

Polycyclic aromatic hydrocarbons exposure in humans and reproductive health outcomes: evidence from systematic reviews with meta-analyses of observational studies

Supplementary Tables

Supplementary Table 1. PRISMA checklist of items to include when reporting a systematic review or meta-analysis

Supplementary Table 2. MOOSE checklist for meta-analyses of observational studies

Supplementary Table 3. Search strategy

Supplementary Table 4. Description of 15 associations between PAHs exposure and reproductive health outcomes

Supplementary Table 5. The results of GRADE assessment of the evidence certainty on the association between exposure of PAHs and reproductive health outcomes

Supplementary Table 6. Sensitivity analysis results of associations limited to cohort studies

Supplementary Table 7. Sensitivity analysis results of excluded associations due to overlap

Supplementary Table 8. The summary results of associations excluded due to lack of data for quantitative synthesis

Supplementary Table 1: PRISMA checklist of items to include when reporting a systematic review or meta-analysis

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	1
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	2
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	2
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	3
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	3

Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	3
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	3
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	3
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	3
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	3
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	3-4
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	3
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	4
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	NA
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses,	4

		meta-regression), if done, indicating which were pre-specified.	
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	5-6, Figure 1
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	6, Supplementary Table 4
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome-level assessment (see Item 12).	7-8, Figure 3 and Supplementary Table 5
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group and (b) effect estimates and confidence intervals, ideally with a forest plot.	Figure 3
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	6-8, Figure 3 and Supplementary Table 4
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	Supplementary Table 5
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses,	8,

		meta-regression[see Item 16]).	Supplementary Table 6-8
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., health care providers, users, and policy makers).	8-10
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review level (e.g., incomplete retrieval of identified research, reporting bias).	10
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	10-11
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	NA

From: Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G., & PRISMA Group (2009). Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *PLoS medicine*, 6(7), e1000097. ^[1]

NA, not applicable.

Supplementary Table 2: MOOSE checklist for meta-analyses of observational studies

Item No.	Recommendation	Reported on Page No.
Reporting of background should include		
1	Problem definition	2
2	Hypothesis statement	NA
3	Description of study outcome(s)	3, Figure 2 and 3, Supplementary Table 4
4	Type of exposure or intervention used	3, Figure 3, Supplementary Table 4
5	Type of study designs used	3-4
6	Study population	Supplementary Table 4
Reporting of search strategy should include		
7	Qualifications of searchers (e.g., librarians and investigators)	3
8	Search strategy, including time period included in the synthesis and key words	3
9	Effort to include all available studies, including contact with authors	3
10	Databases and registries searched	3
11	Search software used, name and version, including special features used (e.g., explosion)	NA
12	Use of hand searching (e.g., reference lists of obtained articles)	3-4
13	List of citations located and those excluded, including justification	NA
14	Method of addressing articles published in languages other than English	3-4

15	Method of handling abstracts and unpublished studies	3-4
16	Description of any contact with authors	NA
Reporting of methods should include		
17	Description of relevance or appropriateness of studies assembled for assessing the hypothesis to be tested	NA
18	Rationale for the selection and coding of data (e.g., sound clinical principles or convenience)	NA
19	Documentation of how data were classified and coded (e.g., multiple raters, blinding and interrater reliability)	NA
20	Assessment of confounding (e.g., comparability of cases and controls in studies where appropriate)	NA
21	Assessment of study quality, including blinding of quality assessors, stratification or regression on possible predictors of study results	4-5, Supplementary Table 5
22	Assessment of heterogeneity	4-5
23	Description of statistical methods (e.g., complete description of fixed or random effects models, justification of whether the chosen models account for predictors of study results, dose-response models, or cumulative meta-analysis) in sufficient detail to be replicated	5
24	Provision of appropriate tables and graphics	NA
Reporting of results should include		
25	Graphic summarizing individual study estimates and overall estimate	Figure 3, Supplementary Table 4

