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Two health information systems to characterize poisoning in Brazil—a descriptive study

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ABSTRACT

Background Poisoning is a worldwide public health problem that involves individuals of all ages and a wide range of chemicals. This study investigated the data from two health information systems to characterize poisoning events in the Federal District (DF), Brazil.

Methods Data related to the period from 2009 to 2013 were obtained from the poison information center (Centro de Informação Toxicológica, CIT) and the Notifiable Diseases Information System (Sistema Nacional de Agravos de Notificação, SINAN) of the DF.

Results A total of 3622 cases were reported to CIT-DF and 5702 cases to SINAN-DF. Most of the cases in CIT-DF (53%) occurred with children up to 9 years old, while this corresponded to 33.9% in SINAN-DF. Unintentional poisoning was the main circumstance involved in the cases. Pharmaceuticals were the main agent (44.3–47.1% of the cases), mainly clonazepan and paracetamol, and pesticides the most fatal (2.4% fatality rate). Out of the 47 fatal cases reported to the systems, only four were reported to both; six cases occurred with children up to 6 years.

Conclusion Under-reporting and missing information were identified in both systems, but the data were complementary to describe the epidemiology of poisoning cases in the DF.

Keywords Brazil, chumbinho, Federal District, information systems, pesticides, pharmaceuticals, poisoning

Introduction

The massive expansion of the availability and use of chemicals over the past decades, including pharmaceuticals, has increased concern over human exposure worldwide. Poisoning is one of the 13 main causes of fatal deaths among adolescents of 15–19 years, and the unintentional poisoning death rates per 100 000 children and adolescents, aged 0–17 years, were estimated to be 1.8 globally, ranging from 0.5 in high-income countries to 2 in low and middle-income countries.[1] An estimated 804 000 deaths by suicide occurred worldwide in 2012, and ingestion of pesticides is considered a major method used in these events.[2] According to the National Toxicological Information System (Sistema Nacional de Informação Toxicológica, SINITOX), 105 875 human poisoning cases occurred in Brazil in 2011, from which 28.6% involved medicines.[3]

Data on poisoning and exposure in any country come mainly from poisoning information centers, which have the main function of providing information and advice concerning the diagnosis, prognosis, treatment and prevention of poisoning, on the toxicity of chemicals and other agents and the risks they pose to humans and animals.[4,5] In Brazil, the poisoning centers respond to calls related to human and animal exposure to chemicals, plants, venomous and non-venomous animals, made by health professionals from clinics and hospitals, and from the public, and to whom basic care information may be provided. The poisoning information center of the Federal District (Centro de Informação Toxicológica do Distrito Federal, CIT-DF) is one of the 34 poisoning centers in the country, which are responsible for providing data to SINITOX.[3] Another important source of poisoning data in Brazil is the Notifiable Disease Information System (Sistema Nacional de Agravos de Notificação, SINAN), developed at the beginning of the 1990s, which collects information on diseases, injuries and public health events from the public and

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private health system of ~70% of the Brazilian states and the Federal District (DF).[6] Reporting poisoning due to occupational pesticides has been compulsory in the System since 1997, covering all chemicals involved in occupational exposure since 2004, and all poison events since 2011.[6,7]

As the poisoning centers and SINAN have different objectives and mechanisms of data collection, one poisoning event might not be reported to both systems, and the data collected may vary substantially between them. This lack of a sound unified database limits the assessment of the real extent of the poisoning problem in Brazil. A detailed investigation of the data from the two sources (CIT and SINAM) can provide a more realistic picture of poisoning, indicate potential under-reporting, provide information to improve data collection and actions that could promote and prevent these events, and optimize the costs invested in the actions.

The aims of this study were to describe the data provided by two information systems to characterize poisonings involving chemicals and plants in the DF of Brazil, and to identify under-reporting in the databases. The DF is located in the Midwest region of Brazil, with a total area of 5 779 999 km^2, including the country's capital Brasilia, and a population of 2 570 163 in 2010.[8]

Methods

This is a retrospective and descriptive study related to poisoning cases in the DF during the period of 2009 to 2013 reported to two information systems, SINAN of the DF and the poisoning information center (CIT).

