 1.96; 95% CI 1.24–3.09; conotruncal defects increased 2.81-fold.
- A Danish cohort of more than one million live births: the OR for heart defects rose from 1.13 to 1.42 across categories of arsenic in drinking water. The arsenic source was not coal.

Null findings:

- a neural-tube-defect study on the US–Mexico border found no overall differences in As, Cd, and Pb biomarkers between 184 cases and 225 controls;
- a Japanese cohort of 90,163 mothers found no association between five metals and 369 limb anomalies;
- the Port Pirie cohort associated lead with preterm birth but not with congenital anomalies.

For reproducibility, a matrix of pollutant, outcome, study type, and limitation is published. Interpretation in sections 7.2–7.5 follows the rule in section 1.2: a mechanistic or area-level signal is not presented as individual causation.

7.6. Full matrix of studies on pollutants and specific malformations

This matrix addresses a different question from studies of coal-producing regions. It asks whether human or experimental evidence exists for pollutants that may occur along the coal chain but often have other sources as well. Therefore, “associated with the coal chain” does not mean “originated specifically from coal in this study.”

Pollutant and design	Outcome and result	Connection with coal	Main limitation
PAHs, 128 case-control pairs, placenta + mice, 2026	neural tube defects; highest tertile of total PAHs OR 5.04 (1.96–12.96); benzo[a]pyrene in mice: 5.7% versus 1.8%	PAHs are produced by combustion, coking, and waste fires, but the source mixture was not apportioned	placenta was collected at termination/delivery, not during the critical window; small study; DOI
27 PAHs, 117 NTD cases + 121 controls, serum, 2015	13 detected PAHs were higher among cases; gradients were reported for many compounds	mixed combustion sources	blood was collected at the end of pregnancy; source not established; PubMed
Occupational PAHs, NBDPS, 4,775 CHD cases + 7,734 controls, 2020	highest quartile: conotruncal defects OR 1.41 (1.00–2.00), tetralogy of Fallot 1.83 (1.21–2.78); null results for most subtypes	occupations included exposure to coke and coal tar, but were not limited to them	dose was estimated by experts from occupation; PubMed
Occupational PAHs, NBDPS, 1,907 CHD cases + 2,853 controls, 2012	no adjusted association with isolated CHD groups was found	mixed occupational sources	exposure was rare and estimated rather than measured; PubMed
Occupational PAHs, 805 cleft lip ± palate cases, 439 cleft-palate cases, 2,989 controls, 2013	cleft lip ± palate OR 1.47 (1.02–2.12) and a trend; null result for isolated cleft palate	mixed sources	expert assessment of occupation, not a biomarker; PubMed
Occupational PAHs, 520 NTD cases + 2,989 controls, 2012	overall comparisons were null; spina bifida among women with normal/low BMI OR 2.59 (1.32–5.07)	mixed sources	subgroup result and a small number of exposed participants; PubMed
Household coal combustion, 610 NTD cases + 837 controls, 2011	any exposure OR 1.6 (1.1–2.1)	coal-specific household exposure	questionnaire; the responsible substance cannot be isolated, and the result cannot be transferred directly to open-pit mining; DOI
PM2.5/PM10, Israel, 396,334 births followed through age six, 2023	nonlinear associations with anomalies of the circulatory, respiratory, digestive, genital, and integumentary systems; cardiac anomalies in Q2 OR 1.09 (1.02–1.15)	dust from mines and transport is possible, but composition is unknown	address at birth; no monotonic pattern in later quartiles; PubMed

Pollutant and design	Outcome and result	Connection with coal	Main limitation
PM10, PM2.5, NO2, SO2, Wuhan, 70,854 pregnancies, 2023	1,352 congenital malformations; high first-trimester exposure OR 1.13–1.23, with stronger associations in the cold season	coal-fired power generation is only one urban source	monitoring-station background, residual confounding, one centre; PubMed
Meta-analysis of 26 air-pollution studies, 2020	PM2.5: pulmonary artery stenosis OR 1.42, tetralogy of Fallot 1.52; NO2: stenosis 1.74; SO2: ventricular septal defect 1.15, orofacial defects 1.27	nonspecific mixture	heterogeneity in exposure and outcome definitions, multiple comparisons; PubMed
Arsenic and cadmium in hair, 339 CHD cases + 333 controls, 2016	dose gradient for arsenic; highest cadmium group: CHD OR 1.96 (1.24–3.09), conotruncal defects 2.81-fold	metals may occur in coal and ash, but also in water, food, tobacco, and industrial emissions	hair, external contamination, unknown source; PubMed
Arsenic in water, Denmark, 1,042,413 live births, 2022	CHD: OR 1.13, 1.33, and 1.42 across increasing categories	non-coal comparative example	live births only; water-supply model without personal-consumption data; PubMed
As/Cd/Pb/Hg, 184 NTD cases + 225 controls, 2006	no overall significant biomarker differences were found	many sources are possible	small biomarker subsample, measurements after pregnancy; PubMed
Lead, Italian registry and three periods of declining pollution, 2001	excess cardiovascular malformations declined from RR 2.59 to 1.18 and 0.97; clefts and musculoskeletal malformations also declined	non-coal industrial example	ecological time trend and simultaneous changes; PubMed
Lead, Port Pirie, 831 pregnant women and 749 outcomes, 1986	dose-related association with preterm birth; no association with congenital malformations was found	non-coal smelter source	limited power for rare malformations and older diagnostic methods; PubMed
Cd/Pb/Hg/Se/Mn mixture, Japan, 90,163 pregnancies, 2024	among 369 limb anomalies, no associations were found with individual metals or the mixture	sources were nonspecific	blood collected in mid/late pregnancy may miss organogenesis; PubMed
Cadmium, pregnant mice, exposure on day 8	induced NTDs and growth restriction and reduced placental folate transport	cadmium may occur in coal and ash	high injected dose; neither human nor inhalation exposure; PubMed
Benzo[a]pyrene, metanephric culture and pregnant mice, 2011	AHR-dependent changes in WT1 and nephrogenesis targets; mutant Ahr was protective	coal combustion, coking, and waste fires are possible sources	altered renal programming is not equivalent to clinically diagnosed human CAKUT; PubMed
Formaldehyde and solvents, Japan, 67,503 births, 2019	no broad associations with occupational exposure were found; home renovation and male genital anomalies OR 1.81 (1.03–3.17)	formaldehyde is not specific to coal	self-report, multiple testing, uncertain source and dose; PubMed

