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Acute poisoning with pesticides in the state of Mato Grosso do Sul, Brazil

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Abstract

Exposure to pesticides has been the source of many acute and chronic health problems in the rural population, mainly in developing countries. The objective of this study was to characterize the poisonings from acute exposure to agricultural pesticides used in the state of Mato Grosso do Sul, Brazil, from 1992 to 2002, which were reported to the Integrated Center of Toxicological Vigilance of the State Health Department. A total of 1355 involuntary (accidental or occupational) and voluntary (intentional self-poisoning) cases were reported during the period of the study. The majority of the poisonings occurred with men ranging in age from 15 to 49 years of age (55.1%). One hundred seventy-six poisonings lead to death, with a case fatality rate (CFR) three times higher than the average Brazilian CFR. The pesticide poisoning rates, per 100,000 inhabitants living in rural areas, ranged from 25 to 65.7 during the period of the study. In 2000, the micro-region of Campo Grande, where the state capital is located, had the highest rate, with 100.5 exposure/100,000 inhabitants, followed by Dourados, the larger agricultural region of the state. Insecticides were involved in 75.7% of the poisoning cases, followed by herbicides, with 12.2% of the cases. The anticholinestherase insecticides methamidophos, carbofuran and monochrotophos were the primary pesticides involved in the poisonings. The insecticide dimethoate was associated with the highest CFR (30.8%). The high rates of pesticide poisoning in the rural populations of certain regions of the state of Mato Grosso do Sul indicate the need for a more detailed study concerning the risk of pesticide poisoning among these populations.

Keywords: Pesticide poisoning; Rural population; Mato Grosso do Sul, Brazil

1. Introduction

The use of pesticides in food production is extensive around the world and their irrational use poses a threat to both human health and the environment. Mainly, the unprotected use of pesticides in the field by farmers during mixing, loading and application to

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crops can cause acute poisonings, in addition to the development of various diseases from chronic exposure (Stokes et al., 1995; Smit et al., 2003). Non-occupational exposure can also occur with residents from areas of high agricultural activity, including children, due to pesticide drift from the field (Azaroff and Neas, 1999; CDC, 2003).

The latest estimate by WHO (1990) indicated that there might be as many as 1 million involuntary poisonings worldwide each year and 2 million people hospitalized for voluntary ingestion of pesticides. Although the unsafe use of pesticides represents a human health problem in both developed and developing countries, the latter are more affected. Based on a survey of self-reported minor poisoning in Asia, it was estimated that there could be as many as 25 million agricultural workers in the developing world suffering an episode of pesticide poisoning each year (WHO, 1990). The reasons for the high rates of pesticide exposure in developing countries are many, including the lack of an effective regulation system, poor labeling of pesticides, illiteracy and insufficient knowledge of pesticide hazards and the high costs of protective equipment (WHO, 2004a; Oliveira and Toniato, 1995; Maumbe and Swinton, 2003). Even if available, protective garb used under tropical conditions in some countries are uncomfortable and it is unlikely to be used by the farmers. In addition, small-scale farmers in developing countries use a larger amount of the most toxic pesticides due to lower retail prices of these compounds (WHO, 2002, 2004a; Maumbe and Swinton, 2003).

Brazil is the 3rd largest consumer of pesticides in the world, with over 300 million tons of formulated products in 2001, placing 8th in use per ha (Fairbanks, 2001). Annually, over 5000 cases of poisoning with agricultural pesticides are reported officially in the country (SINITOX, 2004). While the ingestion of medicinal drugs accounted for the majority of poisonings reported between 1997 and 2001, pesticide exposure was the most common cause of death after poisoning (SINITOX, 2004).

The state of Mato Grosso do Sul (MS), in the central-west region of the country, has an economy based on livestock and agriculture, primarily of cotton, soybeans, sugarcane and wheat. This study investigates the reported cases of acute human poisoning by agricultural pesticides in the state between 1992 and 2002. The aim was to characterize the individuals, the circumstances and the pesticides involved in the cases, in addition to identifying the main regions in the state which might be at higher risk for pesticide exposure.

