Available online at www.sciencedirect.com
SCIENCE DIRECT
Environmental Research 99 (2005) 158–163
Environmental Research
www.elsevier.com/locate/envres

Environmental pathways of exposure to DDT for children living in a malarious area of Chiapas, Mexico

Crispín Herrera-Portugal[a,*], Héctor Ochoa[b], Guadalupe Franco-Sánchez[a], Leticia Yáñez[c], Fernando Díaz-Barriga[c]

[a] *Universidad Autónoma de Chiapas, Facultad de Ciencias Químicas, Laboratorio de Toxicología Ambiental, Km. 2 Carretera a Puerto Madero, CP 30700, Tapachula, Chiapas, México*
[b] *El Colegio de la Frontera Sur (ECOSUR), México*
[c] *Facultad de Medicina, Universidad Autónoma de San Luis Potosí, Unidad Pediátrica Ambiental, México*

Received 13 July 2004; received in revised form 24 February 2005; accepted 7 March 2005
Available online 18 April 2005

Abstract

Considering that DDT was used for control of malaria vectors in Mexico, and taking into account that the information regarding children in areas exposed to DDT is scarce, we started a research program for the assessment of health effects in children living in DDT sprayed areas. In this first report, we present information about pathways of exposure in two communities with a different history of exposure to DDT. Environmental pathways such as outdoor soils, indoor soils and household dust were assessed comparing a community highly exposed to DDT (HEC) and a community less exposed to DDT (LEC). Also in these communities, a cross-sectional study of 60 children (30 in each community) aged 6–12 years was conducted. Tests included a questionnaire and the measurement of whole blood DDT and DDE. Results show that in children living in the HEC, DDT and DDE mean blood levels were higher (15.9 ± 8.2 and 58.2 ± 29.2 μg/L) than in the LEC (1.9 ± 3.6 and 9.2 ± 5.7 μg/L) ($P < 0.01$). Concentrations of DDT, DDE and DDD in indoor soil were higher in the HEC (10.3 ± 10; 4.9 ± 5.8; and 4.4 ± 9.1 mg/kg) than in the LEC (0.3 ± 0.3; 0.04 ± 0.06; and 0.03 ± 0.04 mg/kg) ($P < 0.001$). Similar results were obtained for outdoor soils; in the HEC, levels for DDT, DDE and DDD were 3.1 ± 3.0; 1.0 ± 0.8; and 0.3 ± 0.2 mg/kg; whereas levels in the LEC were 0.16 ± 0.2; 0.02 ± 0.03; and 0.02 ± 0.03 mg/kg ($P < 0.001$). High concentrations of DDT, DDE, and DDD were obtained in samples of indoor dust collected from the walls in the HEC (17.5 ± 10.0; 5.5 ± 6.2; and 9.8 ± 16.8 mg/kg); levels in the LEC were lower (0.6 ± 0.9; 0.07 ± 0.1; and 0.05 ± 0.07 mg/kg) ($P < 0.001$). We did not find any correlation between blood levels of DDE and total DDT with environmental concentrations but there levels increased in LEC and HEC as the frequency of fish consumption increased ($P < 0.01$).

Keywords: DDT; DDE; DDD; Children

1. Introduction

DDT is an organochlorine insecticide available in different presentations, including aerosols, dustable powders, emulsifiable concentrates, granules, and wettable powders (WHO, 1979). Commercial formulations of DDT normally consist of 77% $p'p'$-DDT, 15% $o'p'$-DDT, 4% $p'p'$-DDE, and less than 1% $o'p'$-DDD, $p'p'$-DDD, and $o'p'$-DDE (WHO, 1979). DDT is very persistent in the environment, with a reported half-life of approximately 15 years, and is immobile in soils. Breakdown products in the soil environment are DDE and DDD, which are also highly persistent and have similar chemical and physical properties (ATSDR, 2002).

In 1945, DDT was used for the first time in Mexico for the control of Malaria (Stapleton, 1998); and an extensive program started in 1956 (Fernández De Castro, 1988). The use of DDT in the control program

*Corresponding author. Fax: +52 962 6262461.
E-mail address: cportugal@prodigy.net.mx (C. Herrera-Portugal).