7.7. How the matrix changes the interpretation

The evidence does not form a single, simple causal chain. The most consistent human signals concern PAHs, air pollution during critical windows, and certain metals; mechanistic experiments show possible pathways of injury. At the same time, large or well-designed studies report null results for particular outcomes, exposures, and concentrations. This is expected: congenital malformations are heterogeneous, critical windows differ, particle composition varies, and rare outcomes require large samples.

The appropriate conclusion is neither that every coal-producing city must cause the same malformation nor that one study's null result cancels all the others. The matrix shows which agents and outcomes warrant measurement in Kuzbass: PAHs and their metabolites, PM_{2.5}/PM₁₀ with chemical speciation, arsenic, cadmium, lead, and other metals—combined with precise congenital-malformation phenotyping and a calendar of organogenesis.

8. International research in coal regions

This section examines the full international corpus assembled for the project, not only a handful of examples. The overview table does not replace analysis of individual studies: positive, null, and contradictory results are presented separately.

8.1. Scope of the international evidence corpus

This corpus includes **27 identified studies and research materials** from nine countries. This is not a claim that every existing publication was found: the search was not registered as a systematic review, and the absence of a country or paper from the corpus does not prove that no research exists. The register deliberately includes not only positive findings but also null studies, counter-analyses, and sources lower in the evidence hierarchy.

The studies concern different parts of the coal chain: surface mining, power plants, coke production, household coal combustion, an open-cut mine fire, and mixed pollution in coal-industrial regions. Their outcomes also differ: specific congenital malformations, pregnancy loss, preterm birth, infant weight and growth, and molecular markers of prenatal exposure. They therefore cannot be combined into one numerical estimate.

For each entry below, we report the design, sample, exposure assessment, result, main limitation, and primary source. The phrase “direct study of congenital malformations” means only that its endpoint matches the subject of this investigation; it does not mean that causation was established.

8.2. United States: mining, industrial sites, and power-plant closures

US-MTR-2011 — Ahern et al., Central Appalachia.

- **Design and sample:** retrospective ecological analysis of 1,889,071 live births in four states in 1996–2003.
- **Exposure and outcome:** the mother’s county of residence was classified as a mountaintop-removal mining county, another type of coal-mining county, or a non-mining county; seven groups of congenital anomalies were analysed.
- **Result:** for all congenital malformations combined, PRR 1.26; 95% CI 1.21–1.32; elevations were reported in six of seven groups.
- **Main limitation:** county was a proxy for individual dose; only live births were included; no environmental or biological measurements were available for individual women.
- **Significance:** a large direct signal for congenital malformations that requires more precise exposure assessment. [Primary source](#).

US-MTR-2014 — Lamm et al., Appalachian counter-analysis.

- **Design and sample:** reanalysis of West Virginia birth certificates for 1990–2009, with data from 44 hospitals.
- **Exposure and outcome:** county-level coal-mining category and congenital malformations recorded on birth certificates.
- **Result:** the crude PRR 1.43 fell to PRR 1.08; 95% CI 0.97–1.20 after adjustment for hospital.
- **Main limitation:** heterogeneity in hospital reporting, area-level proxy exposure, and inclusion of live births only.
- **Significance:** an important counter-result: it shows that the estimate is sensitive to reporting quality and that the initial association cannot be regarded as robust without further verification. [Primary source](#).

US-MTR-2022 — Cooper, Walker, and Christian, Appalachian Kentucky.