2. Methods

Data on poisoning with agricultural pesticides in the state of Mato Grosso do Sul, Brazil from 1992 to 2002 were obtained from the Integrated Center of Toxicological Vigilance of the State Health Department (CIVITOX/MS). Trained personnel at the Center received information (by telephone, 24 h/day and 7 days/week) on the poisoning cases from treating doctors or other trained health professionals from the public and private medical system of the State. Case reporting was not mandatory before June 7, 2001. The information received was manually compiled into a “report card”, and included the date of poisoning, pesticide involved, sex, age and address of the individual, circumstance of poisoning and occurrence of death. Only cases of exposure to pesticide that resulted in clinical symptoms were reported to the Center. Some report cards contained no data for some required information. The pesticides were reported either as the commercial name or the active ingredient. For this study, data from the report cards were transferred to an Epi-info/2000 computer program for analysis.

Poisoning data at the national level were obtained from the National System of Toxic-Pharmacological Information (SINITOX, 2004). The SINITOX receives data from 32 Centers of Toxicological Vigilance in the country, covering 17 states. The database available covers the period from 1997 to 2001, and includes data from CIVITOX/MS for 1999 and 2000, but not for 2001. Data for 1997 and 1998 did not specify the states in which the data were collected. Information did not include the pesticides involved in the poisonings. In both MS state and national data sources, poisonings with pesticide that occurred domestically were reported separately and were not included in the study.

Data on rural populations of the state of Mato Grosso do Sul and Brazil were obtained from the Brazilian Institute of Geography and Statistic

(IBGE, 2004). As no data were available for the years of 1994 and 2002, the rural populations of the state for each of these years were estimated from a logarithmic regression from data available within the period of the study ($r=0.60$).

3. Results and discussion

3.1. The profile of the poisonings

A total of 1355 cases of poisonings by involuntary (occupational or accidental) or voluntary exposure (intentional self-poisoning) to agricultural pesticides occurring in the state of Mato Grosso do Sul (MS) from 1992 to 2002 were reported, with an average of 123.2 poisonings/year. Five hundred six cases were due to voluntary exposure, from which 139 lead to death (27.5%). Only 37 involuntary poisonings were fatal. In 1999 and 2000, the number of poisoning due to pesticide in the state, corresponded, on average, to 6.9% of all poisonings which occurred in the state during these years (1371 and 1511, respectively; SINITOX, 2004).

Most of the poisonings from pesticide exposure in MS occurred among men from 15 to 49 years of age (55.1% of the occurrences with this information) (Fig. 1), reflecting the primary work force in the country rural activity. However, children from 5 to 14 years old (6.6% of the cases) might also have been exposed during labor. According to the Brazilian Institute of Geography and Statistic (IBGE, 2004), 58.7% of the children within this age range living in agricultural areas in the country in 2001 were involved in agricultural activities. Accidental exposure and poisoning involving individuals of all ages not directly involved in labor work can be related to factors such as inappropriate storage of the pesticides, access to contaminated equipment and dust and pesticide drift from spray application in the field (Azaroff and Neas, 1999). Children may also be poisoned when playing close to the field or following their parents during spraying operations (WHO, 2004b).

Table 1 shows a comparison between the occurrence of pesticide poisoning reported in the state of MS and in the country, these later data being obtained from the National System of Toxic-Pharmacological Information (SINITOX, 2004). Although, in average, MS accounts for only 2.4% of the poisonings with pesticides of agriculture use in Brazil, the case fatality rate (CFR, number of deaths relative to the incidence of poisonings, expressed in percentage) in the state (13%), due to involuntary and voluntary exposure to pesticides, was over 4 times the mortality in the country as a whole. The case fatality rate in the state of MS is close to the rate found in Sri Lanka (15%), but much higher than in the United Kingdom, which