The SINAN data were reported by health professionals from clinics and hospitals all over Brazilian territory; they completed the Poisoning Investigation Form (PIF) and transferred the information to the online-SINAN. The SINAN-DF data considered in this study were provided by the Health Department of the DF. The PIF contains 15 categories of agents involved in the poisonings: pharmaceuticals, rodenticide, industrial chemical, food and beverage, pesticide (domestic, agricultural or public health use), veterinary drug, metals, drugs of abuse, cleaning products, cosmetics, plants, other and unknown. More than one option could be selected (multiple exposure). Additionally, the name of the product(s) (commercial or popular) and the chemical name(s) (active ingredient) could also be entered, in a free-text form.

All the data obtained from the calls received by CIT-DF were entered in an electronic system, from which the information provided in this study was directly obtained. The calls related to human cases were normally received from health professionals, and most of the information calls were performed by the general population. The drop-down agent list in the system is the same as the SINAN PIF list, in addition to venomous and non-venomous animals, which, together with food and beverage, were not considered in this study. In the CIT-DF, even if more than one agent was involved in the reported poisoning case, only the most relevant was included in the electronic system, mainly the first agent mentioned during the call, unless the clinical symptoms proved otherwise. The cases reported to the CIT were followed until the outcome was known, and were classified as exposure only or confirmed as poisoning, based on clinical symptoms and laboratory testing, when available.

Relevant information obtained from both systems included the year of the poisoning event, age of the individual, sex, exposure route, agent involved, name of the chemical or plant, circumstance (unintentional, suicide attempt, occupational, abuse, abortion, environmental, violence) and outcome of the event (fatal, cure, presumed cure, unspecified/unknown/blank). Additionally, the name and birth date of the individual and the mother's name were also obtained for the fatal cases. Variables to be investigated in the study in both databases were total poisoning cases, circumstance, agent(s) involved, age and sex of the individual and fatality. Additionally, the percent of missing data was also evaluated in each database. In this study, pesticides include those of agricultural, domestic and public health use, and rodenticides. Both databases were checked for inconsistencies, such as classifying a pharmaceutical as a pesticide or vice-versa, or imputing the circumstance of suicide attempt to a child younger than 5 years old. Duplications within each database were eliminated. This study was approved by the Ethical Committee of the Foundation for Research and Education of the DF.

Results

During the studied period, 12 303 calls were made to CIT-DF, mainly from health professionals (89.7%), especially medical doctors (81.2%). Most cases (82.6%) were related to human exposure, and 16.6% were information calls. Most of the human exposure cases were confirmed as poisoning cases, and 3622 cases of poisoning with chemicals or plants were the focus of investigation in this study. Figure 1 summarizes the data that arrived at CIT-DF during the period of the study.

A total of 5702 poisoning cases with chemicals or plants were reported to SINAN-DF. The number of cases reported increased in both systems during the period of study, mainly in SINAN-DF (Fig. 2).

The number of cases with missing data is higher in SINAN-DF, mainly related to the outcome of the event (51.8%), circumstance (29.2%), chemical or plant involved

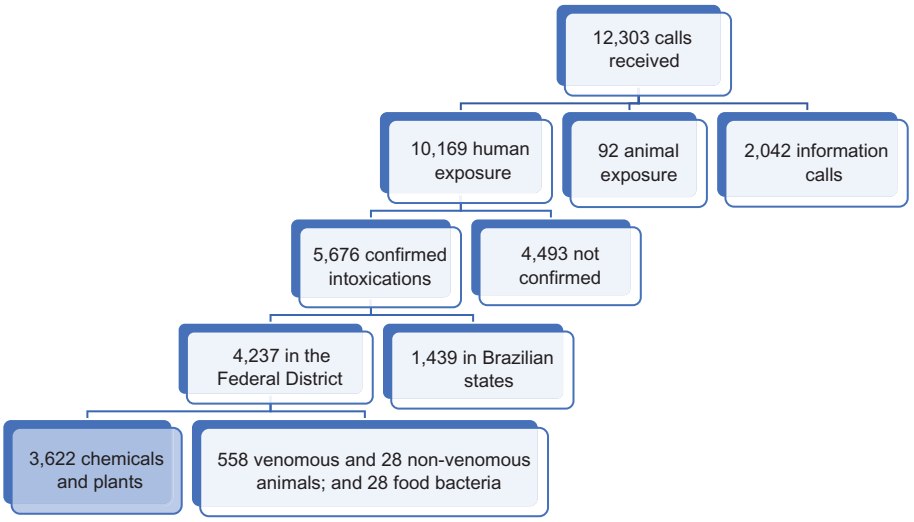

Fig. 1 Summary of the activities performed by the poison information center of the Federal District (CIT-DF) during the period of 2009–13.