- **Design and sample:** geospatial study of 95,581 live births; 34,006 addresses were within 5 km of active mining.
- **Exposure and outcome:** satellite-derived area of active mining within 5 km of the geocoded address; six organ-system groups of congenital malformations.
- **Result:** gastrointestinal malformations had PR 1.88; 95% CI 1.06–3.31 in the low and PR 1.99; 95% CI 1.14–3.47 in the high exposure category.

- **Main limitation:** neither the pollutant nor internal dose was measured; 30.1% of addresses had coarse geocoding; birth-certificate data underascertain congenital malformations; losses and terminations were excluded.
- **Significance:** mining was characterised more precisely than by county classification, but exposure was still not an individual dose. [Primary source.](#)

US-MTR-2021 — Buttling et al., Central Appalachia.

- **Design and sample:** retrospective geospatial cohort of nearly 200,000 geocoded births in 1990–2015.
- **Exposure and outcome:** annual area of active surface mining near the residence; preterm birth and low birth weight.
- **Result:** greater mining activity was associated with adverse gestational-age and birth-weight indicators.
- **Main limitation:** this was not a study of congenital malformations; there was no personal monitoring or biomarker, and address served as a proxy for dose.
- **Significance:** it supports an association between mining and pregnancy outcomes but does not answer the question of specific organ formation. [Primary source.](#)

US-WV-2019 — congenital heart defects in West Virginia.

- **Design and sample:** preliminary study of a single-centre registry and GIS clusters; 16,871 pregnancies and 206 cases of fetal congenital heart defects.
- **Exposure and outcome:** proximity to chemical and coal-mining facilities along the industrial Kanawha River basin; congenital heart defects.
- **Result:** statistically significant spatial clustering of cases along the industrial watershed was reported.
- **Main limitation:** preliminary ecological design, mixed industrial sources, no individual dose, and no reliable source apportionment.
- **Significance:** a direct signal for congenital heart defects that cannot be attributed specifically to coal without a more precise study of the mixture. [Primary source.](#)

US-CA-2018 — Casey et al., power-plant closures in California.

- **Design and sample:** difference-in-differences natural experiment; 57,005 births near eight coal- and oil-fired power plants closed in 2001–2011.
- **Exposure and outcome:** distance from a plant before and after closure; preterm birth.
- **Result:** within 5 km, the proportion of preterm births fell from 7.0% to 5.1%; adjusted change -0.019 ; 95% CI -0.031 to -0.008 .
- **Main limitation:** coal- and oil-fired plants were combined; distance was a proxy for dose; congenital malformations were not studied.

- **Significance:** a change in outcome after removal of the source strengthens causal interpretation for preterm birth, but cannot automatically be extrapolated to congenital malformations. Primary source.

US-NJ-2018 — Yang and Chou, closure of an upwind coal-fired power plant affecting New Jersey.

- **Design and sample:** observational difference-in-differences quasi-experiment using birth records before and after coal combustion ceased at the Portland Generating Station in Pennsylvania on 1 June 2014.
- **Exposure and outcome:** residence in the downwind area and gestational timing relative to the closure; low birth weight and preterm birth.
- **Result:** in downwind areas of New Jersey, closure of the coal-fired units was associated with a 15% reduction in the probability of low birth weight and a 28% reduction in the probability of preterm birth. These are relative changes in probability reported by the authors, not percentage-point changes.
- **Main limitation:** congenital malformations were not studied; meteorology and residence were used as proxies; the intervention was not randomised.
- **Significance:** a second natural experiment consistent with improved outcomes after a source stopped operating. Primary source.

US-ALABAMA-2014 — coke and steel facilities in Alabama.

- **Design and sample:** cross-sectional spatiotemporal study of birth records around coke and steel facilities.
- **Exposure and outcome:** distance to facilities and annual fugitive chemical emissions; low birth weight and preterm birth.
- **Result:** spatiotemporal patterns were consistent with exposure to developmental toxicants from these facilities.
- **Main limitation:** some important individual factors were unavailable; exposure was strongly associated with race and socioeconomic position; congenital malformations were not an endpoint.
- **Significance:** the study concerns the chemical-processing link in the coal chain but cannot separate it from social and other industrial factors. Primary source.

US-PAH-OCC-2012 — occupational PAH exposure and neural tube defects.

- **Design and sample:** case-control study using maternal occupational histories from the National Birth Defects Prevention Study.
- **Exposure and outcome:** expert-assessed occupational exposure to PAHs; pregnancies affected by neural tube defects, including spina bifida.
- **Result:** crude estimates indicated a positive association, particularly for spina bifida.

- **Main limitation:** few women were exposed; the PAH category combined coke ovens, coal tar, transport, food production, and other sources.
- **Significance:** a direct analysis of congenital malformations and PAHs, but not source-specific evidence of coal exposure. [Primary source.](#)

US-CFPP-2021 — Daouda et al., coal-fired power generation and inequality in preterm birth.

