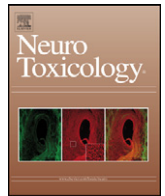




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NeuroToxicology



Current needs and future directions of occupational safety and health in a globalized world

Frederica P. Perera^a, T.Y. Li^a, C. Lin^a, Deliang Tang^a, Steven G. Gilbert^b, Seong-Kyu Kang^c, Michael Aschner^{d,*}

^a Mailman School of Public Health, Columbia University, New York, NY, United States

^b Institute of Neurotoxicology & Neurological Disorders (INND), Seattle, WA, United States

^c Center for Occupational Disease Research KOSHA, Incheon, Republic of Korea

^d Department of Pediatrics, Vanderbilt University Medical Center, 2215-B Garland Avenue, MRB IV, Nashville, TN, United States

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ABSTRACT

This summary provides a synopsis of talks included in a symposium entitled “Current Needs and Future Directions of Occupational Safety and Health in a Globalized World”. The purpose of the symposium was to (1) highlight national and international agencies with occupational health related activities; (2) address electronic (e-)waste issues in developing countries where exposures are secondary to the handling and scavenging of scrap; and (3) discuss the effects of hazardous materials, such as polycyclic aromatic hydrocarbon (PAH) and tobacco smoke on child intelligence quotient (IQ) in developing countries.

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1. Introduction

There are several national and international institutes or organizations related to occupational health. International organizations may be intergovernmental or non-governmental. International intergovernmental organizations include the United Nations (UN) agencies, such as the World Health Organization (WHO) and the International Labour Organization (ILO). The International Agency of Research on Cancer and the International Program on Chemical Safety are also UN agencies.

International non-intergovernmental organizations include the International Commission on Occupational Health (ICOH), the International Occupational Hygiene Association (IOHA), and the International Ergonomic Association (IEA). The International Commission on Radiation Protection and the International Commission on Non-Ionizing Radiation Protection are also independent professional societies endowed with knowledge exchange related to radiation and non-ionizing radiation health effects. The International Union of Toxicology (IUTOX) is an international professional association of worldwide national toxicology societies.

2. International inter-governmental organization

2.1. WHO

The WHO is an international organization that directs and coordinates people's health issues under the auspices of the UN. It was founded in 1948 and as of 2010 it has 193 member states. The WHO is responsible for providing leadership on global health matters, shaping the health research agenda, setting norms and standards, articulating evidence-based policy options, providing technical support, monitoring and assessing health trends.

The Department of Public Health and Environment (PHE) is responsible for occupational and environmental health in the WHO. The Department of PHE is under the responsibility of the Assistant Director General for Health, Security and Environment (HSE) under the auspice of Director General of the WHO. The Department of HSE has approximately 25 staff for occupational and environmental health, including seven staff for occupational health. As of 2010, it is headquartered in Geneva, Switzerland. The WHO has six Regional Offices: African Region (AFRO), The Americas (PAHO), South-East Asia (SEARO), Eastern Mediterranean (EMRO), Western Pacific (WPRO) and Europe (EURO). Each regional office has its own coordinators for occupational and environmental health (OEH), addressing occupational health in its member states.

* Corresponding author. Tel.: +1 615 322 8024; fax: +1 615 936 4080.

E-mail address: michael.aschner@vanderbilt.edu (M. Aschner).

The Ministry of Health of the member states is the contact point of the WHO.

The WHO developed the Neurobehavioral Core Test Batteries (WHO-NCTB) in 1986, which has been widely used in occupational and environmental health to detect subclinical neurotoxic symptoms and signs (WHO, 1986). WHO-NCTB is composed of seven tests: POMS, simple reaction time, digit span, digit symbol, Benton visual test, Santa Ana dexterity test and aiming pursuit (Anger et al., 2000).