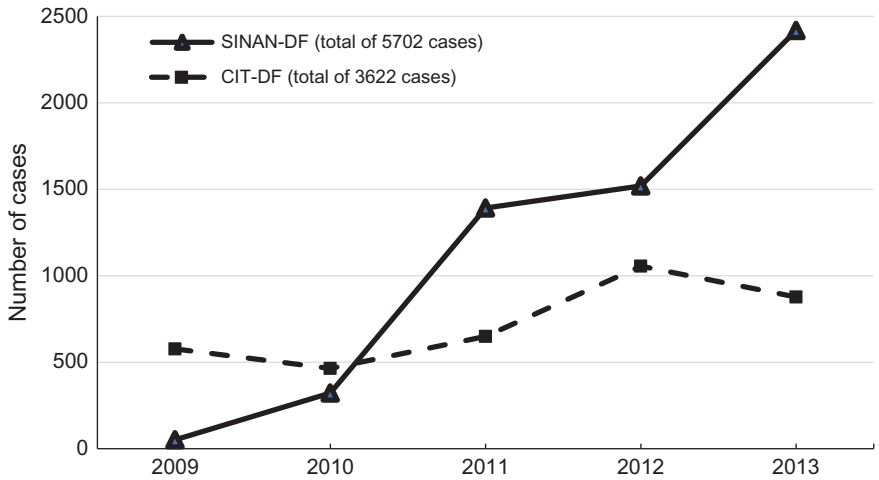

Fig. 2 Poisoning cases reported to SINAN-DF and CIT-DF during the period of 2009–13.

(17.7%), exposure route (12.6%) and agent involved (10%). In CIT-DF, the highest rate of missing data referred to the agent involved (4%). To eliminate any bias due to incomplete data, the results presented in the figures, tables and text are given in percentage of cases for which each piece of information was provided (known cases).

Figure 3 shows the profile of the cases in both systems. Unintentional poisoning (which includes therapeutic use of pharmaceuticals and prescription error) was the circumstance most involved, with a higher proportion in the CIT-DF cases (Fig. 3A). Pharmaceuticals and pesticides were the main agents, reported at similar rates to the systems (47.5 and 44.3% for pharmaceuticals and 15.9 and 16.5% for pesticides in CIT-DF and SINAN-DF, respectively). The proportions of cases involving household cleaning products, industrial chemicals and plants were higher in CIT-DF, and drugs-of-abuse cases were more important in SINAN-DF (Fig. 3B).

The distribution of the individuals' ages varied between the systems, with 53% of the cases involving children up to 9 years old in CIT-DF and 33.9% in SINAN-DF. The proportion was inverted for individuals from 15 to 49 years old, with 33.5% in CIT-DF and 54.1% in SINAN-DF (Fig. 3C). In both systems, most of the poisoning cases involved women (54.9% in SINAN and 51.4% in CIT), with females accounting for 45–47% among children, 63–65% among adolescents (10–19 years), and ~57% among adults. About 70% of the suicide cases involved women; 66–67% individuals were 20–40 years old, and 6.2–6.5% of those were 10–14 years old.

