

Acute pesticide poisoning in Ecuador: a short epidemiological report

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Abstract

Aim The aim of this paper is to analyze the epidemiological pattern, the occupational background and the public health problems of acute pesticide poisoning in Ecuador. This is the first report of its kind.

Subjects and methods This was an observational and retrospective study performed with data from 2001 to 2007 from the National Register of Hospital Admissions/Discharges from the *Instituto Nacional de Estadísticas y Censos*, and also with data from the Ministry of Public Health. Ecuador does not have an official public medical poisoning registry or disease-specific registries.

Results The complete register reported 44,931 cases of poisoning with an average of 6,418 cases per year and a global progressive increase of 2,123 cases in the entire

period. It reported 14,145 cases of pesticide poisoning. Of these, 10,100 cases were due to the effects of the insecticides organophosphate and carbamate. The number of cases by gender was 7,102 (50.21%) males and 7,043 (49.79%) females. The major age group affected was adolescents and young adults.

Conclusion In Ecuador, pesticide poisoning occurs in individuals of both sexes who are between 15 to 25 years old and work in adverse conditions as agricultural farmers. The poisoning especially occurs in flower and banana plantation workers throughout the country. Seventy-one percent of the cases are due to organophosphate and carbamate poisonings, which cause death in 4% of the cases; 57% die in the first 48 h, possibly because of the acute action of AChE inhibitors. The long-term effects of pesticides are still unclear and need further research.

Keywords Ecuador · Poisoning · Epidemiology · Occupational disease · Exposure

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Introduction

The aim of this paper is to analyze the epidemiological pattern, occupational background and the public health problems of pesticide poisoning in Ecuador. This report covers a 7-year period with national data information; it is the first report of its kind.

According to the United Nations Environment Program (Goldmann 2004), pesticides are designed to kill, reduce or repel insects, weeds, rodents, fungi and other organisms that can threaten public health and national economies. Pesticide poisoning is a serious health problem that disproportionately affects infants and children, who may be at higher risk than adults from pesticide exposure because of their rapidly developing physiology, unique behavioral patterns and interactions with the physical environment

(Handal et al. 2007a, b). In Ecuador, a remarkable increase in acute poisonings has been seen, especially compared to former studies (Brito et al. 1998, 2000; González-Andrade et al. 2002). Comparatively, the current cases seem to be having a major impact on the health of our community, provoking particular concern from the health authorities. (Harari et al. 2004; Orozco et al. 2009).

Acute poisoning with pesticides is a global public health problem and accounts for many deaths worldwide every year, even though there are no reliable estimates of how many people per year suffer from pesticide-related health effects. The majority of deaths occur because of exposure to organophosphates, organochlorines and aluminium phosphide (Goel and Aggarwal 2007). It has been observed through the years that poisonings affect specific groups, such as farm workers, especially those working in the flower industry (Colosio et al. 2003).

The problem of poisoning is made worse because of the cumulative effect of other factors such as the socioeconomic and demographic factors, including lower education and greater poverty levels, and the use of local indigenous languages, which restrict the workers' access to complete health care (Cole et al. 2000). Therefore, prevention should now be one of the government's health priorities (Cox and Sorgan 2006). It is important to note that Ecuador is a largely agrarian country exporting bananas, flowers and shrimp. These products require vast amounts of pesticides for their production, and the mechanisms to control the use of pesticides, although they exist, are not fully implemented.

Furthermore, pesticides constitute the largest group of poisonings in Ecuador, and their effects on the population have been described widely, as shown below. Pesticide poisoning can cause focal neurological and developmental toxicity (Bjørning-Poulsen et al. 2008), affect the neurological system (Cole et al. 2007), and cause peripheral neuropathies (Grandjean et al. 2006), dermatitis (Handal et al. 2007a), neurological and behavioral deficits in school children (Orozco et al. 2007), toddlers and infants (Handal et al. 2007b), and affect pregnancies (Handal et al. 2008). Also, outcomes related to specific workers, locations and products, such as farmers in the Amazon (Hurtig et al. 2003), banana farmers on the Ecuadorian coast (Matamoros and Vanrolleghem 2001) and farmers working to eradicate malaria (Roberts et al. 1997), have been described. However, the most affected group is the flower workers in the highlands of the Andes (Taylor 2006; Breihl 2007).

Subjects and methods

Type of study This is an observational, retrospective study that evaluates the pesticide poisonings reported in Ecuador

from 2001 until 2007. This is currently the only public information available with national coverage.