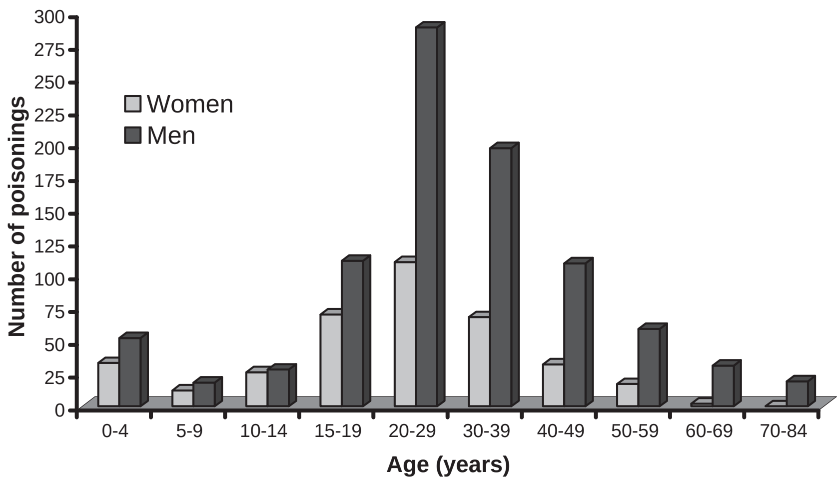

Fig. 1. Sex and age of individuals reported to be poisoned by agricultural pesticide use in the state of Mato Grosso do Sul, from 1992 to 2002. For 72 cases, age and/or sex of the individuals were not reported.

Table 1
Poisonings with agricultural pesticide in the state of Mato Grosso do Sul (MS) and in Brazil

	MS (1992–2002)	Brazil[a] (1997–2001)
Total poisonings (number/year)	123.2	5185.4
CFR (%)	13.0	3.0
Intentional self-poisoning (number/year)	46.0	1627
% of total cases	37.3	31.3
CFR (%)	27.7	9.1

[a] SINITOX, 2004; CFR: case fatality ratio = number of deaths/number of poisonings.

was found to be <1% (Roberts et al., 2003). While the percentages of intentional self-poisonings related to all occurrences with agricultural pesticides are comparable in the state and nationally (Table 1), the CFR from intentional self-poisonings was 3 times higher in MS than nationally (27.7% and 9.1%, respectively).

Pesticides are the second most common substance used in intentional self-poisoning in Brazil (SINITOX, 2004) and were involved in 30% of all suicides in India in 1999, 71% in Sri Lanka from 1980 to 1989 and 62% in China from 1998 to 2000 (WHO, 2004a). An exploratory, case-control study conducted in Canada did not confirm the hypothesis of a biologically plausible link between exposure to pesticides and intentional self-poisonings among farm operators (Pickett et al., 1998). However, some studies have shown an association among exposure to pesticides with symptoms of depression, an important factor often linked to suicide attempt (Faria et al., 1999; Stallones and Beseler, 2002).

3.2. The rate of the poisonings

The poisoning rates with agricultural pesticides in the state of MS during the period of the study, considering the rural population, is shown in Fig. 2. The highest rate occurred in 1995, with 65.7 poisonings/100,000 and the lowest in 1996 and 1997. In 1996, no poisonings were reported during 5 consecutive months. The pattern of no reports during consecutive months was not found in the other years, so it is possible that in 1996 the information system from the health system to the CIVITOX/MS may have been interrupted during a certain period. Although reporting of pesticide poisoning became mandatory in the state after June 2001, the poisoning rates decreased 26.3% from 2000 to 2002.

Total Brazilian rural population is available only for the year 2000 (IBGE, 2004), and a comparison of poisoning rates at national and state levels was possible for this year. In 2000, 5127 poisonings due to exposure of agricultural pesticides were reported to have occurred in Brazil (SINITOX, 2004), with a rate of 19.4/100,000 inhabitants living in rural areas. This was lower than the incidence found in the same year in the state of MS (34.2 poisonings/100,000 inhabitants). Fig. 3 shows the pesticide poisoning rates in year 2000 in Brazil and in the micro-regions of MS, located in the central-west region of the country. The southeast region had the highest poisoning rate that year (40.6/100,000 inhabitants) in Brazil. In the state

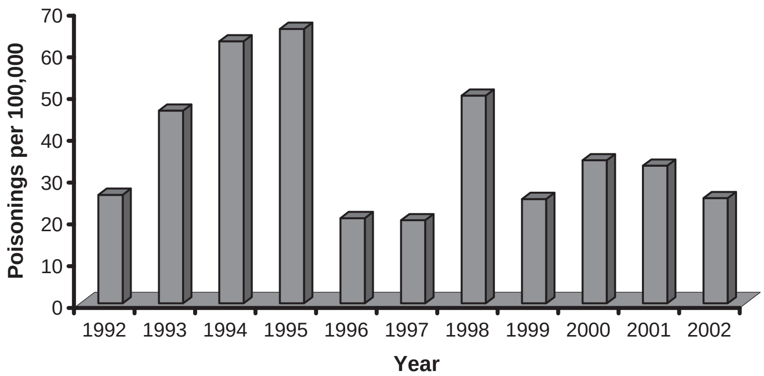

Fig. 2. Evolution of pesticide poisoning rates, per 100,000 inhabitants, considering the rural populations in the state of Mato Grosso do Sul.