Activities in occupational health (OH) at the WHO were curtailed in 1990s and reinstated since 2000s through the global network of collaborating centers (CC). WHO designated 58 institutes from 37 countries as CC in OH as of 2009 (WHO, 2009). The WHO established the Global Plan of Action (GPA) for 2008–2017, which is organized into 5 objectives. There is no specific plan related to neurotoxicology

2.2. ILO

The ILO is the international organization responsible for drawing up and overseeing international labor standards. It was founded in 1919 and has 189 member states (ILO, 2011a,b). The ILO is a tripartite structure that brings together representatives of governments, employers, and workers for promoting 'Decent Work for All'. The Program on Occupational Safety and Health (SAFEWORK) of the Labor Protection Department (PROTRAV) is responsible for occupational safety and health (OSH). PROTRAV belongs to the Social Protection Sector under the Secretary General of the ILO. SAFEWORK has approximately 20 staff for OSH and as of 2010 is headquartered in Geneva, Switzerland. The ILO has five Regional Offices: Africa, Americas, Arab States, Asia and the Pacific, and Europe and Central Asia. Each regional office has its own coordinator for OSH, who leads prevention of occupational injuries and diseases in its member states. The Ministry of Labor or Employment of the member states is the contact point of the ILO. The ILO brings together not only OSH specialists, but also employers and managers, trade unions, public administration and insurance professionals as well as manufacturers and importers.

There are 13 Conventions related to OSH, such as the Chemical Convention, 1990. The ILO published the 4th edition of the Encyclopedia of Occupational Health and Safety, which provides various aspects on OSH knowledge and practices (ILO). The ILO also reports its recommendations on occupational diseases (revised in 2010) and has over the years provided pertinent information on numerous neurotoxic chemicals, such as manganese, arsenic, mercury, lead, carbon disulfide, organic solvents and pesticides, just to name a few (ILO).

3. International non-governmental organizations

3.1. ICOH

The International Commission on Occupational Health (ICOH) is an international non-governmental professional society; it was founded in 1906 in Milan, Italy to celebrate the successful prevention of occupational diseases during construction of the Simplon tunnel (Hobson, 2006; ICOH, 2011). ICOH is the world's leading international scientific society in OH with a membership of 2000 professionals from 93 countries, whose specialties include occupational medicine, toxicology, industrial hygiene, nursing, psychology, statistics, epidemiology and administration (ICOH). ICOH hosts triennial Congresses since 1906. The 30th Congress will be held in Cancun, Mexico in March 2012, followed by Seoul, Korea in May 2015.

ICOH is composed of 35 Scientific Committees including the Scientific Committee of Neurotoxicology and Psychophysiology (SCNP), whose aims are to exchange scientific knowledge on occupational and environmental neurotoxicity. SCNP holds the triennial International Symposium on Neurobehavioral Methods and Effects in Occupational and Environmental Health since 1982 and selected papers from its meetings have been published in peer-reviewed journals (Mergler and Wesseling, 2009). The 11th Symposium was held in Xian, China in June 2011, in conjunction with the International Neurotoxicity Association (INA).

3.2. IOHA

The International Occupational Hygiene Association (IOHA) is an international professional association of occupational hygiene organizations from across the world (IOHA, 2011). The members of IOHA are 27 associations of industrial hygienists from 25 countries. IOHA hosts a biannual international congress since 1987 and the next meeting will be held in Kuala Lumpur, Malaysia in September 2012.

IOHA provides information on occupational exposure limits (OEL) of airborne workplace chemicals in each country, which includes the values drawn from data derived from neurotoxicity studies. IOHA also works on control banding, which is an ILO program to control chemicals at workplace including neurotoxics.

3.3. ISSA

The International Social Security Association (ISSA) is the international organization bringing together social security agencies and organizations, which was founded under ILO in 1927 (ISSA, 1927). Its aim is to promote exchange of knowledge and experience on social security. Its members include 350 agencies from 150 countries. ISSA has many agencies for workers compensation insurance as well as health insurance or pension agencies. The Special Commission on Prevention, which is one of 12 Technical Commissions, has 12 international sections on the prevention of occupational risks including research and culture of prevention. It hosts the triennial World Congress on OSH in conjunction with the ILO and the hosting country.

4. National or public institute on OSH

4.1. Independent institutes

The Health and Safety Laboratory (HSL) in the United Kingdom (UK) is the oldest institute in OSH with a centenary year in 2011. HSL belongs to the Health and Safety Executive (HSE), which is an independent authority for safety and health in UK. The scope of HSL is divided into three areas: Plant, Process and People. Occupational neurotoxicology is not included in these sectors. HSL has an international reputation as a center of excellence in incident investigations.

