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Poisoning by agricultural pesticides in the state of Goiás, Brazil, 2005-2015: analysis of records in official information systems

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Abstract *The effect of pesticide use on human health is a problem that has received attention from the scientific community worldwide, especially in central countries, where the highest number of deaths due to human exposure to these agents is observed. Production and productivity increased through the progress of agro-industrialization, but risks to the environment and health were not taken into account. Over time, several cases of environmental contamination and public health problems, poisoning of rural workers, and food residues were observed. These factors triggered the recognition of risks arising from pesticide abuse. This study aimed to characterize pesticide poisonings reported to a toxicological information center of the state of Goiás through a retrospective analysis from 2005 to 2015. Data were mapped and tabulated by the purpose of pesticides, the circumstance of poisoning, and case development. The poisoning profile pointed to a higher occurrence of work- and suicide-related poisonings, with a predominance of poisoned patients, although chronic effects were not recorded, suggesting a false diagnosis of cure.*

Key words *Poisoning, Agrochemicals, Geographic mapping, Information systems, Compulsory notification*

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Introduction

Pest and disease control chemical substances were recorded in Greek and Roman writings more than 3,000 years ago[1]. In Brazil, pesticides were introduced and organized, accompanied by technological packages that implanted large-scale mechanization, associated with other production factors through state financing pre-established expenditure (30% of the financing should be spent on insecticides, and 20% on herbicides). Thus, the objective was to promote territory upgrade through field modernization (agroindustrialization), to ensure higher production and productivity, without considering risks to the environment and health.

Several cases of environmental contamination and public health problems, poisoning of rural workers, and food residues have been observed over time. These factors triggered the recognition of the risks arising from pesticide abuse[1-6]. The effect of pesticide use on human health is a problem that has caught the attention of the scientific community worldwide, especially in emerging countries, where the highest number of deaths resulting from human exposure to these agents is observed[7], because technological packages continue to be imposed, without considering the edaphoclimatic conditions, the historical land, water use processes, and people's know-how.

According to Alves Filho[1], the growing number of issues related to agricultural pesticide use led to the enactment of the Law of Pesticides in 1989, by the Ministry of Health (MS), the Ministry of Agriculture, Livestock and Supply (MAPA), and the Brazilian Institute of Environment and Renewable Natural Resources (IBAMA). Before that (1980), the National Pharmaco-Toxicological Information System (SINITOX) was created, serving as a database of different poisonings. The Pesticide Notification Form was included in the Notifiable Diseases Information System (SINAN) in 1996, merging notification and assistance with the toxicological information control system for the investigation of pesticide accidents. This monitoring aims to expose the situation of pesticide poisoning and delimit fields of action in order to curb the number of accidents[8].

The National Health Surveillance Agency (ANVISA)[9] identified that the Brazilian pesticide market had grown 190% in ten years (2000-2010), against a world market increase of 93% in that same period.

If, on the one hand, the agronomic efficiency of pesticides is perceived, since the user can observe it in the fields or in the urban environment where the chemical compound has been applied and verify its expected action and described on the labels, on the other hand, an issue related to the risk that such products cause to the health of human beings and the impact/destruction they cause in the environment is noted. The action of pesticides generally fails to be selective to the point of removing only what is intended, and, in most cases, extermination occurs in several other classes of fauna and flora components existing at the application site[10].

According to studies by Nishiyama[11], pesticides can cause undesirable effects on health and nature because of their high biological activity and persistence in the environment. Their improper handling can result in acute poisonings and, sometimes, long-term, exposure-related effects (chronic poisonings).

In this sense, the declining number of bees due to the excessive use of pesticides and their consequences for the reproduction of flowers has long been discussed, as bees assist in the pollination process, directly influencing flower reproduction aspects[10]. Concerning the effects of these products on human health, when studying the Municipality of Lucas do Rio Verde (MT), Professor Wanderlei Pignati (UFMT), Jorge Machado and James Cabral found alarming pesticide contamination rates, even affecting the maternal milk of women in the municipality, emphasizing that none of them worked directly in agriculture[12].

Some studies report that farmers do not use Personal Protective Equipment (PPE), as in Nova Friburgo (RJ)[13], showing that around 70% of respondents do not wear this equipment, further facilitating farmer/worker poisoning. We should point out that PPEs are not comfortable equipment, they are hot (with use mostly in an external environment subject to solar radiation, therefore hot) and non-malleable, hindering manual activities. Thus, these individuals resist and reject its use.