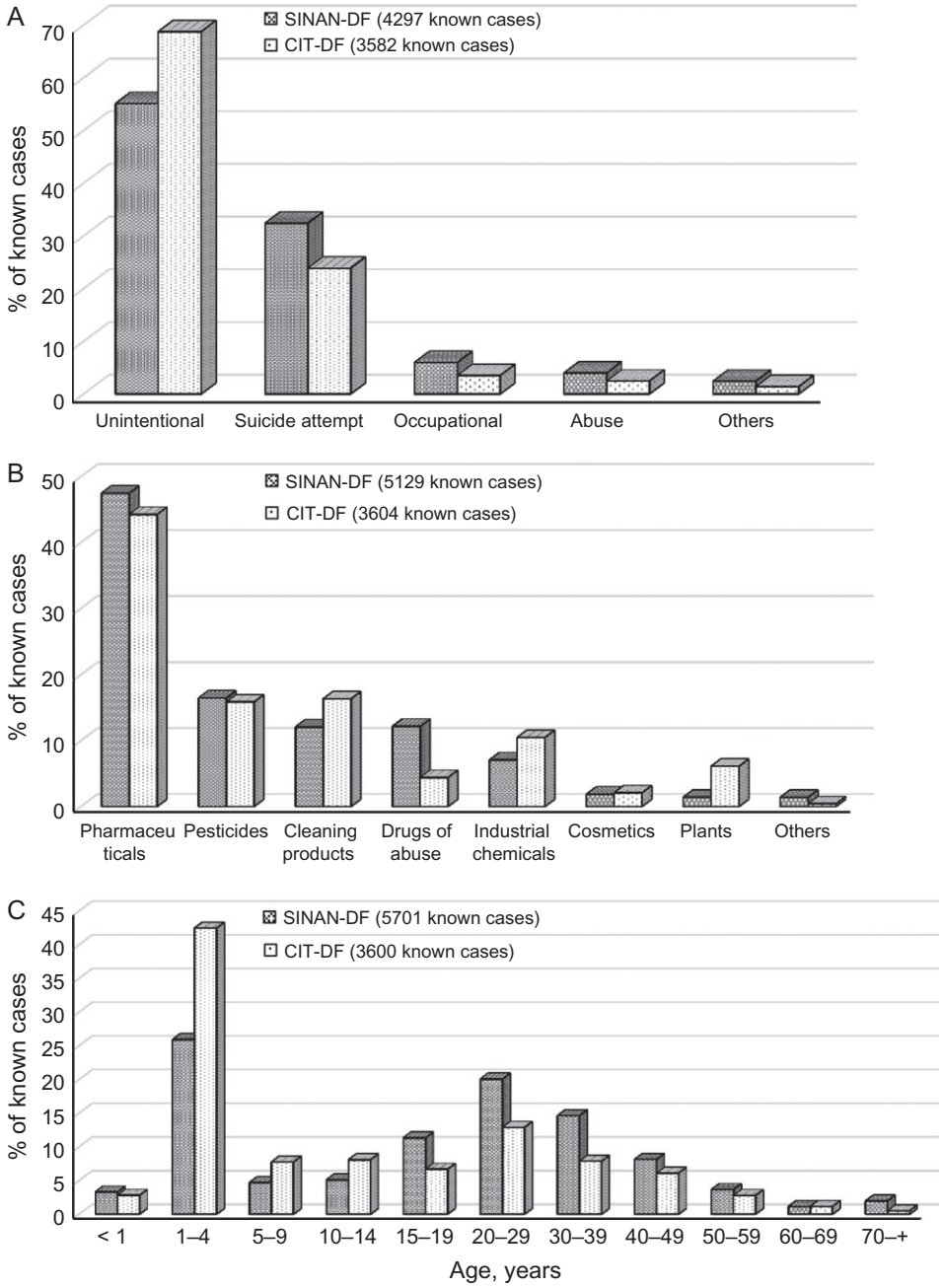

Fig. 3 Human poisoning cases in the Federal District of Brazil reported to SINAN-DF and CIT-DF from 2009 to 2013 according to the circumstance (**A**), the agent involved (**B**) and the age of the patient (**C**). Other circumstances were abortion, environmental accidents and violence. Other agents include metals (mercury, lead, arsenic, copper and thallium), veterinary drugs (mainly cypermethrin or deltamethrin) and carbon monoxide.

In CIT-DF, 66% of the pharmaceutical cases were unintentional, from which 70.8% involved children up to 4 years, and 30% were a suicide attempt (67.2% with individuals aged 20–49 years). The proportion of suicide attempts involving pharmaceuticals in SINAN-DF was higher (47.6%), with unintentional cases accounting for half of the cases with this agent.

