

Exposure of young children working on Mexican tobacco plantations to organophosphorous and carbamic pesticides, indicated by cholinesterase depression

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Abstract

Background Organophosphorous (OP) and carbamic pesticides are used in large quantities on tobacco plantations in Nayarit State, Mexico, where up to 3000 children and their families work. OP and carbamic pesticides are easily inhaled or absorbed through the skin and children may be particularly vulnerable to pesticides because of their smaller body mass, their height and more regular hand- mouth contact. The aim of this study is to assess the effect of pesticide exposure on acetylcholinesterase levels of very young migrant Mexican tobacco workers and younger siblings.

Methods Blood samples were collected from 160 children aged 0–14 years during harvest (exposure) and from 62 children in their home communities 6–9 months after harvest (baseline). Samples were tested for cholinesterase corrected for haemoglobin and ambient temperature.

Results Fifteen per cent of children had depression scores ranging from –40% to 190% of their baseline levels. Thirty-three per cent of children had depression scores of at least 15% and 86% of children were anaemic.

Conclusion These results suggest that very young children are exposed to potentially harmful and toxic amounts of pesticides while working. Further research is needed to assess the actual acute and chronic health impacts of such exposures.

Keywords

anaemia, child labour, developing countries, epidemiology, pesticide

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Introduction

In Mexican tobacco plantations large quantities of organophosphorous (OP) and carbamic pesticides are used routinely. During harvest the industry is dependent on migrant labourers and their families, including children who help their parents to boost the family's income. From as young as 5 years of age children help their parents pick, thread and hang the tobacco leaves. Infants and young children also accompany parents while they work, and risk exposure from playing on contaminated ground and from hand-mouth contact (Carlson 2005).

Organophosphorous and carbamic pesticides depress levels of acetyl cholinesterase (AChE) which can lead to neurological impairment (Eskenazi *et al.* 1999; Cocker *et al.* 2002; Kwong 2002; Carlson 2005). With no clear biomarker for these pesticides, blood cholinesterase levels are used as a proxy measure. Normal levels can vary by as much as 300%, so assessment of exposure is done through comparison on an individual basis with baseline levels. An AChE depression of 15% compared with baseline indicates overexposure (Cocker *et al.* 2002), 40–50% depression is associated with mild neurotoxic effects and serious effects can occur at 80% depression (Kwong 2002).

Table 1. Characteristics of sample

| | Working/exposed | | Not working/unexposed | | Totals | |
|-----------------|--------------------|------------------|-----------------------|------------------|--------------------|------------------|
| Sex (n = 160) | Female 49 (47%) | Male 21 (53%) | Female 35 (62%) | Male 55 (38%) | Female 84 (52%) | Male 76 (48%) |
| Mean age (year) | 6.6 (CI: 5.7–7.6) | | 5.5 (CI: 4.4–6.7) | | 6.3 (CI: 5.6–7) | |
| <5 | 44 (42%) | | 26 (46%) | | 70 (44%) | |
| 5–9 | 32 (22%) | | 19 (34%) | | 42 (26%) | |
| 10–14 | 37 (36%) | | 11 (20%) | | 48 (30%) | |
| Total | 104 (100%) | | 54 (100%) | | 160 (100%) | |

Pesticides are absorbed through inhalation, ingestion, and through the skin. Children may be especially vulnerable because of their smaller body mass, their physical proximity to the ground and to the tobacco plants (Quang & Woolf 2000).

The Santiago Ixcuntla region of Nayarit State, where this study was conducted, uses the threading and hanging technique to harvest and dry tobacco leaves. This involves picking bunches of green leaves and threading them, using a wide needle, onto a long piece of string. The strings of green tobacco are then hung to dry in rows 1–2 m above the ground. The families sleep and shelter from the sun under these rows of hanging tobacco leaves. Young children are of perfect height to pick the lower and middle leaves of the plant and quickly learn the threading technique, making them productive additions to the families' working team.

Tobacco is also a particularly hazardous crop because the nicotine resin which its leaves excrete can trap layers of pesticides. During harvest this resin is transferred to the pickers' hands and clothing, coating them in a thick black substance which contains the residue of up to 30 applications of agrochemicals. These are then rapidly absorbed through the skin. Farms in this region operate within the system of contract agriculture whereby they are supplied with a specified formula of seeds and agrochemicals and must agree to sell their produce back to the supplier. The multinational corporations who provide the seeds and purchase the harvested tobacco have no contractual responsibility towards their work force. Guidelines produced by some tobacco companies recommend the use of full protective equipment (goggles, gloves, mask and a disposable suit) but neither the labourers nor the small farmers who employ them can afford to pay for this equipment.

Most research on exposure to pesticides has focused on the acute or life threatening effects, as well as carcinogenic and teratogenic effects (Eskenazi *et al.* 1999). The purpose of this study was to evaluate the extent and effect of OP and carbamic pesticides exposure on cholinesterase levels of children working or accompanying working parents on tobacco plantations during the harvesting season in Mexico.