Contrary to what happens with acute poisoning, it is challenging to establish the cause and effect relationships for chronic poisonings, that is, for the morbid manifestations that appear months or years after the continued and frequent exposure to small doses of pesticides. The situation is made even more complex by a large number of commercial brands with different active principles, which are not familiar to doctors. In these cases, doctors should rely on the services of a Toxicological Information Center (CIT), which

Ciência & Saúde Coletiva, 25(7):2743-2754, 2020

responds quickly about the chemical composition of a product pointed as responsible for the case and provides specifications for diagnosis, indications about antidotes or other medications and prognosis.

In the State of Goiás, CIT-GO is located in the Superintendency of Health Surveillance (SUVISA) and was founded in 1986, out of the need to have a specialized service capable of providing information related to toxic agents in the environment. The CIT-GO On Duty Service promotes some direction for patient care, thereby reducing their vulnerability and the fragility of the health system in the face of suspected poisoning cases. However, the points of the health care network with referrals to mental health and social services require better articulation, for example, when the poisoning is due to attempted suicide or child contamination, given that nowadays the clinical conduct protocol provides for post-service only through telephone calls to ascertain the condition development of the intoxicated individual, the dosage and the effects of the prescribed medications, and the improvement of the subject's clinical condition.

The poisoning records of CIT-GO, located at the Superintendency of Health Surveillance (SUVISA), in Goiânia (GO), are transmitted through electronic spreadsheets to SINITOX, which stores and makes information available in a directory. Municipalities also forward notification forms to CIT-GO and are responsible for making such poisoning information available to SINITOX. However, these forms generally take time to be passed on or are sometimes not digitized, due to the limited municipal structure, the lack of staff, and mainly lack of political interest, since most of them are hegemonized by agribusiness.

That said, the best way to analyze the poisoning cases of a state or municipality within this federative unit is looking for the poisoning notification forms stored in the Toxicological Information Center within the Superintendencies of Health Surveillance of each federative unit of the country, as SINITOX guides on its website, and through SINAN. Like SINITOX, SINAN is mainly fed by the municipal health secretariats. As it also advises on its website, the Individual Notification Form must be completed by the care units for each patient when suspecting a notifiable health problem or a problem of national, state, or municipal interest.

Notably, these services are excellent notification systems for the health problems of the Brazilian population. However, they are fed by municipal or state secretariats, by professionals overloaded with several other functions that are unable to feed the database with the necessary agility, taking into account that data from SINITOX and SINAN are not always updated to the current year.

This fact becomes important to understand the reasons that lead to underreporting in pesticide contamination cases, since the number of poisonings we will present tends to be much higher, considering information from the National Council of Health Secretariats[14], underreporting in these cases is around 1 to 50, that is, 50 unreported cases for each notified case. Notwithstanding this, the available data are alarming.

In the meantime, data was collected through technical visits to the CIT-GO Library as a methodology, with access authorized by the State Health Secretary of Goiás. The exogenous agricultural poisoning notification forms from 2005 to 2015 were cataloged. It should be noted that the records for 2016 and 2017 were not yet available due to complaint or report receipt and handling operational procedures.

All available forms were tabulated based on existing data, such as, for example, municipalities and month of poisoning, type of poisoning agent, circumstance, and the pesticide that caused the poisoning and case development. Based on these systematized data, the second stage consisted of preparing distribution maps of poisoning and agricultural production cases, based on the State Geoinformation System of Goiás (SIEG) and shapefiles. The software used in the elaboration of the maps was ArcGis, allowing the spatialization and distribution of poisoning cases by agricultural pesticides in the state of Goiás.

We also emphasize the importance of Larissa Mies Bombardi's works in "Small Cartographic Essay on pesticide use in Brazil"[15] and "Geography of pesticide use in Brazil and Linkages with the European Union"[16] in the spatialization and discussion of pesticides in Brazil.

Map of poisonings by agricultural pesticide in the state of Goiás (2005 to 2015)

With the data collection carried out at the CIT-GO Library through records of notifications of exogenous agricultural poisonings from 2005 to 2015, we developed the Map of Poisonings by Agricultural Pesticide in Goiás, from 2005 to 2015 (Figure 1).