- **Design and sample:** longitudinal county-level analysis in the United States for 2000–2018.
- **Exposure and outcome:** pollution from coal-fired power plants by county and time; preterm birth and racial disparities.
- **Result:** the study directly assessed the association of coal-fired power generation with preterm birth and inequality in risk.
- **Main limitation:** exposure was aggregated by county; congenital malformations were not studied; exact quantitative interpretation requires a full article-level audit of the model.
- **Significance:** important to environmental-justice questions, but used here as supporting rather than direct evidence about congenital malformations. [Primary source.](#)

8.3. China: neural tube defects and the Tongliang programme

CN-SHANXI-2011 — Li et al., household coal combustion in Shanxi.

- **Design and sample:** population-based case–control study; 610 neural tube defect cases and 837 controls in 2002–2007.
- **Exposure and outcome:** an index combining housing characteristics related to coal combustion and lifestyle; neural tube defects.
- **Result:** any questionnaire-assessed exposure was associated with OR 1.6; 95% CI 1.1–2.1.
- **Main limitation:** retrospective questionnaire-based index; this concerned household combustion, not emissions from underground or open-pit mining.
- **Significance:** one of the most direct studies of coal and a specific group of congenital malformations. [Primary source.](#)

CN-SHANXI-2023 — coal and tobacco smoke in the periconceptional period.

- **Design and sample:** population-based case–control study; 222 mothers of children with neural tube defects and 517 control mothers in 2010–2016.
- **Exposure and outcome:** household coal combustion and tobacco smoke around conception; neural tube defects.
- **Result:** the study directly examined separate and joint household exposures to coal and tobacco smoke.

- **Main limitation:** retrospective exposure information; the source was household combustion rather than mining.
- **Significance:** it refines the critical window and confounding by smoking; quantitative estimates should be consulted in the primary article. [Primary source.](#)

CN-SHANXI-2013 — placental PAH–DNA adducts.

- **Design and sample:** biomarker case–control study in a Shanxi population with a high prevalence of neural tube defects.
- **Exposure and outcome:** PAH–DNA adducts in placental tissue and an index of household coal combustion; neural tube defects.
- **Result:** no association was found between the household-coal index and the level of placental adducts.
- **Main limitation:** the placental biomarker may not reflect dose during the critical window; source apportionment remained incomplete.
- **Significance:** a null association between the household-coal index and placental PAH–DNA adduct levels that prevents the international corpus from being presented as uniformly positive. [Primary source.](#)

CN-TONGLIANG-2006 — cohort near a coal-fired power plant.

- **Design and sample:** prospective cohort of 150 nonsmoking mothers and newborns in 2002 who lived within 2.5 km of the plant.
- **Exposure and outcome:** benzo[a]pyrene–DNA adducts in cord blood; fetal and child growth; the plant was the principal local source of PAHs.
- **Result:** a higher prenatal PAH biomarker was associated with poorer measures of fetal and child growth.
- **Main limitation:** small cohort, PAH mixture, and no registry of congenital malformations.
- **Significance:** it connects a local source, internal dose, and outcome better than most area-level studies. [Primary source.](#)

CN-TONGLIANG-2008 — cohorts before and after plant closure.

- **Design and sample:** two prospectively designed cohorts: 150 mother–child pairs before closure and 158 after closure.
- **Exposure and outcome:** plant closure and PAH–DNA adducts in cord blood; neurodevelopment at age two.
- **Result:** adduct levels were lower after closure; the adverse developmental association observed before closure was not detected afterwards.
- **Main limitation:** the cohorts were recruited at different times; development rather than congenital malformations was the outcome.

- **Significance:** a strong natural experiment showing that a source, biomarker, and subsequent change in outcome can technically be linked. [Primary source.](#)

CN-TONGLIANG-2014 — molecular findings after plant closure.

- **Design and sample:** the same before-and-after cohorts, supplemented with molecular measurements.
- **Exposure and outcome:** PAH–DNA adducts in cord blood, BDNF, and neurodevelopmental measures.
- **Result:** lower adduct levels, higher BDNF, and better developmental scores were reported after closure.
- **Main limitation:** small, noncontemporaneous cohorts; the study was not powered for rare congenital malformations.
- **Significance:** consistency between biomarker and functional outcome strengthens the Tongliang programme but does not replace a large malformation registry. [Primary source.](#)

8.4. Poland, the Czech Republic, and Croatia

PL-SILESIA-1997 — comparison of three Polish regions.

- **Design and sample:** comparative examination of 11,869 newborns in Wałbrzych, Piotrków Trybunalski, and rural Suwałki.
- **Exposure and outcome:** industrial region versus rural region; congenital malformations.
- **Result:** malformations were registered in 1.9% of newborns in Wałbrzych and 1.2% in Suwałki; limb and musculoskeletal anomalies predominated.
- **Main limitation:** short observation, broad industrial classification, and no measured individual or source-specific exposure.
- **Significance:** a direct regional comparison of congenital malformations, but not a causal test of a specifically coal-related source. [Primary source.](#)

PL-KRAKOW-2017 — personal monitoring of particles and PAHs.

