Children and digital dumpsites

E-waste exposure and child health

World Health Organization

WEB ANNEX

Literature review on the health effects of exposure to e-waste

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Children and digital dumpsites: e-waste exposure and child health. Web Annex. Literature review on the health effects of exposure to e-waste

ISBN 978-92-4-002410-6 (electronic version)

Suggested citation. Web Annex. Literature review on the health effects of exposure to e-waste. In: Children and digital dumpsites: e-waste exposure and child health. Geneva: World Health Organization; 2021. Licence: CC BY-NC-SA 3.0 IGO.

Cataloguing-in-Publication (CIP) data. CIP data are available at http://apps.who.int/iris.

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Plastic from e-waste is piled high at Agbogbloshie dump.

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Acknowledgements

This annex was compiled by Julia Gorman (WHO consultant) and Marie-Noël Bruné Drisse (WHO). Final editing by John Dawson, Nairobi, Kenya. This publication was made possible with financial support from the Swedish International Development Cooperation Agency (Sida) and the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety, Germany.

Table 1. Short-term health effects, stress, injuries

Author	Exposure location	Exposure setting	Exposed population	Primary toxicant	Health outcome
Decharat S *(1)*	Nakhon Si Thammarat province, Thailand	Informal recycling workers versus office staff	Informal recycling workers (aged 18–57 years). Exposed (*n*=54), control (*n*=25)	Mercury	Urinary and airborne mercury levels significantly correlated ($r = 0.552$, $P < 0.001$). The prevalence of insomnia (46.8%), muscle atrophy (36.7%), weakness (24.1%) and headaches were all statistically higher among the exposed group ($P < 0.001$).
Feldt T et al. *(2)*	Agbogbloshie, Ghana	Informal recycling workers vs residents of control urban area	Informal recycling workers. Exposed (*n*=72), control (*n*=40)	PAHs	PAHs metabolite significantly higher in exposed individuals compared to non-exposed individuals. Urine concentrations: 1-OH-phenanthrene 0.85 vs 0.55 µg/g creatinine ($P < 0.001$); 2-/9-OH-phenanthrene 0.55 vs 0.37 µg/g creatinine ($P = 0.005$); 3-OH-phenanthrene 0.99 vs 0.63 µg/g creatinine ($P < 0.001$); 4-OH-phenanthrene 0.22 vs 0.11 µg/g creatinine ($P < 0.001$); 1-OH-pyrene 1.33 vs 0.54 µg/g creatinine ($P < 0.001$). Higher urinary PAH levels found in individuals exposed to e-waste recycling processes.
Yohannessen K et al. *(3)*	Santiago and Temuco, Chile	Informal vs formal recycling workers	Informal recycling workers (*n*=78), formal recycling workers (*n*=15)	Not assessed	Workers generally reported good health; prevalence of chronic diseases reported was comparable to national levels. Few health differences reported between informal and formal workers.

PAH: polycyclic aromatic hydrocarbon.

Table 2. Adverse neonatal outcomes

Author	Exposure location	Exposure setting	Exposed population	Primary toxicant	Health outcome
Guo Y et al. *(4)*	Guiyu, China	Ecological: exposed town vs control town	Mother–infant pairs. Exposed (n=101), control (n=119)	Lead, chromium, cadmium, nickel	Placental lead: 301.43 vs 165.82 ng/g ($P = 0.01$); nickel: 7.64 vs 14.30 ng/g ($P = 0.00$). No differences in cadmium or chromium. No differences in birth weight, birth length or gestational age. Negative correlation between placental nickel and gestational age. Correlation between blood lead and residence in e-waste recycling area.
Guo Y et al. *(5)*	Guiyu, China	Ecological: exposed town vs control town	Mother–infant pairs. Exposed (n=103), control (n=80)	PAHs	Cord blood total PAH: 108.05 vs 79.63 ppb ($P = 0.003$); chromium: 1.57 vs 1.05 ppb ($P = 0.049$); BaP: 2.14 vs 1.64 ppb ($P = 0.001$); DahA: 12.26 vs 11.59 ppb ($P = 0.031$). Increased BaA, chrysene and BaP in neonates with adverse birth outcomes ($P < 0.05$). Maternal PAH exposure linked to adverse effects on neonatal health.
Wu K et al. *(6)*	Guiyu, China	Ecological: exposed town vs control town	Mother–infant pairs. Exposed (n=102), control (n=51)	PBDEs	Cord blood total PBDE: 13.84 vs 5.23 ng g^{-1} lipid ($P < 0.05$). No correlation found between PBDEs and neonate length, gestational age or sex.
Wu K et al. *(7)*	Guiyu, China	Informal recycling	Mother–infant pairs. Exposed (n=108), control (n=59)	PCBs	Cord blood PCBs: 338.56 vs 140.16 ng/g, correlated with mothers' recycling activity. Higher total PCBs with adverse birth outcomes ($t = -2.26$, $P = 0.03$). Negative associations between individual PCB congeners and neonatal height, neonatal weight, Apgar score, gestational age and BMI (all $P < 0.05$).
Wu K et al. *(8)*	Guiyu, China	Informal recycling	Pregnant women. Exposed (n=108), control (n=59)	PFOA	Serum PFOA: 16.95 vs 8.7 ng/mL ($P < 0.001$). Negative association between PFOA and spontaneous abortion ($t = -3.035$, $P = 0.003$) and preterm birth ($t = -2.209$, $P = 0.029$). PFOA associated with 15.99 days reduction in gestational age; 267.3 g reduction in birth weight; 1.91 cm reduction in birth length; 1.37 lg-unit reduction in Apgar score. The same study population as *(7)*.
Li Y et al. *(9)*	Guiyu, China	Ecological: exposed town vs control town	Newborn infants. Exposed 2006 (n=100); 2007 (n=100). Control 2006 (n=52); 2007 (n=50)	Chromium	Cord blood chromium 2006: 303.38 vs 19.95 mg/L; 2007: 99.9 vs 32.48 mg/L. No association with birth weight or birth length. Evidence suggests that chromium may cause DNA damage in neonates.
Xu X et al. *(10)*	Guiyu, China	Informal recycling	Newborn infants. Exposed (n=432), control (n=99)	Lead	Cord blood lead: 10.87 vs 2.25 mg/dL ($P < 0.01$), correlated with recycling activity. Higher rates of adverse birth outcomes: stillbirth (4.72 vs 1.03%); preterm birth (5.68 vs 5.24%); lower birth weight (3168 vs 3258 g); and lower Apgar scores (9.6 vs 9.9, all $P < 0.01$) linked to prenatal lead exposure.