4.2. Institutes under the Ministry of Health

The National Institute for Occupational Safety and Health (NIOSH) is a research institute under the Department of Health and Human Services in the U.S. NIOSH conducted multiple studies on neurotoxicity and selected the topic as one of its top 10 priority occupational illnesses in 1980s. However, neurotoxicity was not included in the National Occupational Research Agenda (NORA) in 1996, which had three categories: disease and injury, work environment and workforce, and research tools and approaches. The category of disease and injury had nine areas excluding

neurotoxic disease. The new NORA launched in 2006 was rearranged by 10 sector based approach.

The Finnish Institute of Occupational Health (FIOH) is an independent agency under the Ministry of Social Affairs and Health. The area of activities is divided into several groups including the brain at work theme. FIOH is a leading institute that has conducted neurotoxicity research since Hänninen performed neurobehavioral tests to workers exposed to lead, carbon disulfide and organic solvents in the 1970s and 1980s (Hänninen, 1988).

The Chinese National Institute of Occupational Center and Poison Control (NIOHPC) is an agency of the Chinese Center for Disease Control (CDC) under the Ministry of Health. The National Institute of Occupational and Environmental Health (NIOEH) in Vietnam is an institute of the Ministry of Health.

4.3. Institutes under the Ministry of Labor or Employment

The Federal Institute of Occupational Safety and Health (BAuA) is a federal agency of the German Federal Ministry of Labor and Social Affairs that conducts research activities in OSH. The National Research Center for the Working Environment (NRCWE) in Denmark is an institute of the Ministry of Employment. The National Institute of Occupational Health in Norway belongs to the Ministry of Labor.

The Occupational Safety and Health Research Institute (OSHRI) of the Korea Occupational Safety and Health Agency (KOSHA) belongs to the Ministry of Employment and Labor, however the budget of OSHRI comes from the Workers' Accident Compensation Insurance Fund.

The Japanese National Institute of Occupational Safety and Health (JNIOSH) is under the auspice of the Ministry of Welfare and Labor.

4.4. Institutes belonging to a compensation insurance body

The Department of Research in the Italian Workers' Compensation Authority (INAIL) is now under compensation authority while its former body, Italian Institute of Occupational Safety and Disease Prevention (ISPESL) was under the Ministry of Health.

The Institute of Occupational Safety and Health (IFA) belongs to the German Social Accident Insurance (DGUV). The National Institute of research and security (INRS) in France belongs to French National Health Insurance Fund for Salaried Workers (CNAMTS).

5. The hazards of technology waste for workers and children

5.1. Background

Communicating electronically is often thought of as inherently "green", since it reduces paper waste and its associated transit. However, rapid innovation in the electronics industry, which brings us smaller and faster cell phones and computers, also produces a rapidly growing pile of outdated electronics. Eventually this equipment will reach the end of its usable lifespan, and will need to be disposed of as electronic waste, or e-waste. E-waste, sometimes referred to as waste electrical and electronic equipment (WEEE) is all too often shipped to China, India, Africa or other developing countries where people use 19th century techniques to extract metals or other components from our 21st century discards (for reports on Asia and Africa see Puckett et al., 2002, 2005; Widmer et al., 2005). One United Nations program estimates that 20–50 million metric tons of e-waste are generated worldwide every year (http://www.electronicstakeback.com/wp-content/uploads/Facts_and_Figures), comprising more than 5% of all municipal solid waste, and containing lead, cadmium, mercury, PBDE, PCBs, and other hazardous chemicals.

Concerns of excessive hazardous waste contamination have led to a patchwork of local bans of electronic wastes from landfills, a movement to encourage consumers to dispose of their e-waste responsibly, and the growth of an e-waste recycling, or "e-cycling," industry. There is a growing concern that the recycling efforts themselves are leading to massive environmental contaminations in the nations who are the major recipients of e-waste, including Nigeria, Ghana, and China. The Basel Convention on the control of transboundary movements of hazardous wastes and their disposal was adopted in Basel, Switzerland on March 22, 1989 and entered into force in 1992, with the aim of controlling the environmental impacts of e-waste shipped from developed to developing countries (<http://www.basel.int/>).

