



Children's environmental health based on birth cohort studies of Asia



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HIGHLIGHTS

- Environmental pollutants have adverse effects on Asia children.
- Mercury and PCB appear more evidence on children's neurodevelopment in Asia area.
- ETS, phthalate, and PFAS need more evidence related to children's health outcomes in Asia area.

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ABSTRACT

Numerous studies have explored the associations between environmental pollutants and pediatric health. Recent studies have investigated the issue in Asia, but no systematic review has been published to date. This study aims to elucidate the issue by summarizing relevant epidemiologic evidence for cohorts in Asia, using information from the Birth Cohort Consortium of Asia (BiCCA).

Environmental pollutants include mercury, environmental tobacco smoke (ETS), polychlorinated biphenyls (PCB), perfluoroalkyl substances (PFAS) and phthalates. This study sought to classify the effects of such compounds on fetal growth and pregnancy outcomes, neurodevelopment and behavioral problems, allergic disease and immune function and the endocrine system and puberty. These evidences showed ETS has been associated with infant birth weight, children's neurodevelopment and allergy disease; mercury and PCB have been shown to affect children's neurodevelopment; phthalate has effects on endocrine function; PFAS alters children's neurodevelopment, the endocrine system, and the allergic response. However, more consistent and coordinated research is necessary to understand the whole picture of single environmental and/or co-exposure and children's health. Therefore, harmonization and international collaboration are also needed in Asia.

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1. Introduction

In order to assess the consequences of prenatal exposure to environmental pollutants and identify the preventable risk factors, several large-scale birth cohort studies have been conducted worldwide

(<http://www.birthcohorts.net/>). Birth cohort studies are those which begin at or before the birth of their subjects, and continue to study the same individuals at later ages, on more than one occasion. Birth cohort studies are a type of observational study in which there is no randomization to exposure classes or attempt to manipulate the exposure. The fetal programming hypothesis illustrated that external maternal malnourishment during pregnancy leads to lifelong, continuing adaptation of the fetus, which in turn results in low birth weight, increased cardiovascular risk, and non-insulin dependent diabetes in adult life (Barker et al., 1989). Developmental Origins of Health and Disease

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(DOHaD) hypotheses posit that prenatal threats including environmental exposures are the origin of all disease and may impact human development (Heindel et al., 2015).

In recent years, air pollution (Lim et al., 2012), arsenic contamination of groundwater in Bangladesh (Mukherjee et al., 2006), melamine events leading to the concern of phthalates exposure may occur through food ingestion, air inhalation, and direct dermal contact with various types of products (Gossner et al., 2009; Wang et al., 2009; Chen et al., 2008), and the Fukushima Daiichi Nuclear Disaster (Yasumura et al., 2012) have aroused public attention in Asia. Birth Cohort Consortium of Asia (BiCCA) was established in 2011 to address these issues (<http://www.bicca.org/>). The BiCCA includes 23 birth cohorts, totaling approximately 70,000 study subjects, which conducted studies in 10 Asian countries. Over the last decade, BiCCA has already published a series of articles about the association between environmental pollutants and children's environmental health. In previous collaboration and investigation (Kishi et al., 2016), most participating cohorts on BiCCA have measured mercury, polychlorinated biphenyls (PCB), perfluoroalkyl substances (PFAS) and phthalates concentration on participant population and half of the cohorts collected information about environmental tobacco smoke (ETS) including second hand smoke; thence, this review focuses on these five pollutants.

ETS pollutant is common issue in worldwide but the issue is often overlooked. ETS can cause diseases, disability, and even death. Globally, 40% of children have been exposed to ETS; 28% of children died from ETS in 2004 (Oberg et al., 2011). Exposed to mercury has effects on the health of fetuses and children (Ginsberg et al., 2004). Previous studies have reported levels of individual PCB, total PCB, hydroxylated PCB metabolites (OH-PCB), and total OH-PCB (Marek et al., 2013; Park et al., 2009). The incidents in Yusho, Seveso, and Yucheng increased awareness about related health effects in children (Yoshimura et al., 2001). Phthalates and PFAS are endocrine disrupting chemicals (EDCs), which may cause adverse health effects (Agay-Shay et al., 2015). Phthalates may affect the human endocrine system triggering developmental problems caused by endocrine toxicity (Katsikantami et al., 2016). PFAS with longer half-lives bind to proteins in blood serum and accumulate and circulate in the organs of human body (Jensen and Leffers, 2008). On the other hand, most Asia countries experienced rapidly industrializing development and many western companies' manufacturing factories was built in Asia resulting in unconscious industrial disposal or emerging environmental pollutants. Gene sensitivity (Jorde and Wooding, 2004), life styles, and living environment (Olesen, 2004), and unsolid regulation of environmental chemicals (Sharma et al., 2014) are different from western countries. Moreover, several studies have examined the effects of these compounds on human health in Asia; therefore, this review aims to provide a summary of the relevant literature. We included research published by groups that were not part of the BiCCA to present a comprehensive investigation of the association between exposure to environmental pollutants and related effects on health of children.