Table 2. Adverse neonatal outcomes continued

Author	Exposure location	Exposure setting	Exposed population	Primary toxicant	Health outcome
Xu L et al. *(11)*	Guiyu, China	Exposed town vs control town	Pregnant women and newborn infants. Exposed pregnant women (*n*=99), control (*n*=86)	Lead, cadmium	Cord blood lead: 498.80 vs 27.01; cadmium: 96.19 vs 12.65 ng/g. Cadmium correlated with 205.05 g reduction in neonatal weight and 0.44 cm reduction in body length. No statistical significance found with lead.
Xu L et al. *(12)*	Guiyu, China	Exposed town vs control town. Some participants employed in e-waste recycling	Pregnant women and newborn infants. Exposed pregnant women (*n*=69), control (*n*=86)	PBDEs	Cord blood PBDEs: 32.25 vs 5.13 ng/g. PBDE concentration negatively correlated with head circumference (33.52 vs 34.92 cm, $P < 0.05$) and neonatal BMI (11.90 vs 12.69 kg/m^2, $P < 0.05$), and strongly negatively correlated with Apgar1 score (9.16 vs 10.0, $P < 0.001$).
Zhang Y et al. *(13)*	Guiyu, China	Exposed town vs control town. One participant did work related to e-waste during pregnancy	Pregnant women and newborn infants. Exposed pregnant women (*n*=237), control (*n*=212)	Cadmium	Maternal urinary cadmium with female neonates: 1.59 vs 0.92; with male neonates: 1.38 vs 0.74 µg/g creatinine ($P = 0.00$). Maternal urinary cadmium level with female neonates significantly inversely associated with birth weight, length, head circumference, and Apgar 1 and 5 scores (all $P < 0.05$), and significant association with Apgar 1 score in male neonates ($P = 0.004$).
Huo X et al. *(14)*	Guiyu, China	Exposed town vs control town	Pregnant women. Exposed (*n*=155), control (*n*=102)	OH-PAHs	Maternal urine OH-PAH: 6.87 vs 3.90 µg/g creatinine ($P < 0.001$). PAHs linked to decrease of 234.56 g in weight, 1.72 cm in head circumference, 1.06 kg/m^2 in BMI and 0.42 in Apgar 1 score (all $P < 0.05$).
Li M et al. *(15)*	Guiyu, China	Exposed town vs control town	Pregnant women. Exposed (*n*=150), control (*n*=150)	PBDEs	Cord blood PBDEs: 71.92 vs 15.52 ng/g lipid weight ($P < 0.01$). Neonatal head circumference, BMI and Apgar 1 score negatively correlated with PBDEs (all $P < 0.01$).

BaA: benzo[a]anthracene; BaP: benzo[a]pyrene; BMI: body mass index; DahA: dibenz[a,h]anthracene; OH-PAH: hydroxylated polycyclic aromatic hydrocarbon; PAH: polycyclic aromatic hydrocarbon; PBDE: polybrominated diphenyl ether; PCB: polychlorinated biphenyl; PFOA: perfluorooctanoic acid.

Table 3. Short placental telomere

Author	Exposure location	Exposure setting	Exposed population	Primary toxicant	Health outcome
Lin S et al. *(16)*	Guiyu, China	Exposed town vs control town	Newborn infants. Exposed (n=220), control (n=93)	Cadmium, lead	Cord blood cadmium: 0.0929 vs 0.0239 µg/g ($P < 0.01$); lead 1.2491 vs 1.3525 µg/g ($P > 0.05$). Cord blood cadmium negatively correlated with placental telomere length ($r = -0.138$, $P = 0.013$), no significant correlation between cord blood lead and telomere length.