0013-9351/$ - see front matter © 2005 Elsevier Inc. All rights reserved.
doi:10.1016/j.envres.2005.03.010

was abandoned in the year 2000, when it was substituted by pyrethroids (Caballero, 2001). The insecticide was widely used in many communities of Mexico, and due to its persistence, it can now be found in different environments such as sediments of tropical coastal lagoons (Carvalho et al., 2002; González-Farías et al., 2002; Noreña-Barroso et al., 1998), soils (Yáñez et al., 2002), and food (Albert., 1996; Waliszewski et al., 1997). Furthermore, in DDT sprayed areas, several studies have reported high levels of DDT and its metabolites in human tissues such as milk (Torres-Arreola et al., 1999; Waliszewski et al., 1996), blood (López-Carrillo et al., 2001; Yáñez et al., 2002), and adipose tissue (Rivero-Rodríguez et al., 1997; Waliszewski et al., 2000; Waliszewski et al., 2001). All this information has recently being reviewed in Díaz-Barriga et al. (2002).

Exposure to DDT is a health risk factor, as in humans, DDT has been related to inmunosuppression (Svensson et al., 1994; Vine et al., 2001); reproductive effects (Rylander et al., 1996; Longnecker et al., 2001); shortened duration of lactation (Gladen and Rogan, 1995); neurological and behavioral effects (Miersma et al., 2003; Dorner and Plagemann, 2002); and genotoxicity (Rabello et al., 1975; Yáñez et al., 2004). Furthermore, DDE, a DDT metabolite, was shown to modulate immune responses in exposed children in the Arctic (Dewailly et al., 2000; Dallaire et al., 2004), there is a need to decrease the exposure in children, and thus, the identification of those pathways of exposure relevant for children is a critical issue in high risk areas (sprayed areas).

Taking into account that the information regarding children in areas exposed to DDT is scarce, we started a research program for the assessment of health effects in children living in DDT sprayed areas. In this first report, we present information about pathways of exposure in two communities with a different history of exposure to DDT.

2. Methods

2.1. Communities

These were selected according to their history of DDT spraying and in agreement with information obtained from Mexican authorities in the Health and Agriculture Ministries. We studied a highly exposed community (Cigüeña) with a history of using DDT from 1957 to the year 2000, both for the control of malaria and for agricultural control; and a low exposed community (Faja de Oro) which has a history of domestic DDT spraying from 1957 to 1980. This community is not located in an agricultural area. Both locations are situated in the State of Chiapas, Mexico, and they are classified as communities with a high level of margination (CONAPO, 2000). The parameters considered in the construction of this index were: academical level, housing conditions and income (CONAPO, 2000). It is important to take into account that among housing conditions, dwellings had dirt floors and wood walls. Whereas 850 inhabitants live in La Cigüeña, 1200 people live in Faja de Oro.

2.2. Soil and dust

Both communities were divided into a 70 m grid and 10 dwellings located in the center of the grid were selected for the study. Indoor samples were obtained next to the walls of children's bedrooms, a composite sample of four individual samples being obtained in each dwelling. Also, a composite sample was obtained outdoors; in this case, the four separate samples (from each cardinal point) were collected from around the dwelling, again in areas next to the walls. Dust samples obtained from the bedroom walls were also collected. Soil and dust samples were transported to the laboratory in glass containers and kept under refrigeration (4 °C) until analysis.

2.3. Population

The exposed children (aged 6–12 years) were 30 volunteers selected from the community of La Cigueña; who have lived there since they were born, and for comparison, samples were collected from 30 children living in Faja de Oro, which was considered the less exposed community. The characteristics of both groups are depicted in Table 1. All children had a similar ethnic and socioeconomic background (low income Mexican indigenous). The study was performed between June and December 2003.

Children were not paid to be in the study, they were recruited at random among those families living in the selected dwellings (see above) and that accepted to participate after attending information meetings in the

Table 1
Comparison between children who are residents of high and low exposure communities

	Low exposure $N = 30$	High exposure $N = 30$
Age (years)	8 (2)	10 (2)
Lactancy duration (months)	8 (6)*	14 (10)
Sex		
Female (%)	47	53
Male (%)	53	47
Fish consumption (days in a week)	0.63 (0.41)*	3.76 (1.40)

Mean values (standard deviation). (*) $P < 0.001$.