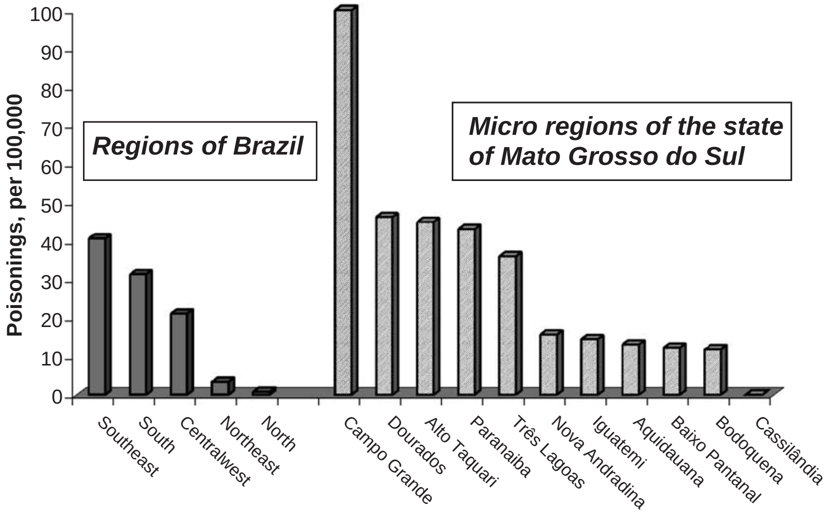

Fig. 3. Distribution of pesticide poisoning rates, per 100,000 inhabitants living in rural areas, in Brazil and Mato Grosso do Sul, in the year 2000.

of MS, the micro-regions of Campo Grande, Dourados, Alto Taquari and Paranaíba had the highest rates, which were also higher than the southeast region of the country. The micro-region of Campo Grande showed a rate more than twice the rates in the state and in the country (100.5/100,000 inhabitants).

In reality, the poisoning rates in Brazil are highly underestimated due to under reporting. According to the Brazilian Ministry of Health, for each reported poisoning, another 50 were not reported (Oliveira-Silva and Meyer, 2003). The reasons for under reporting are known. In some areas of the country, people suffering from acute poisoning may lack access to medical care and may not even report the illness to the medical system (WHO, 2004a; Oliveira-Silva and Meyer, 2003). The symptoms of pesticide poisoning maybe similar to other heath problems, such as skin rash or mild gastroenteritis, so the link to pesticide exposure may not be clear even to health professionals. In addition, the recording of causes of poisoning in the hospitals and the information system from the hospitals to the Center of Toxicological Vigilances, even when mandatory, are not always efficient (Oliveira-Silva and Meyer, 2003).

The micro-region of Campo Grande places 6th in size of agricultural areas within the state of MS, mainly dedicated to soybeans, vegetables and fruits (IBGE, 2004). This micro-region encompasses the capital and the most populated city in the state (Campo Grande) and the rural population accounted for only 1.2% of the region's total population in 2000 (IBGE, 2004). The micro-region of Campo Grande has the best structured health system in the state and the CIVITOX/MS was located in the capital during the period of the study. Furthermore, it is reasonable to presume that under reporting level in the region was low, compared with the other regions within the state, partially justifying the higher rate of poisoning with agricultural products in such an urban area.

On the other hand, the micro-region of Dourados, which had the second highest poisoning rate in 2000 (46.2/100,000), is the largest crop producer in the state (42.6% of the total production; IBGE, 2004). The region did not possess, during the period of the study, a well structured notification system and it is possible that under reporting had underestimated the number of poisonings. Dourados is also the second largest region for cotton production in the state, crop that consumes 78% of all insecticide commercialized in the country (Fairbanks, 2001). Cassilândia, the larger cotton producer in MS (over 40 thousand tons in 2000; IBGE, 2004), had the lowest poisoning rate within the state, $<1/100,000$ inhabitants (Fig. 3).