26	Table giving descriptive information for each study included	Supplementary Table 4
27	Results of sensitivity testing (e.g., subgroup analysis)	Supplementary Table 6-8
28	Indication of statistical uncertainty of findings	NA
Reporting of discussion should include		
29	Quantitative assessment of bias (e.g., publication bias)	NA
30	Justification for exclusion (e.g., exclusion of non-English language citations)	NA
31	Assessment of quality of included studies	Supplementary Table 5
Reporting of conclusions should include		
32	Consideration of alternative explanations for observed results	NA
33	Generalization of the conclusions (ie, appropriate for the data presented and within the domain of the literature review)	10-11
34	Guidelines for future research	11
35	Disclosure of funding source	11

From: Stroup DF, Berlin JA, Morton SC, et al, for the Meta-analysis Of Observational Studies in Epidemiology (MOOSE) Group. Meta-analysis of Observational Studies in Epidemiology. A Proposal for Reporting. JAMA. 2000;283(15):2008-2012. ^[2]

NA, not applicable.

Supplementary Table 3: Search strategy

Literature search strategy in PubMed
#1 (Polycyclic aromatic hydrocarbons[MeSH Terms]) OR (Polycyclic aromatic hydrocarbons[Title/Abstract]) OR (PAH[Title/Abstract]) OR (PAHs[Title/Abstract]) OR (Polycyclic aromatic hydrocarbons-DNA adduct[Title/Abstract]) OR (PAH-DNA adduct[Title/Abstract]) OR (PAHs-DNA adduct[Title/Abstract]) OR (monohydroxy PAHs[Title/Abstract]) OR (Urinary polycyclic aromatic hydrocarbon metabolites[Title/Abstract]) OR (PAH-metabolites[Title/Abstract]) OR (PAH dose/response[Title/Abstract]) OR (PAH toxicity[Title/Abstract]) OR (OH-PAH[Title/Abstract]) OR (OH-PAHs[Title/Abstract]) OR (Hydroxylated polycyclic aromatic hydrocarbons[Title/Abstract]) OR (Hydroxy-Polycyclic Aromatic Hydrocarbons[Title/Abstract]) OR (polycyclic aromatic hydrocarbons[Title/Abstract])
#2 (meta-analysis[Title/Abstract] OR systematic review[Title/Abstract] OR systematic overview[Title/Abstract])
#3 #1 AND #2
Literature search strategy in Web of Science
#1 TS= (Polycyclic aromatic hydrocarbons OR Polycyclic aromatic hydrocarbons OR PAH OR PAHs OR Polycyclic aromatic hydrocarbons-DNA adduct OR PAH-DNA adduct OR PAHs-DNA adduct OR monohydroxy PAHs OR Urinary polycyclic aromatic hydrocarbon metabolites OR PAH-metabolites OR PAH dose/response OR PAH toxicity OR OH-PAH OR OH-PAHs OR Hydroxylated polycyclic aromatic hydrocarbons OR Hydroxy-Polycyclic Aromatic Hydrocarbons OR polycyclic aromatic hydrocarbons)
#2 TS=(meta-analysis OR systematic review OR systematic overview)
#3 #1 AND #2
Literature search strategy in Embase

#1 "Polycyclic aromatic hydrocarbons" OR "Polycyclic aromatic hydrocarbons" OR "PAH" OR "PAHs" OR "Polycyclic aromatic hydrocarbons-DNA adduct" OR "PAH-DNA adduct" OR "PAHs-DNA adduct" OR "monohydroxy PAHs" OR "Urinary polycyclic aromatic hydrocarbon metabolites" OR "PAH-metabolites" OR "PAH dose/response" OR "PAH toxicity" OR "OH-PAH" OR "OH-PAHs" OR "Hydroxylated polycyclic aromatic hydrocarbons" OR "Hydroxy-Polycyclic Aromatic Hydrocarbons" OR "polycyclic aromatic hydrocarbons"

#2 "meta-analysis" OR "systematic review" OR "systematic overview"

#3 #1 AND #2

Supplementary Table 4: Description of 15 associations between PAHs exposure and reproductive health outcomes

