



The impacts of secondhand smoke on future generations and the responsibility of society as a whole to protect the well-being of our future descendants

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Hypertensive disorders of pregnancy (HDP) continue to be a leading cause of maternal and neonatal mortality and morbidity globally. HDP can not only affect the prognosis of both the mother and infant, but it can also have trans-generational effects on the infant's offspring. The developmental origins of health and disease (DOHaD) approach investigates how conditions during fetal development and early life, such as malnutrition and smoking during the perinatal period, can influence the development of chronic noncommunicable diseases (NCDs) later in life. Epigenetic modifications are regarded as a key mechanism that contributes to the early programming of NCDs, including cardiovascular disease (CVD) and hypertension. Based on DOHaD, low birth weight and preterm birth, which are major adverse neonatal outcomes of HDP [1, 2], are regarded as predisposing factors for hypertension and CVD. Women with a history of low birth weight and preterm birth have an increased risk for HDP [3]. A study from Denmark found that the risk of hypertension during pregnancy tended to increase in both women born following small-for-gestational-age and those born preterm, with odds ratios (ORs) of 1.8 (95% CI 1.1–2.8) and 1.5 (95% CI 0.96–2.5), respectively [3]. In addition, low birth weight and preterm birth are risk factors for chronic hypertension in middle age [4, 5]. A meta-analysis of 14 observational studies found that the hazard ratio for hypertension among infants with a birth weight less than 2.5 kilograms compared to those with

a birth weight greater than 2.5 kilograms was 1.30 (95% CI 1.316–1.46) [4]. These findings suggest that HDP increases the risk of low-birth-weight infants being born, and these infants are associated with a higher risk of HDP and chronic hypertension in later life, which can be transmitted to subsequent generations. Mechanisms underlying the increased risk of hypertension in individuals with low birth weight include a decrease in nephron number, increased vascular resistance, changes in arteriole density and narrowing of arterioles during microvascular development, and epigenetic modifications [6]. Moreover, a history of HDP is associated with an elevated risk of future chronic hypertension and CVD. The Nurses' Health Study II from the US found that women with gestational hypertension in their first pregnancy had a 2.79 (95% CI 2.61–2.97) times higher HR of chronic hypertension [7]. A recent study from the UK Biobank (mean age 57.4 ± 7.8 years) also found a higher risk of coronary artery disease and heart failure in women with a history of HDP, with HRs of 1.8 (95% CI 1.3–2.6) and 1.7 (95% CI 1.04–2.6), respectively [8]. These findings are reflected in the 2018 ACC/AHA cholesterol guidelines, which recommend using a history of preeclampsia as a risk-enhancing factor for atherosclerotic cardiovascular disease (ASCVD) to strengthen statin therapy [9]. As previously noted, HDP can significantly influence the risk of hypertension and CVD in women and offspring throughout life, and this impact is transmitted across generations. However, the incidence of HDP has increased in recent decades due to advanced maternal age at childbirth in many high-income countries and an increased prevalence of overweight and obese women, particularly in Western countries. Therefore, effective interventions for HDP are urgently needed.

Both smoking and secondhand smoke (SHS) exposure have been suspected as potential modifiable risk factors for

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HDP, and several observational studies have evaluated the association between SHS and HDP [10, 11]. However, the results of previous studies have been inconsistent, and robust evidence has not yet been established. Additionally, the impact of smoking and SHS on pregnant women may vary based on genetic background/race [12], making it important to evaluate the risk of SHS in Japanese pregnant women.

Tanaka et al. used large-scale observational data from the Japanese Environment and Children's Study, comprising over 100,000 fetuses and their parents, to assess the association between SHS exposure and HDP risk [13]. They found a linear trend between SHS exposure frequency and HDP risk, even after adjusting for previously reported HDP risk factors, with relative risks (RRs) of HDP in SHS exposure of 4–7 days per week compared to rarely being exposed was 1.18 (95% CI 1.02–1.36). In addition, their study found that the population attributable fractions (PAFs) for the risk of HDP from SHS and perinatal smoking were 3.8% and 1.8%, respectively, indicating that SHS has a greater impact on the risk of HDP than the smoking habits of mothers. While the PAFs have several important assumptions that may not be true in the real world, such as the assumption that removing the exposure does not affect other risk factors (i.e. In this study, not a small number of pregnant women who are regularly exposed to SHS continue to engage in the habit of smoking during pregnancy), the exact numbers of PAFs may not be accurately accessed. However, the study can still emphasize the importance of preventing SHS exposure in pregnant women and the need for those around pregnant women and society to work together to avoid SHS.

In this context, the World Health Organization Framework Convention on Tobacco Control states that “each party shall adopt and implement, in areas of existing national jurisdiction as determined by national law, and actively promote at other jurisdictional levels, the adoption and implementation of effective legislative, executive, administrative, and/or other measures providing for protection from exposure to tobacco smoke in indoor workplaces, public transport, indoor public places, and, as appropriate, other public places.” [14]. Japan, as a party to the convention, fully implemented the revised Health Promotion Act in 2020, making most indoor public facilities and public transport smoke-free. However, this has not been fully achieved, and exposure to SHS in general facilities, businesses, and restaurants is still insufficient. In addition, SHS exposure at home remains a critical issue. While the adult smoking rate in Japan has been gradually decreasing, it is still not low enough. A survey conducted by the Ministry of Health, Labor and Welfare in 2019 found that 27.1% of Japanese men and 7.6% of Japanese women were smokers [15]. The survey also found an increase in the

percentage of adults who were exposed to SHS in the home, at 6.9% [15]. Furthermore, Tanaka et al. reported that approximately 25% of pregnant women were exposed to SHS 4–7 days per week, and around 46% of their partners continued smoking during pregnancy [13]. These numbers are alarmingly high and cannot be ignored. It is also essential to consider the effects of third-hand smoke, which is caused by cigarette smoke absorbed on clothing and in rooms (residual tobacco smoke). As SHS contains more harmful substances, including nicotine, than mainstream smoke, it is vital to raise awareness of the dangers of SHS to pregnant women and fetuses/infants, which can be transmitted to future generations through epigenetic modification, by promoting smoking cessation and smoke-free environments.

In an aging society with a declining birth rate, the protection of the health of pregnant women and fetuses/infants is of the utmost importance. However, protecting pregnant women and women of childbearing age, as well as fetuses and infants, should not be the responsibility of women alone. It is a matter for society as a whole. Therefore, it is crucial that we make further efforts to prevent SHS exposure by men and the partners of pregnant women, and by society as a whole, in order to protect our future descendants.

Compliance with ethical standards

Conflict of interest The author declares no competing interests.

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