- **Design and sample:** prospective cohort of 455 full-term children of nonsmoking mothers.
- **Exposure and outcome:** personal monitoring of PM_{2.5} and PAHs in the second trimester; birth weight, length, and head circumference.
- **Result:** both pollutants were inversely associated with birth measures; the standardised effect of PAHs on weight and length was approximately twice the effect of PM_{2.5}.
- **Main limitation:** full-term births only; the source mixture cannot be attributed unambiguously to coal; congenital malformations were not studied.

- **Significance:** strong individual exposure assessment complements coarser area-level studies. [Primary source](#).

CZ-TEPLICE-2000 — the brown-coal region of Teplice.

- **Design and sample:** prospective population-based study of 3,378 singleton live births in Teplice and 1,505 in the comparison district of Prachatice.
- **Exposure and outcome:** monthly PM₁₀, PM_{2.5}, and carcinogenic PAHs for each mother; intrauterine growth restriction.
- **Result:** in the first month of pregnancy, AOR 1.60 for medium and AOR 2.15 for high c-PAH; per 10 ng/m³, AOR 1.22.
- **Main limitation:** live births and growth rather than congenital malformations were studied; sources were mixed; later source apportionment showed a substantial contribution from local heating.
- **Significance:** one of the strongest studies of a critical window, while also showing why a mixture should not be attributed to one source without apportionment. [Primary source](#).

HR-PLOMIN-2004 — the Plomin 1 coal-fired power plant.

- **Design and sample:** retrospective cohort of 704 women living near the plant in 1987–1989.
- **Exposure and outcome:** daily, weekly, and monthly coal consumption by the plant and calculated SO₂ emissions; gestational duration and birth weight.
- **Result:** higher and more prolonged exposure during the first two months was associated with lower birth weight and shorter gestation.
- **Main limitation:** emissions were used as an ecological proxy for dose; the cohort was small; congenital malformations were not studied.
- **Significance:** a source-specific study identifying an early critical window. [Primary source](#).

8.5. Mongolia: an ecological signal, an intervention, and a biomarker

MN-LOSS-2014 — pollution and spontaneous abortion in Ulaanbaatar.

- **Design and sample:** retrospective ecological time series of 1,219 hospital admissions for spontaneous abortion in 2009–2011.
- **Exposure and outcome:** monthly SO₂, NO₂, CO, PM₁₀, and PM_{2.5} from government monitoring stations; pregnancy loss.
- **Result:** very strong monthly correlations between pollutants and losses were reported, exceeding $r = 0.9$ for SO₂ and CO.
- **Main limitation:** season and temperature may confound the relationship; data were monthly and ecological, with no individual exposure assessment.

- **Significance:** a direct signal for pregnancy loss that cannot be interpreted as an individual relative risk. [Primary source.](#)

MN-UGAAR-2018 — randomised trial of HEPA filters.

- **Design and sample:** single-blind randomised trial of 540 nonsmoking pregnant women; 465 live births.
- **Exposure and outcome:** HEPA filters introduced at a median of 11 weeks reduced household PM_{2.5} by 29%; birth weight and fetal growth.
- **Result:** no convincing change in birth weight was established in the full sample; in the prespecified subgroup of full-term infants, the difference was +85 g; 95% CI 3–167.
- **Main limitation:** the filter affects particles from all sources; intervention began after part of organogenesis; congenital malformations were not studied.
- **Significance:** a rare randomised null/partly positive result, important to an objective appraisal of the corpus. [Primary source.](#)

MN-CADMIUM-2019 — blood cadmium in a UGAAR substudy.

- **Design and sample:** biomarker study of 374 nonsmoking participants with live births.
- **Exposure and outcome:** third-trimester blood cadmium and density of coal-burning stoves within 5 km; birth weight and other growth measures.
- **Result:** a doubling of blood cadmium was associated with a 95 g reduction in birth weight; an interquartile increase in stove density was associated with a 12.2% increase in cadmium.
- **Main limitation:** late biomarker; live births only; cadmium sources were not exclusively coal-related.
- **Significance:** it links a spatial characteristic of coal heating to internal dose and an outcome, but not to congenital malformations. [Primary source.](#)

8.6. India

IN-FUEL-2021 — household fuel and birth weight in NFHS-4.

- **Design and sample:** cross-sectional analysis of the 2015–2016 national survey among singleton full-term births.
- **Exposure and outcome:** primary household fuel; birth weight.
- **Result:** adjusted mean birth weight in the “coal/lignite/charcoal” category was 2,841 g versus 2,957 g for electricity—a difference of 116 g.
- **Main limitation:** several fuels were combined; socioeconomic confounding was likely; weight may have been measured or recalled; congenital malformations were not studied.
- **Significance:** a large supporting result on household fuels that does not isolate coal itself. [Primary source.](#)

IN-CFPP-2024 — Nakkungu, proximity to coal-fired power plants.