5.2. Discarded products

China has some of the greatest challenges as it produces, exports, imports, and consumes the largest portion of global electrical and electronic equipment (Chi et al., 2011). The majority of the e-waste is recycled by the so called informal sector with little safe guards for human health or the environment. The Chinese government has responded by passing regulations to encourage better practices (<http://ewasteguide.info/stepping-efforts-con>). The European Union has developed a series of directive requiring responsible management of e-waste (Ongondo et al., 2011, Widmer et al., 2005). There are an estimated 1 billion phones and over 200 million computers manufactured each year. In China there was an estimated 25 million TVs, 12 million computers, and 40 million mobile phones discarded and this does not count the estimated 35 million tons of e-wasted imported from developed countries (<http://pubs.usgs.gov/fs/fs060-01/fs060-01.pdf>). The challenge is how to safely recycle the discarded material, mitigating human exposures and ill effects.

5.3. Health effects

The workers, including women and children, are mostly unaware of the hazards and unprotected from exposure to the hazardous materials. A 2007 study of children's lead exposure in Guiyu, Guangdong Province, China, that uses primitive recycling/dismantling techniques found that children blood lead levels ranged from 4.40 to 32.67 $\mu\text{g}/\text{dL}$ with a mean of 15.3 $\mu\text{g}/\text{dL}$ while 81.8% (135 of 165) had blood lead levels greater than 10 $\mu\text{g}/\text{dL}$ (Huo et al., 2007). It is well documented that there is no safe level of lead exposure for children (Mazumdar et al., 2011; Gilbert and Weiss, 2006). Environmental contamination and human health are well documented around Guiyu (Deng et al., 2006; Leung et al., 2007; Li et al., 2007a,b; Wong et al., 2007a,b; Yu et al., 2006). PCBs while now banned were widely used in electrical transformers and when dismantled in Taizhou, China (Xing et al., 2010) China, there was significant food contamination.

5.4. Basel Convention

The Basel Convention on the control of transboundary movements of hazardous wastes and their disposal was adopted in Basel, Switzerland on March 22, 1989 and entered into force in 1992, with the aim of controlling the environmental impacts of e-waste shipped from developed to developing countries. Initially, 118 nations signed on to the treaty and to date, 175 countries have ratified the treaty, but the United States has not ratified the treaty. The Basel Convention has the broad aim "to protect human health and the environment against the adverse effects resulting from the generation, management, transboundary movements and disposal of hazardous and other wastes" (Basel, 2011). The Basel Convention was originally convened over the concern that developed

countries were exporting hazardous waste to developing countries that were not equipped to handle this toxic waste on a manner that protected human health and environmental.

Some states have started requiring safe recycling of e-waste. According to Electronics TakeBack Coalition (ETBC, <http://www.electronicstakeback.com/>), 25 states have passed legislation mandating statewide e-waste recycling. All but two states require that the manufacture pay for some or all collection, transportation, and recycling of their products. The laws vary from state to state as to what products are covered in the take back program. The California law for example, does not include computers, but in 2010 over 172 million pounds of e-waste were recycled (http://ccdigitalpress.org/tes/16_apostel_apostel.pdf). Washington state requires that computers be recycled and 2010 approximates 3.8 million pounds of computers were collected. An informative analysis and comparison of the Washington state and Oregon experience with e-waste recycling was recently completed (NWPSC, 2010). Through the State's program, electronic equipment is taken apart and separated into materials such as glass, plastic, metal and toxic chemicals, then recycled in accordance with the Department of Ecology.

A significant challenge is to ensure the e-waste is recycled responsibly and not just shipped to substandard recycling facility. In 2003 the Basel Action Network (BAN, www.ban.org), a nonprofit organization in Seattle, WA, USA established a voluntary pledge program that e-recyclers would use best practices: no disposal in landfills or incinerators, no prison labor, and no export to poor communities. The need for international standards remained and in 2008 BAN established the e-Stewards Certification program for electronics recyclers (<http://e-stewards.org/>). This program has an inspection and certification program to ensure that members adhere to the best practices for e-recycling. A companion program called e-Stewards Enterprises requires member corporations to only use e-Steward certified companies to handle their e-waste.

