PESTICIDE CONSUMPTION, CENTRAL NERVOUS SYSTEM AND CARDIOVASCULAR CONGENITAL MALFORMATIONS IN THE SOUTH AND SOUTHEAST REGION OF BRAZIL

CLEBER CREMONESE1, CARMEN FREIRE1, ARIANA MACHADO DE CAMARGO2, JAIME SILVA DE LIMA3, SERGIO KOIFMAN1, and ARMANDO MEYER2

1 National School of Public Health, Oswaldo Cruz Foundation (FIOCRUZ), Rio de Janeiro, Brazil
2 Federal University of Rio de Janeiro (UFRJ), Rio de Janeiro, Brazil
3 Federal University of Rio de Janeiro (UFRJ), Rio de Janeiro, Brazil

Environment and Public Health Post-graduation Program
Instituto de Estudos em Saúde Coletiva (IESC)
Department of Biochemistry

Abstract

Objectives: To investigate the association between per capita pesticide consumption and infant mortality rates from CNS and CVS congenital malformations in microregions in the South and Southeast Region of Brazil. Material and Methods: An ecological study was conducted using data on pesticide expenditure in 1985 and 1996, and deaths caused by CNS and CVS malformations in infants under 1 year old in 1986–1990 and 1997–2001, respectively. Per capita pesticide consumption and infant mortality rates were calculated for each microregion. Microregions were grouped according to quintiles of pesticide consumption, taking the first quintile as reference. The association between pesticide consumption and infant mortality was examined by calculating Spearman correlation coefficients (r) and mortality rate ratios (RR), stratifying by gender and type of microregion (urban or rural). Results: Significant and positive correlations between per capita pesticide consumption and rates of mortality due to CNS and CVS defects were observed in rural but not urban microregions. In general, mortality RRs for the 2 types of malformations in rural microregions were significantly higher in each quintile of pesticide consumption compared to the lowest quintile in the 2 study periods, with elevations ranging between 10% and 30%. Likewise, mortality RRs in these microregions showed significant trends of increase across quintiles of pesticide consumption in both study periods. In urban areas, however, mortality RRs from both CNS and CVS malformations were weak and not statistically significant, and a trend of increase of mortality with increasing pesticide usage was not observed. Conclusions: The results show the relevance of pesticide exposure in rural areas with intense agricultural activity, suggesting that such prenatal exposures may be related with the occurrence of certain congenital defects.

Key words:
Pesticides, Congenital malformations, Central nervous system, Cardiovascular system, Ecological study

This work was partially supported by the Ministry of Health, the Brazilian National Research Council (CNPq), and the CAPES (“Coordenação de Aperfeiçoamento de Pessoal de Nível Superior”). Cleber Cremonese has a CAPES predoctoral grant, Carmen Freire has a "Jovens Talentos" grant (number A022-2013) from the CNPq (Science Without Borders Program). Jaime Lima and Armando Meyer are supported by the CNPq ("Bolsa de Produtividade em Pesquisa"). Sergio Koifman is supported by the CNPq (grant number 308986/2010-5 and INCT-Cancer Control) and FAPERJ (grant E-26/102.869/2012).

Received: October 17, 2013. Accepted: March 11, 2014.

Corresponding author: C. Freire, Environment and Public Health Post-graduation Program, National School of Public Health, FIOCRUZ, Rua Leopoldo Bulhões, 1480, CEP: 21041-210, Rio de Janeiro, RJ, Brazil (e-mail: cfreire@ugr.es).
INTRODUCTION

About 5% of newborn babies worldwide are affected by birth defects, which contribute significantly to infant mortality rates across different ethnic groups [1–3]. In the USA, birth defects are the main cause of infant mortality, being responsible for 20.1% of the total number of deaths [4]. In Latin America, congenital anomalies are responsible for 25% of pediatric hospital admissions and they represent the 3rd cause of mortality among infants in the 1st year of life [5]. In Brazil, after the decrease of deaths from infections-related diseases, infant mortality from congenital defects increased proportionally, going from the 5th to the 2nd most important cause of infant mortality [6]. Nevertheless, prevalence of birth defects is commonly underestimated due to underreporting, which is particularly high in developing countries [7,8].

Congenital anomalies of the cardiovascular system (CVS) are the most common type of serious birth defects among live births [9] and are a major cause of postnatal deaths from congenital anomalies. The most common subtypes of CVS malformations include atrial or ventricular septal defects, transposition of the great vessels, persistent truncus arteriosus, teratology of Fallot, and coarctations [10]. Malformations of the central nervous system (CNS) are the 2nd most common type of major congenital anomalies. Most CNS malformations are related to the defects of the neural tube, which usually fuses 18–26 days after ovulation. Failure of closure of the neural tube may lead to anencephaly, encephalocele, spina bifida, or spina bifida occulta. In Brazil, major birth defects represent over 70% of the total birth defects [8]. Despite the importance of these malformations, the causes of most cases of CVS and CNS malformations are not known. Etiologic factors that have been identified include genetics, maternal illnesses, dietary factors, maternal drug exposures, and maternal and paternal environmental exposures [11–13].

It is well known that the fetus is extremely sensitive to environmental exposures during certain critical windows of development [14]. Animal studies have shown that many pesticides have an impact on production, release, transport, metabolism, and elimination of hormones that regulate homeostasis and other developmental processes [15], raising concern for possible teratogenic effects among exposed human populations. Thus, numerous epidemiological studies have examined the possible association between parental exposures to pesticides and the occurrence of congenital anomalies [3,16–20]. Regarding CNS malformations, parental exposure to pesticides was associated with excess of anomalies such as spina bifida, hydrocephaly, and anencephaly in cohort and case-control studies [17,21–23]. Epidemiological evidence of a link between parental exposure to pesticides and CVS is scarcer [24–26].

Developing countries account for 1/3 of global pesticide consumption. In Latin America, Brazil is currently the most important country in pesticide usage and the 3rd largest consumer of pesticides in the world [27]. One previous ecological study in Brazil reported a positive correlation between the state pesticide use in 2000 and deaths from congenital anomalies in 2001 [28]. The present study aimed to explore the association between pesticide consumption and infant mortality caused by CNS and CVS congenital malformations in microregions of the South and Southeast Region of Brazil, using the national information systems.

MATERIAL AND METHODS

Design and study population

An ecological study was conducted to examine the association between per capita consumption of pesticides in 1985 and 1996 in microregions of the South and Southeast Region of Brazil (Figure 1) and rates of infant mortality due to CNS and CVS congenital malformations in subsequent periods, i.e. 1986–1990 and 1997–2001. The study population included all deaths among infants under 1 year