- **Design and sample:** economics master's thesis linking the 2019–2021 DHS with plant capacity, generation, and location.
- **Exposure and outcome:** residence within 50 km and plant characteristics; birth weight.
- **Result:** birth weight near a medium-sized plant was estimated to be approximately 40 g lower; each additional gigawatt of capacity corresponded to a 51.1 g reduction.
- **Main limitation:** the work was not peer-reviewed as a journal article; broad radius; limitations in birth-weight data; CO₂ was a proxy for capacity, not a toxic dose.
- **Significance:** a lower-tier research signal that should not be placed on the same evidentiary level as peer-reviewed cohorts. [Primary source](#).

8.7. Australia and South Africa

AU-HAZELWOOD-2019 — the Hazelwood open-cut coal mine fire.

- **Design and sample:** regional cohort of 3,591 singleton births; 763 pregnancies overlapped with the fire.
- **Exposure and outcome:** modelled mean and peak concentrations of fire-related PM_{2.5} at the maternal address; fetal growth and gestational maturity.
- **Result:** no association with fetal growth or gestational duration was found; possible effect modification by gestational diabetes was noted.
- **Main limitation:** an acute six-week event rather than chronic mining; congenital malformations were not studied; address at delivery was used.
- **Significance:** a substantive null result that limits overgeneralisation from any coal exposure to any outcome. [Primary source](#).

ZA-CFPS-2025 — SAMRC report on coal-fired power-station areas.

- **Design and sample:** institutional comparison of municipal districts with and without coal-fired power stations using national air-quality and health data.
- **Exposure and outcome:** district category; several outcomes, including cleft lip and palate.
- **Result:** the SAMRC reported more cleft cases in districts with coal-fired power stations.
- **Main limitation:** the materials located for this investigation do not include a peer-reviewed paper with fully verifiable methods and effect estimates; the design is ecological.
- **Significance:** this is a grey institutional report and a basis for further verification, not the equivalent of a peer-reviewed case–control study. [SAMRC public statement](#).

8.8. What the full corpus shows

Direct studies of congenital malformations exist, but they are substantially fewer than studies of birth weight, gestational duration, and child development. The direct studies include positive findings as well as counter-analyses and null biomarker results. An honest summary therefore cannot say that “all studies proved the same thing.”

The strongest basis for causal reasoning does not arise from one article but from a combination of designs: area-level signals, critical-window studies, personal monitoring, biomarkers, interventions, and natural experiments after source closure. Yet these different links are almost never assembled within one large cohort with a complete registry of pregnancy outcomes.

Within the present corpus, no direct source-specific study of congenital malformations or complete pregnancy outcomes was identified for coal regions in Colombia, Indonesia, or Germany. This is a result of the search undertaken, not proof that no such studies exist. A [machine-readable register of all 27 entries](#) is published separately, but it does not replace the detailed descriptions presented here.

9. Children’s health after birth

Source: L. A. Glebova, A. V. Bachina, E. V. Koskina, and O. A. Obraztsova. “[Health of the child population of Prokopyevsk in relation to environmental problems](#)”. *Medicine in Kuzbass*. 2013;12(3):35–39.

- Age: 0–14, without separate analysis of children under one, ages 1–4, and ages 5–14.
- Morbidity period: 2003–2012; emissions: 2003–2011.
- Ambient air accounted for 75.6% of combined anthropogenic and industrial pressure.
- Annual mean exceedances: NO₂, 1.7–3 times the limit; benzo[a]pyrene, 2.4–4.1; suspended particulate matter, 1.3–2.2.
- The authors classified the carcinogenic risk from soot, 1.6×10^{-4} , as unacceptable.
- Congenital anomalies: Prokopyevsk 15.52 ± 3.1 per 1,000, region 16.70 ± 1.6 ; $p = 0.76$ — no significant difference between the means.
- Growth rate: 19.14% versus 7.97% in the region.
- With a one-year lag: liquid and gaseous emissions and congenital malformations $r = 0.96$; $p = 0.0004$; suspended particulate matter and congenital malformations $r = 0.87$; $p = 0.0025$.

Limitation: short aggregate time series, no individual exposure, possible shared time trends, and confounding. This is a separate line of evidence about children’s health, not proof of an intrauterine cause.

10. Alternative explanations

Every causal study must address:

Alternative	Why it matters	What must be measured
Diagnosis and registration	improved ultrasound and recording increase detection	year, institution, criteria, and registry completeness
Hospital	reporting differences change area-level results	place of diagnosis and birth, standardisation
Hidden outcomes	severe malformations may not appear among live births	losses, terminations, stillbirths
Age and history	alter baseline risk	age of both parents, parity, previous outcomes
Diabetes, obesity, medication	established risk factors for particular malformations	clinical data before and during pregnancy
Folate, nutrition, infections	affect embryogenesis	biomarkers, treatment, laboratory diagnoses
Smoking and alcohol	personal exposures and confounding	active/passive smoking, biomarkers
Parental occupation	exposure before conception and during pregnancy	occupational history of both parents
Social position	affects exposure and access to screening	income, education, care, and housing
Other sources	metallurgy, chemical industry, transport, and heating are mixed with coal	source apportionment
Moving home	address at birth is not necessarily the address during organogenesis	complete time-resolved address history
Genetics	some malformations have an established genetic cause	karyotype, sequencing when indicated, family history

Alternative explanations are not evidence that pollution is safe. They define requirements for study design; the complete set of factors and ways to measure them is shown above and developed further in section 11.