5.5. Prenatal exposure to polycyclic aromatic hydrocarbon (PAH) exposure and environmental tobacco smoke (ETS) on Child IQ in a Chinese Cohort

China's vast industrial network and power plant system rely on coal for approximately 70–75% of their energy needs (Economy, 2003; Zheng et al., 2002). Coal burning in China is the major source of ambient polycyclic aromatic hydrocarbons (PAHs) (Perera et al., 2008). PAH are also present in tobacco smoke and charred foods. Molecular and epidemiologic studies show that fetuses and infants are more susceptible than adults to environmental toxicants including PAH (Perera et al., 2005b), lead (ATSDR, 2005), and mercury (ATSDR, 1999b). Experimentally, benzo[a]pyrene (BaP), a representative PAH produces neurodevelopmental effects including decreased motor activity, neuromuscular, physiologic and autonomic abnormalities, decreased responsiveness to sensory stimuli, and impairment of memory (Saunders et al., 2002; Wormley et al., 2004). Specifically, Saunders et al. (2002) show in an acute study in adult rats with single doses that ranged from 25–200 mg/kg, that a correlation between neurotoxic effects and BaP plasma, and brain metabolite concentrations, suggesting that metabolism plays an important role in modulating the neurobehavioral effects of BaP. Wormley et al. (2004) show that gestational exposure to BaP attenuates the capacity for LTP in the F1 generation of timed-pregnant rats exposed to BaP aerosol via nose-only inhalation on gestation days 11–21 for 4 h per day. In studies in Europe, the United States, and China, prenatal exposure to PAH has been associated with reduced fetal growth (Choi et al., 2006; Perera et al., 1998; Sram et al., 2005; Tang et al., 2006) and neurodevelopmental deficits (Perera et al., 2006).

PAH–DNA adducts reflect individual variation in exposure, absorption, metabolic activation, and DNA repair (Perera, 1997);

they therefore provide an informative biologic dosimeter that has been associated with risk of cancer and developmental impairment (Bartsch et al., 1983; Perera et al., 2007b; Tang et al., 2001). PAH–DNA adduct concentrations in cord blood have been shown to increase across a gradient of ambient PAH exposure, albeit with substantial interindividual variation (Perera et al., 2005b; Whyatt et al., 1998). Cord blood adducts in the 2002 Tongliang cohort (mean, 0.32 per 10⁸) were significantly higher than those in cohorts of newborns in the United States and Poland (Perera et al., 2005b). As previously reported, in the 2002 Tongliang, Chongqing, China, cohort, PAH–DNA adducts in cord blood were associated with reduction of birth head circumference (Tang et al., 2006) and reduced developmental quotients (DQs) at 2 years of age (Tang et al., 2008).

Lead is also a developmental neurotoxicant even at low levels (ATSDR, 1999a, 2005; Canfield et al., 2003) and was evaluated as a potential confounders of associations between PAH–DNA adducts and developmental outcomes. Prenatal ETS exposure is a known risk factor for neurodevelopmental impairment (Rauh et al., 2006). Our previous studies in New York City found a significant interaction between PAH–DNA adducts in cord blood and prenatal ETS exposure on birth weight (Perera et al., 2005a) and on 3 year mental development (Perera et al., 2007a). We have therefore explored both main effects and interactions between these pollutants and child IQ in the Tongliang cohort.

Subjects in the present analysis were children born to nonsmoking Chinese women in Tongliang between March and June 2002, who had available data on PAH–DNA adducts in cord blood and complete data at age 5 on the Wechsler Preschool and Primary Scale of Intelligence (WPPSI). A questionnaire was administered to the mothers to gather demographic information, lifetime residential history, history of active and passive smoking, occupational exposure during pregnancy, and consumption of PAH-containing meat during pregnancy. ETS exposure was measured by a set of questions about timing, frequency, and the amount of exposure to tobacco smoke in the home. Socioeconomic information related to income and education was also collected. Benzo[a]pyrene (BaP)–DNA adducts were analyzed in extracted cord white blood cell DNA using a high-performance liquid chromatography (HPLC)/fluorescence method that detects BaP tetraols as described (Tang et al., 2006). Lead in umbilical cord blood was analyzed using the standard U.S. Environmental Protection Agency (EPA) method (U.S. Environmental Protection Agency, 2007).