Outcomes	Exposure	Author, Year	Journal	No. of studies	Type of effect metric	Features used for grading the level of evidence						Egger’s <i>P</i> -value *	Excess significance	
						Random <i>P</i> -value	No. of participants	95% PI	<i>I</i> ² (%)	Largest study effect (95% CI)	SSE/ESB		<i>O</i> / <i>E</i> †	<i>P</i> -value ‡
Highly suggestive evidence (class II)														
Bladder cancer (aluminum production workers)	PAHs	Rota et al., 2014 [3]	Archives of Toxicology	10	RR	1.64×10 ⁻⁸	15,834	(1.14, 1.38)	0.0	1.25 (1.06, 1.47)	No/Yes	0.100	4/0.937	0.010
Suggestive evidence (class III)														
Birth length	Dietary PAHs	Sewor et al., 2024 [4]	Environmental Health Perspectives	5	β	0.132	64,966	(-0.18, 0.10)	69.47	-0.002 (-0.004, 0.000)	No/No	0.134	1/0.599	0.472
Weak evidence (class IV)														
Birth weight reduction	PAHs DNA-adducts	Yang et al., 2020 [5]	Plos One	5	OR	0.004	885	(0.79, 1.37)	92.3	1.02 (1.00, 1.04)	No/No	0.276	1/1.478	1.000
Bladder cancer (iron and steel foundry workers)	PAHs	Rota et al., 2014 [3]	Archives of Toxicology	9	RR	0.001	53,272	(1.10, 1.68)	0.0	1.38 (1.00, 1.91)	No/No	0.726	1/0.763	0.549
Offspring ADHD	Prenatal PAHs	Kaur et al., 2023 [6]	International Journal of Environmental Research and Public Health	3	OR	0.008	837	(0.74, 4.01)	22.6	1.85 (1.55, 4.52)	No/No	0.412	4/1.810	NA
No evidence (non-significant association, <i>P</i> > 0.05)														
Birth weight	Dietary PAHs	Sewor et al., 2024 [4]	Environmental Health Perspectives	4	β	0.301	64,534	(-52.65,41.36)	86.5	-0.01 (-0.01, 0.00)	No/No	0.379	3/1.743	0.324
Birth weight reduction	Urinary 1-OHP	Yang et al., 2020 [5]	Plos One	4	OR	0.715	1,758	(0.93, 1.07)	0.0	0.99 (0.96, 1.03)	No/No	0.590	0/0.429	1.000
Head circumference	Dietary PAHs	Sewor et al., 2024 [4]	Environmental Health Perspectives	4	β	0.345	2,842	(-0.00, 0.01)	0.02	0.00 (-0.00, 0.00)	No/No	0.325	0/0.587	1.000
Low birth weight	PAHs	Moghadda mHosseini	Science of the Total Environment	5	OR	0.283	604,950	(0.79, 1.37)	92.3	1.00 (1.00, 1.00)	No/No	0.442	3/2.233	0.662

		et al., 2023 [7]												
Newborn's birth weight	Urinary 1-OHP	Moghadda mHosseini et al., 2023 [7]	Science of the Total Environment	3	β	0.678	2,237	(-0.91, 0.88)	36.6	-0.03 (-0.15, 0.10)	No/No	0.240	1/0.763	1.000
Newborn's birth length	Urinary 1-OHP	Moghadda mHosseini et al., 2023 [7]	Science of the Total Environment	3	β	0.992	2,237	(-0.03, 0.03)	0.0	0.00 (-0.01, 0.00)	No/No	0.205	1/0.296	0.268
Newborn's head circumference	Urinary 1-OHP	Moghadda mHosseini et al., 2023 [7]	Science of the Total Environment	3	β	0.381	2,237	(-2.52, 2.31)	44.3	0.00 (-0.00, 0.01)	No/No	0.130	1/0.542	0.450
Newborn's ponderal index	Urinary 1-OHP	Moghadda mHosseini et al., 2023 [7]	Science of the Total Environment	3	β	0.851	2,237	(-0.08, 0.09)	9.6	-0.00 (-0.01, 0.00)	No/No	0.695	1/0.369	0.326
Newborn's cephalization index	Urinary 1-OHP	Moghadda mHosseini et al., 2023 [7]	Science of the Total Environment	3	β	0.603	2,237	(-12.50,13. 18)	31.6	-0.04 (-0.08, 0.00)	No/No	0.488	1/0.529	0.441
Bladder cancer (carbon black production workers)	PAHs	Rota et al., 2014 [3]	Archives of Toxicology	3	RR	0.231	7,693	(0.11, 13.77)	0.0	1.21 (0.68, 2.19)	No/No	0.195	0/0.173	1.000