In both databases, clonazepam and paracetamol were the drugs most reported, at a higher proportion in SINAN-DF (Fig. 4). One characteristic of this system is that many cases involving pharmaceuticals included drugs from different classes and/or other agents, resulting in a higher proportion for most drugs compared to CIT-DF. For example, 69% of the cases involving fluoxetine had an association with other pharmaceuticals, mainly clonazepam. Furthermore, 36.4% of the cases with clonazepam were associated with other pharmaceuticals and/or drugs of abuse. On the other hand,

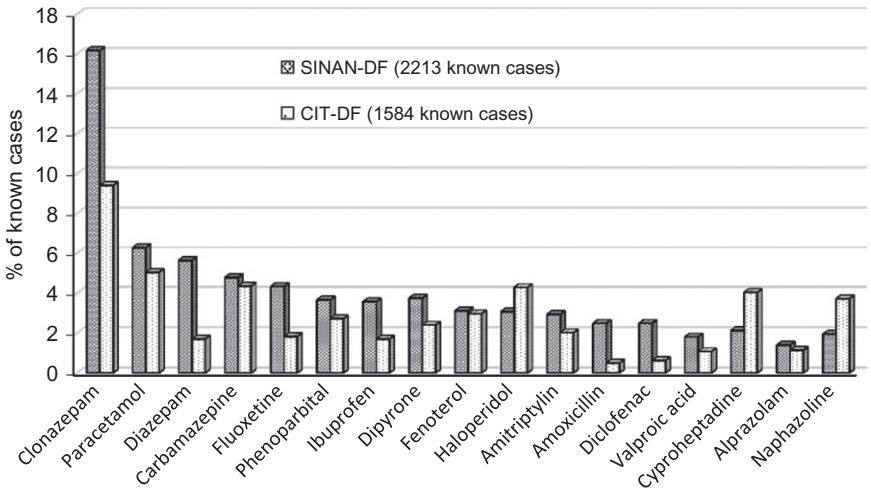

Fig. 4 The main pharmaceuticals involved in the poisonings in the Federal District, Brazil, reported to CIT-DF and SINAN-DF.

Table 1 Poisoning cases involving pesticides reported to SINAN-DF and CIT-DF from 2009 to 2013 in the Federal District, Brazil

SINAN-DF	*CIT-DF*
843 Cases[a]	572 Cases
337 Chumbinho	196 Chumbinho
200 Insecticides (40% pyrethroids, 31.5% acetylcholinesterase inhibitors)	227 Insecticides (58.3% pyrethroids, 13.2% acetylcholinesterase inhibitors)
43 Herbicides (74.4% glyphosate)	26 Herbicides (76.9% glyphosate)
55 Anticoagulants (65% brodifacoum or bromadiolone)	98 Anticoagulants (58.2% brodifacoum or bromadiolone)
194 Unknown agent	24 Unknown agent

[a]65 Associations among different pesticide classes, and with pharmaceuticals, alcohol and/or cocaine.

poisonings with haloperidol, naphazoline and cyproheptadine were more reported to CIT-DF. In ~10% of the SINAN-DF cases, the drug was not reported, while this lacuna represented 1% in CIT-DF.

Table 1 summarizes the information concerning the cases involving pesticides. Almost 8% of the SINAN-DF pesticide cases were associated with pharmaceuticals, alcohol and/or cocaine. Chumbinho, an illegal rodenticide containing mostly acetylcholinesterase inhibitors (carbamates and/or organophosphorus), was involved in over 30% of the cases in each system. Insecticides involved in the cases in both systems were mainly pyrethroids (mainly cypermethrin and deltamethrin), acetylcholinesterase inhibitors (including metamidophos, diclorvos, carbofuran and aldicarb). Glyphosate was the main herbicide involved in the cases, in addition to paraquat and 2,4 D.

Cleaning products were more important in the CIT-DF system (Fig. 3C), mostly involving unintentional cases with children aged 1–4 years. The main product in this category in both databases was sodium hypochlorite (43.7 and 37.8% of the cleaning product cases in SINAN-DF and CIT-DF, respectively). Alcohol was the main drug of abuse involved in the poisonings (66.6% of the drugs of abuse cases in SINAN-DF and 45.9% in CIT-DF). About 52% of the cases with drugs of abuse in both systems involved individuals aged 15–29 years.

Most of the poisoning with plants occurred with children up to 9 years, and the main reported species in both systems were *Dieffenbachia seguine* (an ornamental plant known as comigo-ninguém-pode) and *Jatropha sp* (gossypiifolia and curcas, known as pinhão roxo and branco/manso, respectively). Additionally, plants containing urticating trichomes, known in Brazil as pó-de-mico were reported to CIT-DF.

All cases involving children up to 9 years old in both systems were unintentional, except for one case involving an 8-year-old child reported in SINAN-DF as a suicide attempt. Table 2 shows the cases according to the agent involved. The percentage of known cases were similar in both systems for all agents, with almost half of the cases involving pharmaceuticals (~49%), followed by cleaning products (~22%).