In as of yet unpublished studies, both PAH–DNA adducts and prenatal ETS were generally inversely, but not significantly, associated with the WPPSI scores in the multiple linear regression models. Higher prenatal exposure to PAH (measured by cord PAH–DNA adducts), in combination with prenatal ETS exposure suggested a trend towards association with reductions in verbal and full-scale IQ scores at age 5, after adjusting for confounding variables. This result is consistent with evidence from our prior study in NYC that found an interaction between cord PAH–DNA adducts and prenatal ETS exposure on cognitive development at age 3 (Perera et al., 2007a).

The coal-fired power plant that was the major source of environmental PAH in Tongliang was closed down by the government in December 2004 suggesting direct benefits to the population from this intervention.

Conflict of interest

Not applicable.

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References

- Anger WK, Liang YX, Nell V, Kang SK, Cole D, Bazylewicz-Walczak B, et al. Lessons learned – 15 years of the WHO-NCTB: a review. *Neurotoxicology* 2000;21:837–46.
- ATSDR. Toxicological profile for lead. Washington, DC: Agency for Toxic Substances and Disease Registry, U.S. Department of Health and Human Services; 1999.
- ATSDR. Toxicological profile for mercury. Atlanta, GA: Agency for Toxic Substances and Disease Registry, U.S. Department of Health and Human Services, Public Health Service; 1999.
- ATSDR. Toxicological profile for lead. Atlanta, GA: Agency for Toxic Substances and Disease Registry, U.S. Department of Health and Human Services, Public Health Service; 2005.
- Bartsch H, Terracini B, Malaveille C. Quantitative comparisons of carcinogenicity, mutagenicity and electrophilicity of 10 direct-acting alkylating agents and the initial 06-alkylguanine ratio in DNA with carcinogenic potency in rodents. *Mutat Res* 1983;110:181–219.
- Basel. Basel convention; 2011.
- Canfield RL, Henderson CR, Cory-Slechta DA, Cox C, Jusko TA, Lanphear BP. Intellectual impairment in children with blood lead concentrations below 10 µg/dL. *N Engl J Med* 2003;348:1517–21.
- Chi X, Streicher-Porte M, Wang MY, Reuter MA. Informal electronic waste recycling: a sector review with special focus on China. *Waste Manage* 2011;31:731–42.
- Choi H, Jedrychowski W, Spengler J, Camann DE, Whyatt RM, Rauh V, et al. International studies of prenatal exposure to polycyclic aromatic hydrocarbons and fetal growth. *Environ Health Perspect* 2006;114:1744–50.
- Deng WJ, Louie PKK, Liu WK, Bid XH, Fu JM, Wong MH. Atmospheric levels and cytotoxicity of PAHs and heavy metals in TSP and PM2.5 at an electronic waste recycling site in southeast China. *Atmos Environ* 2006;40:6945–55.
- Economy EC. China's environmental challenge: political, social, and economic implications. New York, NY: Council on Foreign Relations; 2003.
- Gilbert SG, Weiss B. A rationale for lowering the blood lead action level from 10 to 2 µg/dL. *Neurotoxicology* 2006;27:693–701.
- Hanninen H. The psychological performance profile in occupational intoxications. *Neurotoxicol Teratol* 1988;10:485–8.
- Hobson J. ICOH one hundred and the Simplon tunnel. *Occup Med (Lond)* 2006;56:221–2.
- Huo X, Peng L, Xu X, Zheng L, Qiu B, Qi Z, et al. Elevated blood lead levels of children in Guiyu, an electronic waste recycling town in China. *Environ Health Perspect* 2007;115:1113–7.
- ICOH. International Commission on Occupational Health, http://www.icohweb.org/site_new/ico_homepage.asp; 2011.