ADHD, attentional deficit hyperactivity disorder; CI, confidence interval; DNA, deoxyribonucleic acid; ESB, excess significance bias; NA, not available; OR, odds ratio; PAHs, polycyclic aromatic hydrocarbons; PI, prediction interval; SSE, small-study effect; RR, relative risks; 1-OHP, 1-hydroxypayrene; β , regression coefficients.

* P-value of the Egger's regression asymmetry test.

† Observed/expected number of statistically significant studies.

[‡] P-value of the excess statistical significance test.

Supplementary Table 5: The results of GRADE assessment of the evidence certainty on the association between exposure of PAHs and reproductive health outcomes

Outcomes/Exposure	Author, Year	Downgrade factors				Upgrade factors				Quality
		Risk of bias	Indirectness	Inconsistency	Imprecision	Publication bias	Large effect	Dose-response	Plausible confounding	
Birth length/Dietary PAHs	Sewor et al., 2024 ^[4]	Not serious	Not serious	Serious limitation ^a	Not serious	Not serious	No	No	No	Very low
Birth weight/Dietary PAHs	Sewor et al., 2024 ^[4]	Not serious	Not serious	Serious limitation ^a	Not serious	Not serious	No	No	No	Very low
Birth weight reduction/PAHs DNA-adducts	Yang et al., 2020 ^[5]	Serious limitation ^a	Not serious	Serious limitation ^a	Not serious	Not serious	No	No	No	Very low
Birth weight reduction/Urinary 1-OHP	Yang et al., 2020 ^[5]	Not serious	Not serious	Not serious	Not serious	Not serious	No	Yes ^d	No	Moderate
Head circumference/Dietary PAHs	Sewor et al., 2024 ^[4]	Not serious	Not serious	Not serious	Not serious	Not serious	No	No	No	Low
Low birth weight/PAHs	MoghaddamHossein i et al., 2023 ^[7]	Not serious	Not serious	Serious limitation ^a	Not serious	Not serious	No	No	No	Very low
Newborn's birth weight/Urinary 1-OHP	MoghaddamHossein i et al., 2023 ^[7]	Not serious	Not serious	Serious limitation ^a	Not serious	Serious limitation ^b	No	No	No	Very low

Newborn's birth length/ Urinary 1-OHP	MoghaddamHossein i et al., 2023 ^[7]	Not serious	Not serious	Not serious	Not serious	Serious limitation ^b	No	No	No	Very low
Newborn's head circumference/Urinary 1-OHP	MoghaddamHossein i et al., 2023 ^[7]	Not serious	Not serious	Not serious	Not serious	Serious limitation ^b	No	No	No	Very low
Newborn's ponderal index/Urinary 1-OHP	MoghaddamHossein i et al., 2023 ^[7]	Not serious	Not serious	Not serious	Not serious	Not serious	No	No	No	Low
Newborn's cephalization index/Urinary 1-OHP	MoghaddamHossein i et al., 2023 ^[7]	Not serious	Not serious	Not serious	Not serious	Not serious	No	No	No	Low
Bladder cancer (aluminum production workers)/ PAHs	Rota et al., 2014 ^[3]	Not serious	Not serious	Serious limitation ^a	Not serious	Not serious	No	No	No	Very low
Bladder cancer (iron and steel foundry workers)/ PAHs	Rota et al., 2014 ^[3]	Not serious	Not serious	Serious limitation ^a	Not serious	Not serious	No	No	No	Very low
Bladder cancer (carbon black production workers)/PAHs	Rota et al., 2014 ^[3]	Not serious	Not serious	Not serious	Serious limitation ^c	Not serious	No	No	No	Very low