The outcome of the poisoning was unknown in 51.8% of the SINAN-DF cases, and 18 fatal cases were reported in this system. In CIT-DF, 2.2% of the cases had an unknown outcome, and 29 fatalities were reported. In this study, all fatal cases involving alcohol and/or crack/cocaine with unknown circumstance were assumed to be unintentional, and fatalities with adults involving pesticides were considered suicide.

Most of the fatal cases in both systems involved men (56.6 and 62.1% in SINAN-DF and CIT-DF, respectively).

Table 2 Poisoning cases involving children (up to 9 years) reported to SINAN-DF and CIT-DF from 2009 to 2013[a]

	SINAN-DF, N = *1935*	*CIT-DF,* N = *1921*
Pharmaceuticals	879 (49.2)	928 (48.5)
Cleaning products	384 (21.5)	416 (21.8)
Industrial chemicals	189 (10.6)	229 (12.0)
Pesticides	161 (9.0)	175 (9.2)
Cosmetics	77 (4.3)	67 (3.5)
Plants	56 (3.1)	79 (4.1)
Drugs of abuse	7 (0.4)	9 (0.5)
Others	31 (1.7)	9 (0.5)
Unknown	151	9

[a]In parenthesis, the % of known cases.

Table 3 Fatal poisoning cases reported to SINAN-DF and CIT-DF from 2009 to 2013

SINAN-DF, N = *18*	*CIT-DF,* N = *29*
Suicide, 64.7%	**Suicide, 62.1%**
6 Chumbinho	4 Chumbinho
3 Pharmaceuticals (amitriptyline, 2 unknown)	4 Pharmaceuticals (levomepromazine, phenobarbital, carbamazepine, paracetamol)
1 Cypermethrin	7 Pesticides (cypermethrin, deltamethrin, carbofuran, metamidophos, glyphosate, 2 unknown)
1 Sodium hypochlorite	2 Sodium hypochlorite
	1 Unknown agent
Unintentional, 35.3%	**Unintentional, 31.0%**
2 Pharmaceuticals (azithromycin, paracetamol)	4 Pharmaceuticals (stanozolol, benzidamine, amitriptyline, dipyrone)
3 Drugs of abuse (2 alcohol, 1 unknown)	2 Pesticides (cypermethrin and deltamethrin)
1 Sodium hypochlorite	1 Glycerin
1 Unknown agent	2 Drugs of abuse (cocaine, unknown)
1 unknown circumstance	**Other circumstances, 6.7%**
	Homicide (chumbinho)
	Occupational (formaldehyde)

Suicide was the main circumstance involved in the fatal cases, primarily with pharmaceuticals, chumbinho, and other pesticides, in addition to sodium hypochlorite (Table 3). All children's fatal cases were male, three reported to SINAN-DF (two aged below 1 year who ingested azithromycin or sodium hypochlorite, and one with a 6-year-old child who ingested paracetamol) and three reported to CIT-DF (1–4 years, after ingestion of deltamethrin, benzydamine or dipyrone).

After cross-checking the individual information on the fatal cases (name, date of birth and mother's name), only four cases were reported to both systems, all with adults, two involving chumbinho, one involving deltamethrin and one cypermethrin. A detailed search in the SINAN-DF data with no outcome information (by the individual age, agent involved and circumstance) did not match any of the 25 fatal cases reported only to CIT-DF. Hence, at least 43 fatal poisonings occurred in the DF during the period of the study, six involving children up to 6 years.

Discussion

Main findings of this study

This study compared the poisoning cases that occurred in the DF area of Brazil and were reported to two information systems. As expected, the number of cases in SINAN-DF, to which reporting is compulsory, was much larger during the period of the study compared to those from CIT-DF, to which reporting is voluntary. However, the latter was more efficient in capturing cases occurring with children, and the fatal cases, due to the high number of cases in SINAN with unknown outcome and the active follow-up of the cases by the CIT personnel. In general, most of the poisoning cases were unintentional, involving pharmaceuticals and individuals of all age ranges, mainly women. Clonazepam and paracetamol were the main pharmaceuticals involved in the cases, and pesticides, including the illegal rodenticide chumbinho, the most fatal agent.

What is already known on this topic?