- ILO. Encyclopaedia on occupational health and safety., 4th edition Geneva: International Labour Organization; 2011. In: <http://www.ilocis.org/en/contilo.html>.
- ILO, International Labour Organization. R194: recommendation concerning the list of occupational diseases and the recording and notification of occupational accidents and disease., 2011. In: <http://www.ilo.org/ilolex/cgi-lex/convde.pl?R194>.
- IOHA. International Occupational Hygiene Association., 2011. In: <http://www.ioha.net/>.
- ISSA. International Social Security Association., 1927. In: <http://www.issa.int/About-ISSA/ISSA-History>.
- Leung AO, Luksemburg WJ, Wong AS, Wong MH. Spatial distribution of polybrominated diphenyl ethers and polychlorinated dibenzo-p-dioxins and dibenzofurans in soil and combusted residue at Guiyu, an electronic waste recycling site in southeast China. *Environ Sci Technol* 2007;41:2730–7.
- Li H, Yu L, Sheng G, Fu J, Peng P. Severe PCDD/F and PBDD/F pollution in air around an electronic waste dismantling area in China. *Environ Sci Technol* 2007a;41:5641–6.
- Li JG, Wu YN, Zhang L, Zhao YF. Dietary intake of polychlorinated dioxins, furans and dioxin-like polychlorinated biphenyls from foods of animal origin in China. *Food Addit Contam* 2007b;24:186–93.
- Mazumdar M, Bellinger DC, Gregas M, Abanilla K, Bacic J, Needleman HL. Low-level environmental lead exposure in childhood and adult intellectual function: a follow-up study. *Environ Health* 2011;10:24.
- Mergler D, Wesseling C. 10th international symposium on neurobehavioral methods and effects in environmental and occupational health: meeting report. *Neurotoxicology* 2009;30:1134.
- NWSPSC NPSC. Preliminary analysis of e-cycle programs in Washington and Oregon. Seattle; 2010.
- Ongondo FO, Williams ID, Cherrett TJ. How are WEEE doing? A global review of the management of electrical and electronic wastes. *Waste Manage* 2011;31:714–30.
- Perera FP. Environment and cancer who are susceptible? *Science* 1997;278:1068–73.
- Perera FP, Rauh V, Whyatt RM, Tang D, Tsai WY, Bernert JT, et al. A summary of recent findings on birth outcomes and developmental effects of prenatal ETS, PAH, and pesticide exposures. *Neurotoxicology* 2005a;26:573–87.
- Perera FP, Rauh V, Whyatt RM, Tsai WY, Tang D, Diaz D, et al. Effect of prenatal exposure to airborne polycyclic aromatic hydrocarbons on neurodevelopment in the first 3 years of life among inner-city children. *Environ Health Perspect* 2006;114:1287–92.
- Perera FP, Tang D, Rauh V, Tu YH, Tsai WY, Becker M, et al. Relationship between polycyclic aromatic hydrocarbon–DNA adducts, environmental tobacco smoke, and child development in the World Trade Center cohort. *Environ Health Perspect* 2007a;115:1497–502.
- Perera FP, Tang D, Whyatt R, Lederman SA, Jedrychowski W. DNA damage from polycyclic aromatic hydrocarbons measured by benzo[a]pyrene–DNA adducts in mothers and newborns from Northern Manhattan, the World Trade Center Area, Poland, and China. *Cancer Epidemiol Biomarkers Prev* 2005b;14:709–14.
- Perera FP, Tang W, Herbstman J, Edwards SC, Tang D, Ho S-M. Prenatal exposure to airborne polycyclic aromatic hydrocarbons and alterations in DNA methylation in cord blood. In: 19th annual conference of the international society for environmental epidemiology (ISEE). Mexico City, Mexico: International Society for Environmental Epidemiology; 2007.
- Perera FP, Whyatt RM, Jedrychowski W, Rauh V, Manchester D, Santella RM, et al. Recent developments in molecular epidemiology: a study of the effects of environmental polycyclic aromatic hydrocarbons on birth outcomes in Poland. *Am J Epidemiol* 1998;147:309–14.