2. Methods

We used the PubMed search engine (National Library of Medicine) to search and identify relevant articles about epidemiological studies of health outcomes and environmental exposure in Asia. The keyword used included different combinations of related to pregnancy women, children health outcomes, and environmental pollutants as the following. Various keywords culled from the literature review were used to investigate population, exposure, and outcomes.

Keywords for population were: pregnancy; pregnant; birth; toddler; child; children; childhood. Keywords for Asia area were: Abkhazia; Afghanistan; Armenia; Azerbaijan; Bahrain; Bangladesh; Bhutan; Brunei; Cambodia; China; East Timor; India; Indonesia; Iran; Iraq; Israel; Japan; Jordan; Kazakhstan; Kuwait; Kyrgyzstan; Laos; Lebanon; Malaysia; Maldives; Mongolia; Myanmar; Nagorno-Karabakh; Nepal;

Northern Cyprus; North Korea; Oman; Pakistan; Palestine; Philippines; Qatar; Saudi Arabia; Singapore; South Korea; South Ossetia; Sri Lanka; Syria; Taiwan; Tajikistan; Thailand; Turkey; Turkmenistan; United Arab Emirates; Uzbekistan; Vietnam; Yemen.

Keywords for exposure were: tobacco smoke; biomass smoke; second hand smoke; heavy metal; mercury endocrine disruptor; persistent organic pollutant; polychlorinated biphenyl (PCB); organochlorine compound (OCs); hexachlorobenzene (HCB); perfluoroalkyl substance (PFAS); perfluorinated compound; perfluoroalkyl acid; perfluorooctane sulfonate (PFOS); perfluorooctanoate (PFOA); and phthalate.

Keywords for outcomes were: birth outcome; birth weight; fetal growth; birth size; preterm birth; gestational duration; gestational length; birth defect; congenital malformation; neurodevelopment; cognition; autism; attention deficit hyperactivity disorder; allergy; asthma; wheeze; lung function; bronchitis; pneumonia; respiratory tract infection; immune system; postnatal growth; obesity; body mass index; waist circumference; dyslipidemia; lipids; cholesterol; triglycerides; diabetes; insulin; glucose; hypertension; blood pressure; endocrine function; puberty; and pre-puberty.

The literature search covered a period extending through January 31, 2017 with no other restrictions on the date of publication. We included articles that investigated prenatal/maternal, in utero exposures, or postnatal childhood exposure. All articles were based on birth cohort studies and published in the English language.

Articles investigating co-exposure to other environment pollutants were included in the present study. Ultimately, exposure to five compounds was investigated. Children's health outcomes were classified to one of four categories: fetal growth and pregnancy outcome, neurodevelopment and behavioral problems, allergic disease and immune function and endocrine function and puberty. Fetal growth and pregnancy outcomes included birth weight, birth length, head circumference, and gestational age by questionnaire and physical examination. Information related to all outcomes was collected by questionnaire and physical examination.

3. Environmental tobacco smoke (ETS)

Table 1 shows that association between ETS exposure, fetal growth and pregnancy outcomes, neurodevelopment and behavioral problems, and allergic disease and immune function. Birth weight was the common measurement on all cohorts, and ISAAC questionnaire was used by three cohorts, but neurodevelopment and behavioral questionnaires varied from different birth cohorts.

3.1. Fetal growth and pregnancy outcomes

Five birth cohort studies explored the association between ETS and birth weight. Two studies investigated the association between ETS and birth weight including the genetic effects. The results of a study conducted on 1388 newly married mothers of liveborn singletons in Anqing, China showed that 2 maternal metabolic genes, cytochrome P-450 1A1 (CYP1A1) MspI and epoxide hydrolase 1 (EPHX1) Tyr113His were involved in the association of self-reported passive smoke exposure during pregnancy and infant birth weight (Wu et al., 2007). Another study explored 1784 native Japanese mother-child pairs from Hokkaido study. The results showed that maternal 5,10-MTHFR C677T polymorphism was independently associated with improvement in infant birth weight among nonsmokers. However, 5,10-MTHFR 1298AA might be associated with folate impairment and could be also associated with ETS exposure during pregnancy on reducing infant birth weight (Yila et al., 2012). Two studies on ETS also explored the effects of active smoking on birth weight and gestational condition. Miyake et al. (2013) reported that maternal smoke during pregnancy increased the risk of a child being born small for gestational age (SGA) and decreased birth weight (Miyake et al., 2013). Using data from a national birth cohort in Taiwan (N = 21,248), Ko et al. (2014) found that maternal smoking

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