In 2011, notification of poisonings under any circumstance became compulsory in SINAN, which explains the marked increase in cases reported in this and subsequent years in the system. The SINAN legislation, which applies to all Brazilian states and the DF, requires that all health professionals and other health establishment employees report to the system the diseases or adverse health events that are listed as being of compulsory reporting, a list that is frequently updated. Poisoning was included in the list in 1997, but only related to occupational exposure to pesticides; in 2004 this was expanded to all chemicals involved in occupational exposure, and in 2011 to all poisoning events.[6,7] Calls to poison information centers are voluntary, made mainly by health professionals seeking, primarily, advice on first aid, and management of the poisoning. There was an increased number of calls to the Center from 2009 to 2012, but the reasons for the drop in 2013 are unknown. About 16% of

the calls received were information calls, a similar rate found in other Brazilian Centers.[9]

Most of the poisoning cases that occurred in the DF involved females, a similar finding to what was reported in other regions of Brazil[9,10] and in other countries.[5,11,12] Pharmaceuticals were the main agent involved in the poisonings in both systems, accounting for over 40% of the cases, similar to what was reported to CIT in Rio Grande do Sul (RS), in the extreme south of the country (45.3%).[9] Poisoning center data also indicated that pharmaceuticals were the agent most involved in poisonings in Korea (65.5%),[13] the United States (57%),[5] Israel (44.2%)[11] and Thailand (41.4%).[14] In the UK, 70% of all telephone enquiries to the TOXBASE in 2013/14 were related to pharmaceuticals.[15] On the other hand, pharmaceuticals and pesticides accounted each for ~35% of the cases reported to a South Africa poisoning center.[12]

Cases involving children up to 4 years accounted for 45.8% of all cases reported to CIT-DF, higher than the proportion reported to CIT-RS[9,16] and to SINITOX (~30%).[3] Children under 5 years of age tend to touch, test and explore their surroundings, thus coming in contact with toxic chemicals that are unsafely stored, mainly pharmaceuticals and cleaning products,[1,17] which are indeed the main agents involved in the poisoning cases with this population in the DF and elsewhere.[16–19] Poisoning with children up to 4 years old accounted for <30% of reports in SINAN-DF. One reason why CIT has a higher proportion of pediatric calls may be because poison information centers have traditionally been used for parents calling about child exposure. Furthermore, this population may also require more attention from the health professionals, who call the Center to obtain information or confirm the procedures after a chemical poisoning case.

Unintentional exposure was the main circumstance involved in the poisonings in both systems, mostly involving children up to 4 years (58 and 66% of the cases in SINAN-DF and CIT-DF, respectively). Suicide attempts were the second most frequent circumstance, with a higher percentage reported to SINAN-DF, which was expected as they occur mainly with adults. About 70% of the suicide attempts involved women in both systems, similar to what was reported to CIT-RS.[9,16] Although the global age-standardized suicide rate is higher for males than females (9.5 and 2.5 per 100 000 population, respectively, in Brazil),[2] women probably prefer to use chemicals rather than other more violent methods, such as hanging and firearms.

A recent study estimated that suicides with pesticide ranged from 0.9% of all suicide events in low- and middle-income countries in the European region to 48.3% in low- and middle-income countries in the Western Pacific region, with a higher rate in countries with a larger rural population.[20] In the DF, 24.7% (SINAN-DF) to 31.8% (CIT-DF) of the suicide attempts involved pesticides, while the rate reported by CIT-RS was 11%,[9,16] although this state is the third largest pesticide user in the country.[21]

CIT-DF data showed that pesticides were the most fatal agent in the DF during the period of the study (2.5% fatality rate against 0.5% for pharmaceuticals), higher than the rate found at the national level in 2012 (1.6%),[3] but much lower than that in RS (22.9% in 2013),[9] which correlates well with the much higher pesticide usage in the state. The fatality rates for pharmaceuticals and pesticides estimated from the SINAN-DF data (0.2 and 0.83%, respectively) are clearly underestimated due to the high incompleteness of the poisoning outcome information in this database. In Peru, data from the National Register of Hospital Admissions from 2001 to 2007 indicated a fatality rate of 3.7% for pesticides.[22]