- Perera F, Li T, Zhou Z, Yuan T, Chen Y, et al. Benefits of reducing prenatal exposure to coal-burning pollutants to children's neurodevelopment in China. *Environ Health Perspect* 2008;116(10). doi: 10.1289/ehp.11480.
- Puckett J, Byster L, Westervelt S, Gutierrez R, Davis S, Hussain A, et al. Exporting harm the high-tech trashing of Asia. Network BA; 2002.
- Puckett J, Westervelt S, Gutierrez R, Takamiya Y. The digital dump: exporting re-use and abuse to Africa. 2005 (Print Version).
- Rauh VA, Garfinkel R, Perera FP, Andrews HF, Hoepner L, Barr DB, et al. Impact of prenatal chlorpyrifos exposure on neurodevelopment in the first 3 years of life among inner-city children. *Pediatrics* 2006;118:e1845–59.
- Saunders CR, Ramesh A, Shockley DC. Modulation of neurotoxic behavior in F-344 rats by temporal disposition of benzo(a)pyrene. *Toxicol Lett* 2002;129:33–45.
- Sram RJ, Binkova B, Dejmejk J, Bobak M. Ambient air pollution and pregnancy outcomes: a review of the literature. *Environ Health Perspect* 2005;113:375–82.
- Tang D, Cho S, Rundle A, Chen S, Perera FP. PAH–DNA adducts and XRCC1 in breast cancer case-control study. New Orleans, LA: AACR Proceedings; 2001.
- Tang D, Li TY, Liu JJ, Chen YH, Qu L, Perera FP. PAH–DNA adducts in cord blood and fetal and child development in a Chinese cohort. *Environ Health Perspect* 2006;114:1297–300.
- Tang D, Li TY, Liu JJ, Zhou ZJ, Yuan T, Chen YH, et al. Effects of prenatal exposure to coal burning pollutants on children's development in China. *Environ Health Perspect* 2008;116:674–9.
- U.S. Environmental Protection Agency. Particulate matter. Washington, D.C.: U.S. Environmental Protection Agency; 2007.
- WHO, World Health Organization. Field evaluation of WHO neurobehavioral core test battery. Geneva: WHO Office of Occupational Health; 1986.
- WHO, World Health Organization, Collaborating center in occupational health. Geneva, http://www.who.int/occupational_health/cc_compendium.pdf; 2009.
- Whyatt RM, Bell DA, Santella RM, Garte SJ, Jedrychowski W, Gladek-Yarborough A, et al. Polycyclic aromatic hydrocarbon–DNA adducts in human placenta and modulation by CYP1A1 induction and genotype. *Carcinogenesis* 1998;19:1389–92.
- Widmer R, Oswald-Krapf H, Sinha-Khetriwal D, Schnellmann M, Böni H. Global perspectives on e-waste. *Environ Impact Assess Rev* 2005;25:436–58.
- Wong CS, Duzgoren-Aydin NS, Aydin A, Wong MH. Evidence of excessive releases of metals from primitive e-waste processing in Guiyu, China. *Environ Pollut* 2007a;148:62–72.
- Wong MH, Wu SC, Deng WJ, Yu XZ, Luo Q, Leung AO, et al. Export of toxic chemicals – a review of the case of uncontrolled electronic-waste recycling. *Environ Pollut* 2007b;149:131–40.
- Wormley DD, Chirwa S, Nayyar T, Wu J, Johnson S, Brown LA, et al. Inhaled benzo(a)pyrene impairs long-term potentiation in the F1 generation rat dentate gyrus. *Cell Mol Biol (Noisy-le-Grand France)* 2004;50:715–21.
- Xing GH, Wu SC, Wong MH. Dietary exposure to PCBs based on food consumption survey and food basket analysis at Taizhou, China – the world's major site for recycling transformers. *Chemosphere* 2010;81:1239–44.
- Yu XZ, Gao Y, Wu SC, Zhang HB, Cheung KC, Wong MH. Distribution of polycyclic aromatic hydrocarbons in soils at Guiyu area of China, affected by recycling of electronic waste using primitive technologies. *Chemosphere* 2006;65:1500–9.
- Zheng T, Niu S, Lu B, Fan X, Sun F, Wang J, et al. Childhood asthma in Beijing, China: a population-based case-control study. *Am J Epidemiol* 2002;156:977–83.