Offspring ADHD/ Prenatal PAHs	Kaur et al., 2023 ^[6]	Not serious	Not serious	Serious limitation ^a	Not serious	Not serious	No	No	No	Very low
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ADHD, attentional deficit hyperactivity disorder; CI, confidence interval; DNA, deoxyribonucleic acid; ESB, excess significance bias; NA, not available; OR, odds ratio; PAHs, polycyclic aromatic hydrocarbons; PI, prediction interval; SSE, small-study effect; RR, relative risks; 1-OHP, 1-hydroxypayrene; β , regression coefficients.

^a Downgraded by one level for inconsistency: $I^2 > 50\%$ or $I^2 > 75\%$ and heterogeneity was mainly explained.

^b Downgraded by one level for publication bias: asymmetry on funnel plot, the P of Deek's test < 0.1 , the P of Egger's test or Begg's test < 0.05 .

^c Downgraded by one level for imprecision: events < 300 .

^d Upgraded by one level for existence of dose-response.

Supplementary Table 6: Sensitivity analysis results of associations limited to cohort studies

Outcomes/Exposure	Author, Year	Features used for grading the level of evidence						Evidence class of sensitivity analysis*	Evidence class of main analysis*
		Random P-value	No. of participants	95% PI	I ²	Largest study effect (95% CI)	SSE/ESB		
Low birth weight/PAHs	MoghaddamHossein i et al., 2023 ^[7]	0.479	132337	NA	70.60%	1.00 (1.00, 1.00)	No/No	Not significant	Not significant
Birth weight reduction/ Urinary 1-OHP	Yang et al., 2020 ^[5]	0.691	261	(0.81, 1.22)	0.00%	0.99 (0.96, 1.03)	No/No	Not significant	Not significant

ADHD, attentional deficit hyperactivity disorder; CI, confidence interval; ESB, excess significance bias; NA, not available; PAHs, polycyclic aromatic hydrocarbons; PI, prediction interval; SSE, small-study effect; 1-OHP, 1-hydrocypayrene.

* Evidence class was assessed by the established criteria utilized in previous umbrella reviews.

Supplementary Table 7: Sensitivity analysis results of excluded associations due to overlap

Outcomes/Exposure	Author, Year	Features used for grading the level of evidence						Evidence class of sensitivity analysis*	Evidence class of main analysis*
		Random <i>P</i> -value	No. of participants	95% PI	<i>I</i> ²	Largest study effect (95% CI)	SSE/ESB		
Bladder cancer (aluminum production workers)/PAHs	Rota et al., 2014 ^[3]	0.073	15834	(0.60, 2.75)	65.80%	1.30 (1.09, 1.54)	No/No	Not significant	Weak
Bladder cancer (iron and steel foundry workers)/PAHs	Rota et al., 2014 ^[3]	0.050	53272	(0.51, 3.75)	70.10%	1.10 (0.80, 1.52)	No/No	Weak	Weak

ADHD, attentional deficit hyperactivity disorder; CI, confidence interval; ESB, excess significance bias; PAHs, polycyclic aromatic hydrocarbons; PI, prediction interval; SSE, small-study effect.

* Evidence class was assessed by the established criteria utilized in previous umbrella reviews.

Supplementary Table 8: The summary results of associations excluded due to lack of data for quantitative synthesis