One highly toxic product involved in the poisoning and fatal cases in the DF and other Brazilian regions is the illegal rodenticide chumbinho, widely sold in street markets around the country. This product is formulated with agricultural insecticides, mainly the carbamate aldicarb, but may also contain other carbamates, organophosphorus and cumarinic compounds.[23,24] A similar product, called tres-pasitos, was involved in various poisoning cases in the USA, brought into the country mainly from the Dominican Republic.[25]

In this study, poisoning with chumbinho accounted for ~40% of the SINAN-DF pesticide cases and 34.2% in CIT-DF, mostly after suicide attempts. The fatality rates estimated in both systems (1.8 and 2.6%, respectively) were lower than what was estimated for this product using the CIT-DF data from 2002 to 2006 (5.2%),[26] probably due to better knowledge from the health personnel on how to manage patients with cholinergic symptoms.

Clonazepam was the main pharmaceutical involved in the poisoning cases in both systems, in addition to diazepam and alprazolam, but none of the cases were reported to be fatal. Clonazepam was also the main drug involved in the poisoning cases reported to CIT-RS, accounting for ~16% of the pharmaceutical cases.[9,16] Benzodiazepines are commonly prescribed worldwide for anxiety, stress and insomnia,[27] and although they are generally considered safe, their extensive use can lead to cognitive decline and psychiatric disorders, which are a contributing factor in suicides and poisoning deaths.[28]

Paracetamol, a highly hepatotoxic compound,[29] was the second pharmaceutical most involved in the poisoning cases in both systems, including the fatal case of a 6-year-old child reported to SINAN-DF, similar to findings in Rio Grande

do Sul.[9,16] In the UK, paracetamol was the main pharmaceutical inquired about in TOXBASE (30% of the cases),[15] and accounted for ~10% of all fatal poisonings in the USA in 2014.[5]

In principle, all the poisoning cases reported to CIT-DF should also have been reported to SINAN-DF, as the source of information—clinics and hospitals of the DF—for both systems is the same, and reporting to SINAN-DF is compulsory. However, only four of the 47 fatal cases identified (8.5%) were reported to both systems, indicating a high level of under-reporting in SINAN, a conclusion that can be extrapolated to poisoning cases in general. Other studies conducted in the country have also indicated under-reporting and incompleteness of data in SINAN, either related to pesticide poisoning[30] or suicide attempts.[31] Reasons for this include a lack of knowledge among the professionals about the most updated compulsory list, and poor understanding and perception of the importance of notifying poisoning to the system.

While data from SINAN and CIT could describe the poisoning cases that occurred in the DF during the period of study, they were not sufficient to describe fatalities. In most cases, health professionals report the poisonings to SINAN before the outcome is known, and although the CIT team actively follows the case until it is closed, the number of cases in this system is limited due to the voluntary characteristic of the system. A detailed investigation into the fatal poisoning cases in the DF requires the inclusion of death certificate data, which are the basis of the Brazilian mortality information system (Sistema de Informação de Mortalidade, SIM) and the forensic reports of the medical institutes (Instituto Médico Legal, IML). This investigation showed that 338 fatal poisoning cases occurred in the DF during the period of 2009 to 2013.[32]

What this study adds?

This study offers a major contribution at the international level, as poisoning data from developing countries are limited in the literature, and to the best of our knowledge, no studies conducted in other countries have compared data from two different poisoning information systems. This comparison is available for other Brazilian regions, but was limited to a single agent (pesticides) or circumstance (suicide). The use of data from both systems was essential to describe the profile of poisoning in the DF of Brazil, although the number of fatal cases was underestimated. Improvements are needed in both systems, mainly by decreasing the rate of under-reporting and incompleteness of the data provided to SINAN, which depends primarily on better training and awareness of the personnel responsible for reporting the cases. CIT could also benefit from this process, by an increased number of telephone inquiries made to the Center. This will lead to a more accurate picture of poisoning events in the region and in Brazil, allowing the detection of pattern changes over time, and will support government actions to prevent these events and their outcomes, including death.

Limitations of this study

The high level of data incompleteness was the major limitation of this study, mainly on the outcome of the event in the SINAN-DF system, which limited the number of fatal cases found in the system, and on the name of the chemicals involved, which compromised a better description of the poisoning cases. A quantitative estimation of poisoning under-reporting on each system was not conducted, and was performed only for the fatal cases. This study did not include data from death certificates, which limited the assessment of the total number of fatal cases that occurred in the region during the studied period.

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