11. Minimum design for a study capable of moving closer to an answer

11.1. Population and outcomes

All recognised pregnancies in Kiselyovsk, Prokopyevsk, Novokuznetsk, and comparable territories over at least 8–10 years:

1. early clinically recognised losses;
2. late miscarriages;
3. terminations following prenatal diagnosis;
4. stillbirths;
5. live births followed for at least one year, preferably longer.

11.2. Critical windows

- the three months before conception;
- weeks 1–4, 5–8, and 9–12 separately;
- later trimesters;
- actual home and work addresses, moves, and time spent outside the city.

11.3. External exposure

An independent network with uniform quality control:

- PM_{2.5} and PM₁₀ with chemical analysis of filters;
- black carbon;
- a panel of PAHs, not benzo[a]pyrene alone;
- As, Cd, Pb, Hg, Mn, Ni, Cr, and other elements;
- SO₂, NO/NO₂/NO_x, CO, O₃, formaldehyde, benzene, and phenol;
- deposited dust, water, and soil;
- meteorology and mixing-layer height.

The source model must include operating patterns of open-pit mines, blasting, waste-dump fires, transport, boiler houses, coke production, and metallurgy.

11.4. Internal dose

In a prospective subcohort recruited before or early in pregnancy:

- repeated blood and urine samples;
- PAH metabolites;
- metals in validated biomatrices;
- markers of inflammation and oxidative stress;
- placenta and cord blood;
- prespecified DNA adducts and mechanistic markers.

11.5. Phenotyping

Not only `Q00-Q99`, but specific forms:

- anencephaly, spina bifida, encephalocele;
- subtypes of congenital heart defects;
- CAKUT separately from other genitourinary anomalies;
- limb-reduction defects;
- cleft lip with or without cleft palate, and isolated cleft palate;
- chromosomal and established monogenic causes.

Diagnosis should be confirmed by a group blinded to exposure.

11.6. Analysis and openness

- preregistration of the protocol and hypotheses;
- power calculation for rare phenotypes;
- mixture, source, and distributed-lag models;
- prespecified rules for missing data and multiple comparisons;
- negative-control periods;
- independent replication;
- accessible de-identified data and code within the limits of medical confidentiality.

11.7. A realistic two-level design

Level A: retrospective linkage of registries covering all outcomes for 10–15 years, with address histories and pollution models.

Level B: a prospective subcohort of several thousand women with personal monitors and repeated biomonitoring.

The large registry provides power for rare congenital malformations; the subcohort validates the dose model.

Sections 11.1–11.7 form a complete, testable design: population, exposure windows, external and internal dose, phenotyping, analysis, openness, and a realistic two-level structure.

12. The rights of women and children

A legally accurate formulation:

A woman's right is not to a state guarantee of a perfect pregnancy outcome, but to conditions that minimise preventable risk to her and her future child: a clean environment, prevention of hazardous exposure, reliable information, and science-based protection of reproductive health.

Russian legal basis

- Constitution of the Russian Federation, Article 38: protection of motherhood and childhood.
- Article 41: the right to health protection and medical care.
- Article 42: a favourable environment, reliable information about it, and compensation for damage caused by an environmental violation.
- Federal Law No. 323-FZ, Article 18: health protection is ensured in part through environmental protection.
- Federal Law No. 7-FZ: the right to a favourable environment, the presumption of environmental hazard from planned activity, impact assessment, and prevention of harm.
- Federal Law No. 52-FZ: sanitary and epidemiological well-being is connected with the absence of harmful environmental exposure.

International legal basis

- International Covenant on Economic, Social and Cultural Rights, Article 12.
- UN Committee General Comments Nos. 14, 22, and 27: health includes environmental and informational determinants, including determinants of reproductive health.
- CEDAW, Article 12 and General Recommendation No. 24.
- Convention on the Rights of the Child, Article 24.
- Committee on the Rights of the Child General Comment No. 26: clean air, a non-toxic environment, and high-quality data concerning pregnant women, infants, and children during critical windows of development.
- UN General Assembly Resolution 76/300 on the right to a clean, healthy, and sustainable environment.

Limitations:

- these norms do not guarantee a child without a medical condition;
- general comments of treaty bodies are not equivalent to a judgment of a Russian court;
- a General Assembly resolution has a different legal weight from a ratified treaty;
- individual compensation generally requires harm, a violation, and causation.

The verifiable legal basis is set out above, and clickable links to the Constitution, federal laws, and UN documents are collected in section 16.

13. Ecocide: boundaries of the term

Article 358 of the Criminal Code of the Russian Federation defines ecocide as mass destruction of plant or animal life, poisoning of the atmosphere or water resources, and other acts capable of causing an environmental catastrophe.