Source of information The data are from the National Register of Hospital Admissions/Discharges of the *Instituto Nacional de Estadísticas y Censos*, INEC (INEC 2009) and the Ministry of Public Health, MSP (WHO c2007). The INEC register is national, run and funded by the Government. The register's information is provided mainly by the centers and hospitals belonging to the Ministry of Public Health (MSP, 2009), which covers the entire country and includes public maternity clinics, children's hospitals and general hospitals, which gather the information locally. The register has been extensively used in previous epidemiological studies. However, Ecuador does not have an official public medical poisoning registry or disease-specific registries.

Study variables The selected variables are listed in Chap. XIX of Injury, Poisoning and Certain Contrasting Consequences of Outside Causes of the International Classification of Diseases (WHO 2007). As an additional measure, duplicate records were excluded from the database to take account of the readmissions registry. This is a comprehensive analysis that studies toxic groups with similar effects without detailing specific subgroups or substances.

Statistical analysis We calculated the prevalence rate of 10,000 admissions with 5,462,700 registered admissions/discharges and an overall prevalence rate of 10,000 inhabitants.

Results

The complete register reported 44,931 cases of poisonings with an average of 6,418 cases per year and a global progressive increase of 2,123 cases in the entire period. The overall prevalence rate of poisonings was 82.25 of 10,000 admissions/discharges. The period analyzed was the 7 years between 2001 and 2007. This document reports 14,145 cases of pesticide poisonings; of them, 10,100 cases were due to the effects of organophosphate and carbamate insecticides (71.40%). The prevalence of pesticide poisoning was 25.89 of 10,000 admissions/discharges. Table 1 shows the distribution of cases of pesticide poisoning by year. The most common cause of intoxications in Ecuador was the toxic effect of pesticides, with organophosphates occupying first place. Table 2 shows the distribution of pesticide poisoning by type and year.

Table 3 shows the distribution of poisonings by subgroups of age, and Table 4 shows the distribution of mortality by type of poisoning, overall death before to 48 h and after 48 h of hospitalization. The gender variable remained

Table 1 Distribution of cases of pesticide poisoning by year

Code	Pathology–ICD 10	Year							
		2001	2002	2003	2004	2005	2006	2007	Total
T60	Toxic effect of pesticides: all types	15,11	1,996	1,816	2,188	2,150	2,224	2,260	14,145
	%	10.68	14.11	12.84	15.47	15.20	15.72	15.98	100

Prevalence rate: 25.89 of 10,000 admissions/discharges

constant between both genders with a modest increase in the men; the distribution of the number of cases by sex was 7,102 (50.21%) males and 7,043 (49.79%) females. The major age group affected by poisoning was that of adolescents and young adults between 15 to 25 years old.

Discussion

Limitations of this study

This study has at least four limitations in connection with the findings. First, this report does not specify the severity of each poisoning; it analyzed the crude information without thoroughly analyzing each clinical setting. This limits the usefulness of these data for health-care planning and justifies carrying out broader studies on this issue. Second, it was not possible to determine how much of the variation was attributable to risk factors, and the sources of the diagnoses used in each case influenced the prevalence of some of the poisonings. This varies across the hospitals and provinces in Ecuador. In some cases, the limitations are greater, and clinical experience is still the main criteria of diagnosis.

The findings in this report represent a conservative estimate of the number of cases of poisoning each year across the nation. These data are only an estimate for poisonings that would be higher in some cases if based on systems that contain other sources of ascertainment. Fourth, these national estimates represent minimum estimates for

the impact of these poisonings, because even those surveillance systems with active case findings do not achieve 100% ascertainment. Finally, some of the most common cases could be underrepresented and could not be included because identification of these conditions depends on referral patterns and access to and use of diagnostic procedures that change from one hospital to another.

Pesticide poisoning

The prevalence of pesticide poisoning in Ecuador was 25.89 per 10,000. In comparison, studies in developed countries have demonstrated annual incidence rates of pesticide poisoning of agricultural workers to be as high as 1.82 per 10,000 (Calvert et al. 2004), showing a significant difference. Worldwide, developing countries suffer 99% of the deaths from pesticide poisoning even though they use only 20% of the world's agrochemicals. A primary problem is the improper use and handling of pesticides. Safety is further hampered by the illiteracy and poverty that prevails in most farming communities in developing countries.