The two major cotton regions growing within the state, however, have farming practices that might partially explain the wide range of poisoning rates.

While 62% of the farms in Dourados region are classified as small farms (<50 ha), Cassilândia has mostly median and large properties (85% of all farms) (IBGE, 2004). In general, the level of pesticide application technology on small farms is low and costal sprayers are still used by growers. Manual equipments result in imprecise spraying, substantial drift and leaking of pesticides during operation, what favor human exposure to pesticides. The authors have witnessed a farmer saturated with pesticide solution after a manual spray operation in the northwest region of the country. In addition, small growers have less access to technical information and hazard information concerning the use of pesticides (WHO, 2004a). Faria et al. (1999) also found that the risks of poisoning by pesticides in the south of Brazil was higher on small farms compared with larger farms, which used more advanced pesticide application technology.

Other studies conducted in Brazil have shown that rural populations might be exposed to pesticides at critical levels. In the state of Rio de Janeiro, in the southeast of the country, inhibition of blood cholinesterase, a biological marker for exposure to organophosphate and carbamate insecticides, was found in individuals reporting symptoms such as headache, abdominal pain, anxiety and insomnia (Peres et al., 2001). In a study conducted in the southern region, 39.4% of the potato producers reported health problems after the application of pesticides and 31.5% were hospitalized due to the exposure (Agostinetto et al., 1998). In Mato Grosso do Sul, one study conducted in the micro-region of Dourados in 1990 indicated that 81% of the farmers had poisoning symptoms typical of pesticide exposure, including muscular and head pain, weakness and nausea (Gonzaga and Santos, 1991). To date this is the only published study on pesticide poisoning conducted in the state.

3.3. The pesticides involved

From the reports investigated in this study, 1231 (90.8%) cited the class of the pesticide involved in the poisonings, and 908 cited the products or the active ingredients (74 different compounds). Insecticides were involved in 1026 of the poisoning cases. The organophosphorus insecticides methamidophos (171 cases), monochrotophos (81 cases) and malathion (61 cases), and the *N*-methyl carbamate carbofuran (96 cases) were the most frequent pesticides involved (Table 2). These compounds are called anticholinesterase insecticides as they inhibit the nervous tissue enzyme acetylcholinesterase, responsible for the inactivation of the neurotransmitter acetylcholine (Ecobichon, 1996). The organophosphorus insecticides (OP) are known to inhibit acetylcholinesterase almost irreversibly, and in most cases, are more toxic than the carbamates (Ecobichon, 1996). OPs have also been described as the primary pesticides involved in poisonings in many countries (Roberts et al., 2003; Sherwood et al., 2002; Teixeira et al., 2004).

Table 2
Pesticides reported to be most involved in poisoning cases in Mato Grosso do Sul, from 1991 to 2002[a]

Active ingredient	Involuntary (occupational or accidental)		Intentional self-poisoning		CFR[b] (%)
	Cases	Death	Cases	Death	
Insecticide[c]	735	15	291	47	6.0
Methamidophos	107	1	64	19	11.5
Carbofuran	84	3	12	1	4.1
Monochrotophos	45	4	36	14	22.2
Malathion	35	2	26	2	6.5
Dimethoate	5	0	8	4	30.8
Aldrin	15	2	32	0	13.3
Cypermethrin	33	1	6	1	5.1
Chlorpyrifos	20	1	12	1	6.2
Endosulfan	11	0	6	4	23.5
DDT or lindane	5	0	3	0	0
Others or not reported	375	1	86	1	–
Herbicide[d]	117	5	48	5	6.0
2,4 D	17	1	2	0	5.5
Glyphosate	36	1	11	0	2.1
2,4 D+picloran	30	2	11	4	14.6
Trifuralin	16	0	1	0	0
Paraquat	2	0	4	1	16.6
Picloran	4	1	0	0	25.0
Others or not reported	12	0	19	0	–
Fungicide	17	0	0	0	0
Other classes	11	1	12	0	–

[a] 1231 cases with pesticide classification reported, 908 cases with active ingredient reported; only 73 out of the 176 fatal cases with active ingredient reported.

[b] Case fatality ratio for each compound, from involuntary or voluntary exposure.

[c] Includes 40 occurrences with association with other pesticides or ant killers.