The medical materials assembled here do not prove the elements of the offence. A criminal-law conclusion requires established acts, a responsible subject, culpability, scale, causation, and classification by a competent authority or court.

As of October 2026, ecocide is not a separate fifth crime under the Rome Statute currently in force. Vanuatu, supported by Fiji and Samoa, has proposed amendments; the process is ongoing. The Office of the Prosecutor of the International Criminal Court addresses environmental harm through the Statute's existing crimes.

The title of the article therefore remains a question. This section provides the basis for distinguishing the public and criminal-law meanings of the term; primary legal documents are linked in section 16.

14. What is established about the evidence gap, and what remains a hypothesis

Established

- Official series on congenital malformations and pollution exist, but are published mainly as aggregates.
- Bachina and co-authors identified area-level and temporal signals and proposed stronger monitoring.
- No continuation of this line at the level of individual exposure during pregnancy was found in public sources.
- The article on terminations in 2012–2021 identified an increase in central nervous system malformations but did not analyse pollution.
- Gulyaeva's research line examines genetic susceptibility in small, partly overlapping samples without personal dose measurements.
- According to a 2020 document, the Hydrometeorological Service conducted no regular observations in Kiselyovsk.
- The international literature contains recurring signals and natural experiments, but complete causal chains are rare.

Not established

- The cause of the congenital malformations in Natalia Zubkova's daughters.
- Pollutant doses during her pregnancies.
- A prohibition on Bachina continuing the subject.
- The complete absence of any non-public or unpublished research in Kuzbass.
- That state authorities took no action after the 2020 samples.
- The motives of individual researchers, institutions, or officials.
- A legally established fact of ecocide.

Supported public conclusion

The verified public materials contain enough warning signals to justify precaution and a large study. They do not establish an individual cause. No publicly verifiable system connecting source, dose during the critical window, and the full pregnancy outcome was found.

15. Unresolved questions

1. What is the exact period of Bachina's dataset of 6,813 cases: 2000–2012 or 2005–2012?
2. What were the r_n , coefficient type, and underlying observations for each correlation in chapter 5 of the full dissertation?
3. Did Bachina's registry include stillbirths and terminations following prenatal diagnosis?
4. How was the "pollutant contribution of up to 26.43%" calculated?
5. Did a comparable municipal series continue after 2012, and where is it held?
6. How complete is the regional registry created under Order No. 268?
7. Where are the results of the unscheduled inspection of boiler house No. 25 and the follow-up measurements?
8. What is the precise extent of overlap among the clinical samples in Gulyaeva's publications?
9. Which large projects on pregnancy and pollution were submitted, funded, or rejected?
10. Which industrial environmental-monitoring data are available by day and source?
11. Are separate public health indicators available for children under one, ages 1–4, 0–4, and 5–14 in coal-mining cities?
12. Which studies of male reproductive health used an individual assessment of coal-related exposure?

16. Principal primary sources

Russia and Kuzbass

- Bachina, A. V. Dissertation and dissertation abstract. Kemerovo, 2015.
- Bachina, A. V., et al. "Hygienic substantiation of a regional model for monitoring congenital pathology in Kuzbass". 2017.
- Shabaldin, A. V., et al. Study of congenital malformations in Kemerovo. 2014.
- Glebova, L. A., et al. Children's health in Prokopyevsk. 2013.
- Glebova, L. A., Bachina, A. V., and Koskina, E. V. Priorities for social and hygienic monitoring. 2013.

- Saltykova, P. E., et al. Pregnancy terminations due to congenital malformations. 2024.
- Gulyaeva, O. N., et al.: 2018, 2021, 2022, 2023, 2024-1, 2024-2.
- Russian Ministry of Health Order No. 268.
- State reports of the Rospotrebnadzor Office for Kemerovo Region–Kuzbass; exact table and page references for the values used are given in section 2.
- Kiselyovsk documents and “The Day the Air Was Measured”.

International studies

- Ahern et al., 2011: DOI.
- Lamm et al., 2014: PubMed.
- Cooper, Walker, Christian, 2022: PMC.
- Li et al., Shanxi: DOI.
- Tang et al., Tongliang: DOI.
- Perera et al., after the plant closure: PMC.
- Tongliang molecular findings: PMC.

- Dejmek et al., Teplice: PMC.
- Mohorovic, Plomin: PubMed.
- UGAAR: PubMed.
- Mongolia, cadmium: PubMed.
- California power-plant closures: PMC.
- Yang, M., and Chou, S.-Y., 2018. Closure of a Pennsylvania coal-fired power plant and pregnancy outcomes in downwind areas of New Jersey: DOI.

Law

- Constitution of the Russian Federation.
- Federal Law No. 323-FZ.
- Federal Law No. 7-FZ.
- Federal Law No. 52-FZ.
- UN Committee General Comment No. 14.
- Committee on the Rights of the Child General Comment No. 26.
- Article 358 of the Criminal Code of the Russian Federation.
- Vanuatu proposal on ecocide.