Pesticides classified as extremely or highly hazardous by the FAO and WHO, including those banned in other countries, continue to be used in developing countries. Many farmers in developing countries continue to be exposed to pesticides because of storing them in or near their residences, and inadequate or unsafe handling practices.

There is evidence of a gradual increase in the number of cases of occupational disease caused by pesticides. This is a critical public health problem because it shows that there

Table 2 Distribution of pesticide poisoning by type and year

Code	Poisoning	2001	2002	2003	2004	2005	2006	2007	Total	%
T60.0	Organophosphate and carbamate insecticides	1,137	1,472	1,318	1,552	1,497	1,540	1,584	10,100	71.40
T60.9	Plaguicides	173	213	193	268	228	255	223	1,553	10.98
T60.4	Rodenticides, Thallium	74	149	177	177	189	227	193	1,186	8.38
T60.3	Herbicides and fungicides	111	125	99	140	209	181	197	1,062	7.51
T60.8	Other plaguicides	6	20	15	14	10	10	33	108	0.76
T60.2	Other insecticides	9	9	8	16	10	7	18	77	0.54
T60.1	Halogenated insecticides	1	8	6	21	7	4	12	59	0.42
		1,511	1,996	1,816	2,188	2,150	2,224	2,260	14,145	100.00

Table 3 Distribution of poisonings by sub-groups of age

Age	Toddlers and children 1–4	School-age children 5–9	Middle-school children 10–14	Adolescents 15–19	Young adults 20–24	Adults 1 25–34	Adults 2 35–44	Adults 3 45–55	Adults 4 55–65	Seniors + 65	Total
N=	1,572	375	992	3,077	2,607	2,578	1,387	796	374	387	14,145
%	11.11	2.65	7.01	21.75	18.43	18.23	9.81	5.63	2.64	2.74	100

have been no control or prevention programs, or sufficient resources, and the country does not have established policies to protect workers. In the last 15 years, the abandonment of several traditional agro-exports, like coffee, cocoa and cotton, and the openness to non-traditional products with high capital investment, such as flowers and timber products with high worldwide demand, have caused a quick deterioration of ancient agricultural practices, traditional farms and indigenous folk communities because of the aggressive expansion of agro-industries. In this context, social and cultural relations in the country have experienced a radical transformation. This has increased the consumption of farm pesticides sold for floriculture in Ecuador since 1998, with a substantial increase in the use of active chemicals.

Pesticides by type

The most frequent source of pesticide poisoning was organophosphate and carbamate pesticides, with 10,100 cases (71.40%) causing 4% of total deaths; 57.1% of the patients died in the first 48 h of hospitalization as a consequence of acute effects. Inhibition of acetylcholinesterase (AChE) is generally accepted to be the most important acute toxic action of organophosphate compounds, leading to an accumulation of acetylcholine followed by dysfunction of cholinergic signaling.

The impact of long-term exposure to AChE-inhibiting organophosphate and carbamate pesticides on the systemic health of agricultural workers remains unclear in Ecuador, but the long-term consequences seem mainly to affect the

respiratory system. Exposure is usually multichemical, and, in many cases, no biomarkers are available. The effects of low-level, long-term exposure to pesticides, pesticide products and related chemicals have been of concern recently. They have a wide range of health effects including mutagenic effects and being carcinogens or probable carcinogens, endocrine disrupters and toxic to the reproductive system, and being neurotoxic substances, with the organophosphate pesticides as a group being the focus of interest of a great deal of medical research.

Organophosphates are used as insecticides for agricultural and domestic use, but they are also used as nerve agents in warfare and terrorist attacks. Carbamates are also a group of reversible acetylcholinesterase inhibitors that could potentially cause cholinergic crisis, leading to death, similar to the action of organophosphate poisoning. Other important manifestations are intermediate neurotoxic syndrome and delayed polyneuropathy.

Occupational aspects

Poisoning in Ecuador has a strong occupational component related to farm work in flower and banana plantations in the villages. The poor labor conditions of the workers are the primary reason for this type of poisoning. Therefore, they become an acquired problem that is preventable and that is caused by the minimal health conditions of the farm workers.

