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Review

Revisiting pesticide exposure and children's health: Focus on China

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HIGHLIGHTS

- Pesticides are widely used in China and around the world.
- There is an increasing public awareness of pesticides and child health globally.
- China is still in the early stages and few epidemiological data are available.
- We have addressed some limitations and incompletenesses from current literature.
- These deficiencies should be interpreted with caution in future studies.

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ABSTRACT

China is now becoming the largest consumer of pesticides worldwide. In recent years, there has been a heightened public awareness of pesticides and children's health in North America and around the world. Human epidemiological studies have examined the relationship of pesticide exposures with children's health such as neurodevelopment and cancer, and they reported less consistent results. With regard to this topic, however, China is still in the early stages of cross-sectional or case–control design, and few data have been available. Furthermore, we have discussed several important limitations such as study design, exposure measurement, and developmental assessment from current literature, which should be interpreted with caution. We also presented the vulnerability and source of children's exposure to pesticides.

Contents

1. Introduction

Pesticides are substances intended for preventing, destroying, repelling, or mitigating any pest. Pesticides are commonly referred to by their

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functional class, including insecticide, herbicide, fungicide, and various other substances used to control pests (US Environmental Protection Agency, 2012). China is one of the earliest countries to use pesticides. As early as in the Ming Dynasty (1378–1644 AD), the most well-known Chinese herbal "Ben Cao Gang Mu", compiled by Li Shizhen, had recorded a number of plants and minerals that used as pesticides such as veratridine, arsenolite, and lime (W. Zhang et al., 2011). Nowadays, the use of pesticides worldwide is increasing gradually as human population and food requirements increase. Meanwhile, the overuse and misuse of pesticides have become a major problem globally, especially in developing countries like China, which increase related environmental and health risks. A 2002 study for the Global Greengrants Fund revealed that as much as 40% of pesticides on the market in China are sold under false brand names (Pesticide Action Network North America, 2003). Infants and children have been identified by both the US National Research Council and International Life Sciences Institute as groups within the population who require special consideration in risk assessment because of their unique exposure patterns and special vulnerabilities to environmental hazards (Landrigan et al., 2004). Therefore, there is an urgent need for research to fill the gaps of information on exposures and health consequences of pesticide exposures to the fetus and children.

The purpose of this article is to a) revisit the pattern and amount of pesticide use in China; b) present the vulnerability and source of children's exposure to pesticides; c) summarize the epidemiological studies from North America and China regarding exposure to pesticides and children's health consequences; and d) highlight some intrinsic limitations and incompletenesses of evidence from current literature which should be taken into consideration in future studies.

2. Pesticide use in China

Worldwide, over 5.2 billion pounds of pesticides is applied each year, and roughly 85% of the pesticides currently used are devoted to the agricultural sector (Grube et al., 2011). Insecticides, herbicides, and fungicides are the most common types of conventional pesticide (Grube et al., 2011). Almost all countries make general use of the major pesticides, but they each use specific pattern of pesticides in correspondence with their typical crop. As shown in Fig. 1, 35% of the pesticide used is insecticide in China, as against 8% and 17% in the U.S. and the world, respectively. The use of herbicides and fungicides is correspondingly less heavy (Ministry of Environmental Protection of China, 2008; Grube et al., 2011). Although China has experienced a rapid urbanization transition over the past several decades, it is still a large developing agricultural country with agriculture accounting for more than 12% of the total gross domestic product (Economy Watch, 2010). In China, the majority of conventional pesticide use is dedicated to agriculture, while the remainder is used in residential, commercial, and industrial settings (W. Zhang et al., 2011). Pesticides can also be grouped by their chemical class. Among these, organochlorine (OC) pesticides such as DDT were widely used in agriculture and pest control between the 1940s and 1970s. However, concern over their persistence in the environment and tendency to bioaccumulate led the Chinese government to restrict or ban their use during the 1980s (W. Zhang et al., 2011). Consequently, insecticides such as organophosphates (OPs) and pyrethroids (PYRs) have become attractive alternatives to OC pesticides because they do not persist in the environment. In the last two decades, the use of OP pesticides has been responsible for nearly 30% of total pesticide applications nationwide (He, 2008), it indicates that OP pesticides play important roles in controlling insects, weeds, and diseases on farms and in urban landscapes. The amount of pesticide use in China has been dramatically increased in recent years (Fig. 2), and China is now becoming the largest consumer of pesticides in the world. More than 1.6 million tons of pesticides (roughly 3.5 billion pounds) are used annually in China (National Bureau of Statistics of China, 2011). However, approximately 1.1 billion pounds of pesticides were applied to the U.S. each year (Grube et al., 2011). Indeed, increasing food production has long been the priority of the Chinese government to meet food requirements for its large population. Under the adage "if little is good, more is better", many farmers overuse or improper use pesticides to get greater yields, which in turn, contribute to the excess residues of agricultural crops and the loss of agricultural land. In China, organophosphates are currently the most heavily used pesticide in agriculture whereas pyrethroids are the most common class of pesticide used in homes.

3. Children's vulnerability to pesticide

The primary benefits are the consequences of the pesticide's effects — the direct gains expected from their use. Without pesticide uses in China, the production of fruits, vegetables, and cereals would lose 78%, 54%, and 32%, respectively (Cai, 2008). Although the benefits of pesticides are well recognized, their potential adverse effects on human health remain unclear. Historically, health risk assessment focused on adult exposure and toxicity and gave little consideration to vulnerable life stages such as fetal development and early childhood (Landrigan et al., 2004). The hazard of pesticides to children's health has been the subject of great concern globally since the publication of the report "Pesticides in the Diets of Infants and Children" by the National Academy of Sciences (U.S. NAS) in 1993 (National Research Council, 1993). Evidence has shown that pesticide from the mother can readily pass through the placenta and transfer to the fetus, making the fetus susceptible to pesticide poisoning (Bradman et al., 2003). Even low-level pesticide exposure early in life, at levels that may not harm the pregnant mother, could impair infant growth and development. Fetus and young children may be more susceptible to the potentially toxic effects of pesticides, not only because their organ systems, specifically the brain and central nervous system, are developing rapidly but also because they have lower levels of

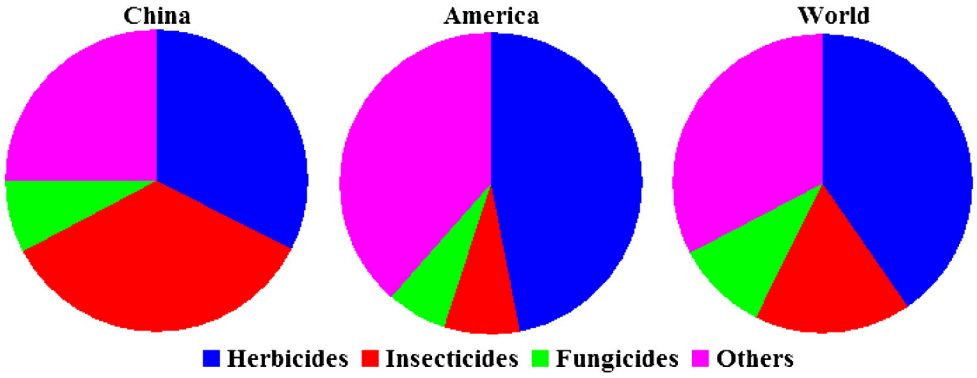

Fig. 1. Consumption pattern of pesticides (Grube et al., 2011; Ministry of Environmental Protection of China, 2008).