Author, Year	No. of included Studies	Exposure	Outcomes	Results	Conclusions
Amster et al., 2021 ^[8]	7	PAHs	Adverse birth outcomes, life time cancer	Increased risk	A significant adverse effect from particulate matter and polyaromatic hydrocarbon emissions on morbidity and mortality.
Kakavandi et al., 2023 ^[9]	17	PAHs	Male infertility	Increased risk	There is a significant negative relationship between PAHs metabolites and sperm volume, concentration, motility, morphology, as well as an observed DNA degeneration.
Patelarou et al., 2014 ^[10]	4	PAHs	Adverse birth outcomes	Increased risk	Three publications found an increased risk of exposure to PAHs and restricted infant growth.
Perera et al., 2019 ^[11]	22	PAHs	Adverse birth, respiratory, cognitive and behavioral outcomes	Increased risk	Prenatal exposure to airborne PAHs is associated with decreased IQ and attention problems/ADHD.
Rafiee et al., 2023 ^[12]	3	PAHs	Adverse reproductive outcomes in women	Increased risk	Exposure to PAHs is associated with adverse reproductive outcomes defined as PCOS, POF, and reproductive hormone imbalance.
Ramaiah et al., 2023 ^[13]	6	PAHs	Childhood intelligence	Increased risk	Exposure to PAHs during pregnancy has an adverse impact on childhood IQ.
Veber et al., 2022 ^[14]	8	PAHs	Adverse birth outcomes	Increased risk	All studies included in this review that used B(a)P–DNA adducts as a PAHs-exposure indicator showed adverse effects of B(a)P on birth weight.

ADHD, attentional deficit hyperactivity disorder; B(a)P, benzo(a)pyrene; DNA, deoxyribonucleic acid; IQ, intellectual quotient; PAHs, polycyclic aromatic hydrocarbons; PCOS, polycystic ovary syndrome; POF, premature ovarian failure.

References:

1. Moher D, Liberati A, Tetzlaff J, Altman DG, PRISMA Group. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *PLoS Med.* 2009;6(7):e1000097. doi:10.1371/journal.pmed.1000097.
2. Stroup DF, Berlin JA, Morton SC, Olkin I, Williamson GD, Rennie D, Moher D, Becker BJ, Sipe TA, Thacker SB, Meta-analysis Of Observational Studies in Epidemiology (MOOSE) Group. Meta-analysis of observational studies in epidemiology: a proposal for reporting. *JAMA.* 2000;283(15):2008-2012. doi:10.1001/jama.283.15.2008.
3. Rota M, Bosetti C, Boccia S, Boffetta P, La Vecchia C. Occupational exposures to polycyclic aromatic hydrocarbons and respiratory and urinary tract cancers: an updated systematic review and a meta-analysis to 2014. *Arch Toxicol.* 2014;88(8):1479-1490. doi:10.1007/s00204-014-1296-5.
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9. Kakavandi B, Rafiemanesh H, Giannakis S, Beheshtaeen F, Samoili S, Hashemi M, Abdi F. Establishing the relationship between Polycyclic Aromatic Hydrocarbons (PAHs) exposure and male infertility: A systematic review. *Ecotoxicol Environ Saf.* 2023;250:114485. doi:10.1016/j.ecoenv.2022.114485.

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11. Perera F, Ashrafi A, Kinney P, Mills D. Towards a fuller assessment of benefits to children's health of reducing air pollution and mitigating climate change due to fossil fuel combustion. *Environ Res.* 2019;172:55-72. doi:10.1016/j.envres.2018.12.016.

12. Rafiee A, Hoseini M, Akbari S, Mahabee-Gittens EM. Exposure to Polycyclic Aromatic Hydrocarbons and adverse reproductive outcomes in women: current status and future perspectives. *Rev Environ Health.* 2024;39(2):305-311. doi:10.1515/reveh-2022-0182.

13. Ramaiah P, Altalbawy FMA, Margiana R, Kumar NB, Kahar F, Jalil AT, Komariah A, Failoc-Rojas VE, Kadhim MM, Sivaraman R, Iswanto AH, Mustafa YF, Najafi ML. The association between prenatal exposure to polycyclic aromatic hydrocarbons and childhood intelligence: a systematic review of observational studies. *Environ Sci Pollut Res Int.* 2023;30(8):19592-19601. doi:10.1007/s11356-023-25309-w.

14. Veber T, Dahal U, Lang K, Orru K, Orru H. Industrial Air Pollution Leads to Adverse Birth Outcomes: A Systematized Review of Different Exposure Metrics and Health Effects in Newborns. *Public Health Rev.* 2022;43:1604775. doi:10.3389/phrs.2022.1604775.