The register does not contain information about the location of the exposures, but indicates that the poisonings in this study occurred in the workplace. Concerning the

Table 4 Distribution of mortality by type of pesticide, cases by type, death before 48 h and after 48 h of hospitalization

ICD-10	Type of pesticide	N ₁	N ₂	%	<48h	%	>48h	%
T60.0	Organophosphate and carbamate insecticides	10,100	408	4.04	233	57.1	175	42.9
T60.3	Herbicides and fungicides	1,062	66	6.21	32	48.5	34	51.5
T60.4	Rodenticides, Thallium	1,186	7	0.59	4	57.1	3	42.9
T60.8	Other plaguicides	108	1	0.93	0	0.0	1	100.0
T60.9	Plaguicides	1,553	38	2.45	27	71.1	11	28.9
	Other causes	136	n/a	n/a	n/a	n/a	n/a	n/a
	Total	14,145	520		296		224	

N₁ = cases by type; N₂ = number of fatal cases; n/a: data not available

nature of the exposure, it seems to be mostly unintentional. In addition, it seems that in Latin America, compared to other areas such as Asia, the incidence of voluntary poisoning is low, mainly because of strong religious beliefs concerning suicide, even when there is easy access to pesticides in and around the domestic environment in rural areas. This analysis could not eliminate cases of intentional poisonings at the victim's home. This issue requires further specific and deeper studies for clarification.

Gender issues

The ratio of male to female cases is almost the same, showing a slight difference between genders. Furthermore, the new living conditions in the countryside and additional workload have caused particular problems for the women. With the transformation of rural women into workers, the old patriarchal dependency relationships have been replaced by labor relations and commercial work with destructive impacts on the cultures of communities. This situation is directly related to working on flower plantations in the Ecuadorian highlands and banana plantations along the coast. This sociological issue needs to be analyzed more deeply in future research.

Age issues

Agricultural workers start their jobs at a young age and thus begin to be exposed to pesticides and harmful substances early in life. Farm workers are usually young, with vitality and adaptability to the demands of working overtime, high productivity and performance, and a demanding pace. They have adequate levels of training to be able to farm and have a low level of participation in the indigenous peasant organizations.

The neurological development of children living in the poor communities in the region is affected by the reduced incomes, malnutrition, and parental deficiencies concerning their formal education. Parenting skills are weakened by chronic exposure to pesticides. Another risk group is toddlers and children of 1 to 4 years, who are affected in 12.93% of the cases. Mothers working in the cut-flower industry during pregnancy may develop problems associated with delayed neuronal behavioral development in children aged 3–23 months. Possible hazards associated with working in the flower industry during pregnancy include pesticide exposure, exhaustion and job stress. This study could not identify the reasons, but the main reason seems to be that children are not constantly cared for by their mothers, who usually have to work. Access to child care centers is limited, and there are often numerous children to take care of at home. We need further research to ascertain the precise problems.

Public health concerns

The study of poisoning is intricate and requires further precise and specific analysis for each specific case. This means that priorities must be set for clinical studies on particular populations. The facts are not sufficient to establish direct causal relationships.

However, this is the first overview of poisonings covering a long period of time, in this case 7 years. The study indicates that there is an urgent need for the health authorities to establish preventive and restorative measures and create study groups to monitor various diseases. Furthermore, human and laboratory resources are insufficient for establishing diagnoses, and this may interfere with identifying cases of poisoning. The World Health Organization (WHO) recently developed a tool that standardizes the definition of cases of acute poisoning and contributes towards improving the estimates of the incidence of pesticide poisoning.

Despite the intensive use of pesticides, official records regarding poisoning are limited to acute cases and are almost nonexistent for cases of chronic poisoning. Hospitalizations resulting from toxic exposures to these chemicals can be reduced by the implementation of public health measures, such as prevention and environmental remediation.

It should be emphasized that today the majority of poisonings are an occupational problem, especially for the children who have been affected and probably already have some kind of disability. It is also necessary to strengthen the laws regulating pesticide use and to implement immediate measures to curb the problem. Also child labor practices need to be reformed. Much work still needs to be done concerning pesticide poisonings in Ecuador.

Conclusion

In Ecuador, pesticide poisoning occurs in individuals of both sexes between 15 to 25 years of age working in adverse conditions as agricultural farmers; it often occurs in flower and banana plantation workers throughout the country. Seventy-one percent of the cases are due to organophosphate and carbamate poisonings, which cause death in 4% of the cases; 57% die in the first 48 h, possibly because of the acute action of AChE inhibitors. The long-term effects of pesticide poisonings on the people of Ecuador are still unclear.

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Conflict of interest None declared.

Ethical approval Not required as the study was a retrospective analysis of a database.

Contribution of the authors All authors contributed equally to the conception, design, analysis and interpretation of the data, drafting the article and further revision of this paper.

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