[d] Includes 4 occurrences with association of fungicides or insecticides.

The OPs were among the most lethal compounds involved in the occurrences (Table 2), with case fatality ratios (CFR) from involuntary and voluntary exposure reaching 30.8% (dimethoate). These compounds were also the pesticides of choice in intentional self-poisonings (28.8% of the cases), with an average CFR for this type of exposure of 27.4%. The CFRs shown in Table 2, however, should be interpreted with caution. In 103 of the 176 fatal poisoning cases, including 93 intentional self-poisonings, the active ingredient involved was not reported. While methamidophos, carbofuran and monocrotophos, classified by WHO (2002) as highly hazardous (Class Ib), had CFRs ranging from 4.1% to 22.2%, dimethoate, a moderately hazardous compound (Class II), had the highest calculated CFR (Table 2). Other than the toxicity of the compound, many factors affect the outcome of an acute poisoning, including the degree of the exposure and the time between the exposure and medical care.

Methamidophos and monocrotophos are approved and commonly used on many crops in Brazil, including cotton, soybeans and wheat; carbofuran is registered for cotton and wheat (ANVISA, 2004). These are the main crops grown in the state of MS. In Sri Lanka, the withdrawal of registration of anticholinesterase insecticides has greatly decreased the number of deaths due to pesticide poisoning. However, the switch in agricultural practices to using the moderately toxic insecticide endosulfan brought poisoning level to previously, until this compound was also banned in 1998 (Roberts et al., 2003). Indeed, endosulfan was also among the main compounds involved in the poisonings reported in MS, with a CFR of 23.5% (Table 2).

Aldrin, DDT and lindane, persistent organochlorine insecticides (OC) banned in Brazil for agricultural use in 1985 (ANVISA, 2004), were also among the main pesticides involved in the poisonings (54 reports), including two fatal involuntary poisonings (Table 2). Although banned, these compounds are still used in some areas of the state (IBAMA, 2002).

Herbicides are responsible for over 50% of the Brazilian pesticide market (SINDAG, 2004), however, due to their overall lower acute toxicity, when compared with the insecticides (23.5% of the market), they represented only 13.4% of the poisoning cases. 2,4 D, glyphosate and picloran were the herbicides most frequently involved in poisonings, with 41 poisonings from the exposure to 2,4 D+picloran (Table 2). Glyphosate, the second most frequent herbicide involved in the poisonings, is classified as having low toxicity (Class IV). However, deaths following intentional ingestion and pneumonitis after acute exposure have been described in the literature (Stella and Ryan, 2004; Pushnoy et al., 1998). With the recent approval of glyphosate for use as a post-emergent herbicide in transgenic soybeans in Brazil (ANVISA, 2004), it is possible that poisonings from exposure to this compound will increase in the country.

Reported poisoning with fungicides (Table 2) involved, among others, thiram, bentazone and metalaxyl-M (Class III) and thiabendazole and captan (unlikely to present acute hazard in normal use; WHO, 2002). Other classes of compounds reported included nematicides, acaricides and fumigants. Methyl bromide, a highly acute toxic compound, responsible for one lethal intoxication (Table 2), is widely used in Brazil and other countries as a soil fumigant (ANVISA, 2004).

4. Conclusions

The pesticide market in Brazil has tripled in the past 10 years, reaching over 3.1 million US$ in 2003 (SINDAG, 2004). This increase, however, was not followed by a more intensive action from the industries and government authorities toward the enforcement of good agricultural practices in the field and by education programs to guarantee the safe use of these compounds by the farmers (Peres et al., 2001; Oliveira-Silva and Meyer, 2003).

Some authors have suggested that government restriction to the most hazardous pesticides (Class I and II) would be of great importance in reducing the number of poisoning cases and case fatalities (Roberts et al., 2003; Konradsen et al., 2003). In any case, government actions, such as educational and prevention programs, stronger regulation and a more efficient information system are essential to access and prevent poisoning from pesticide exposure.

This study has clearly shown that the agricultural population, mainly in the micro-regions of Campo Grande and Dourados, in the state of Mato Grosso do Sul, is at significant risk to pesticide exposure. These results point to the need for an in depth investigation of poisonings within this region and for the implementation of strategies that would minimize the risk of intentional and unintentional pesticide poisoning.

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