Table 2. Acetyl cholinesterase depression

| Cholinesterase depression (n = 62) | Working/ exposed | Not working/ unexposed | Total |
|---------------------------------------|---------------------|---------------------------|-----------|
| <15% AChE depression | 41 (76%) | 1 (13%) | 42 (67%) |
| ≥15% AChE depression | 8 (15%) | 3 (37%) | 11 (18%) |
| ≥40% AChE depression | 5 (9%) | 4 (50%) | 9 (15%) |
| Total | 54 (100%) | 8 (100%) | 62 (100%) |

Methods

The study was carried out in the state of Nayarit, where 80% of Mexico's tobacco is produced. Blood samples were taken from 160 children (104 working or accompanying working parents and 56 non working local children who live near the plantations) during the 1995 harvest season. Baseline (non-exposure) samples were obtained from 62 (38 girls and 24 boys, mean age 6.3 years) of the 160 children in their home communities in the Sierra region of Nayarit, 6–9 months later (54 from working children and 8 non-working). Parents also provided sociodemographic and medical information about their children (see Table 1).

Blood samples were analysed for haemoglobin and for acetylcholinesterase, the latter using the EQM OP Test Mate Kit (EQM Research Inc, Cincinnati, OH, USA). Results are given in International Units per gram of haemoglobin, corrected for ambient temperature and haemoglobin. Data were analysed using Intercooled Stata version 8.

Results

Of the 62 paired samples (exposed and baseline unexposed) 20 (33%) had an AChE depression of at least 15% of their basal rate during the period of intensive exposure (Range +32% to –190%) (see Table 2). Non-working children were more likely to have AChE depressions of more than 15%. Nine children had AChE depression rates of between 40% and 190% of their basal value during harvest. There were no significant differences in AChE depression between ages or sex. Haemoglobin measure-

Table 3. Haemoglobin and anaemia ($n = 160$) during exposure

| | Not working | Working | Total |
|--|---------------------|---------------------|---------------------|
| Anaemia | 95 (90.5%) | 55 (98.2%) | 149 (93%) |
| Mean levels of haemoglobin during exposure | 9.5 (CI: 2.21–9.77) | 9.3 (CI: 8.94–9.68) | 9.42 (CI: 9.2–9.64) |

ments were carried-out as part of the necessary correction process and these showed that 93% ($n = 149$) of the children were anaemic, defined as <9.5 mg/L for infants, <11 mg/L for children aged 12–24 months and <12 mg/L for >2 years (see Table 3). There was no correlation between AChE depression and levels of haemoglobin. Normal childhood illnesses were reported by parents, including respiratory tract infections, gastroenteritis and nausea, but there was no significant association between illness and levels of AChE depression.

Discussion

The study is limited by a small sample size and reliance on parental recall for health, which may underreport real levels of illness. Nevertheless, the study raises important issues which need to be corroborated with further research.

Firstly, the levels of cholinesterase depression found suggest that some children may be absorbing toxic amounts of OP and carbamic pesticides. A study of Yaqui children from an agricultural region in Northern Mexico where pesticides are routinely used, found statistically significant differences in stamina, gross and fine eye co-ordination and 30 min memory between exposed and unexposed children (Guillette *et al.* 1998), but did not link neurological ability with any clinical measurement of pesticide exposure. The nine children in this study with AChE depression scores of $\leq 40\%$ could be expected to display mild to serious neurological impairments.

Second, in our study there was no difference between AChE depression levels in working and non-working groups. This suggests the problem may be greater than originally anticipated, spreading beyond the children and adults who work on plantations to local people affected by generalized environmental contamination, including contamination of drinking water from pesticide run-off (as was the case in Guillette's study).

Third, the children in this study are very young, and toxic exposure at such a young age could cause permanent neurological damage (Eskenazi *et al.* 1999). Fourteen of the children who accompany working parents were infants, exposed to pesticides on a daily basis.

Fourth, the prevalence of anaemia in this study is very high and much higher than Mexican norms: national prevalences are quoted at 28% in urban under fives, and 30% in rural populations (Villalpando *et al.* 2003). A study among workers in grape

gardens in India concluded that pesticide exposure was probably affecting the production of red blood cells (Patil *et al.* 2003). But a nutritional aetiology is likely to be implicated in the children in our study, given the lack of association with levels of AChE depression and the fact that the basic diet of these children consists of corn tortillas. Further research examining red blood cell parameters in exposed children is necessary to establish aetiology.

In Mexico the massive use of pesticides is a serious public health concern and an area where more research is necessary. Pesticide awareness programmes have been initiated, but protective clothing and bottled drinking water are beyond the reach of these poor families. Reducing the use of pesticides is another approach and organic farming is growing in popularity. The underlying issues of child labour and the dependence of poor families on children's income, can only be addressed through income-generating schemes, which enable the family to survive without requiring their children to work.

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