This map allowed us to identify the regions of the State with a higher concentration of poi-

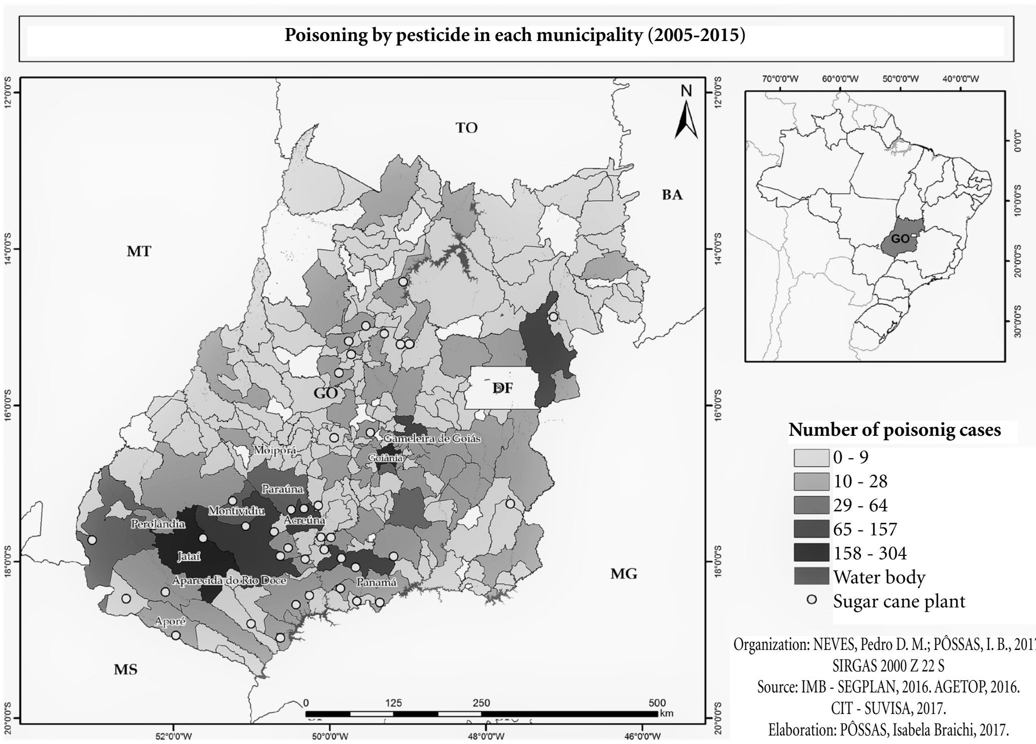

Figure 1. Map of agricultural pesticide poisoning in the state of Goiás (2005-2015).

Source: CIT/SUVISA (2016).

soning cases, to understand the event behind the statements and actions that made Goiás the Brazilian agricultural granary. It highlights that the greater number of pesticide poisoning notifications in areas territorialized by agribusiness, allowing us to establish the agribusiness/pesticide ratio, which, due to the number of pesticides used in large commodity crops, makes these areas champions of harm to the environment and living beings.

In total, 2,987 poisonings were recorded, with the highest incidence found in some municipalities such as Jataí/GO (304 poisonings), Goiânia/GO (249), Rio Verde/GO (157), Anápolis/GO (155), Formosa/GO (114), Acreúna/GO (106), Goiatuba/GO (104), Aparecida de Goiânia/GO (64), Mineiros/GO (56) and Montividiu/GO (46).

It is necessary to consider that these data may be camouflaged because the size of the population of a municipality can interfere with the number of poisonings. Thus, making the relationship between the number of poisoning notifications by the population estimate of the municipalities, as per the IBGE[17], we have the information in Table 1.

Table 1 shows us that Goiânia/GO is not one of the municipalities with the highest rates of poisoned people when related to the number of inhabitants. Among the municipalities with the highest number of poisoned people are Aporé/GO, with one poisoning for every 163 inhabitants, Acreúna/GO, with one poisoning for every 205 inhabitants, Montividiu/GO, with one poisoning for every 263 inhabitants, Jataí/GO, with one poisoning for every 3,195 inhabitants, Goiatuba/GO, with one poisoning for every 328 inhabitants, and Paraúna, with one poisoning for every 329 inhabitants.

That said, in order to avoid data concealment due to disproportion, the information contained in the map (Figure 2) refers to poisoning notification cases per pesticide per inhabitant of each municipality.

We can infer, looking at Figure 2, that the Goiás Southwestern Micro-Region recorded the highest amount of poisoning notifications per inhabitant, justified by the high incidence of ag-

Ciência & Saúde Coletiva, 25(7):2743-2754, 2020

Table 1. Relationship between the number of poisoning reports and the population estimate of the most poisoned municipalities in Goiás (2015).

Municipality	Poisonings	Inhabitants	Pois./ inhab ratio	Municipality	Poisonings	Inhabitants	Pois./ inhab ratio
Aporé	25	4110	164.4	Nerópolis	17	27812	1636.0
Acreúna	106	21905	206.6	Iporá	19	32218	1695.7
Montividiu	46	12337	268.2	Morrinhos	25	45000	1800.0
Jataí	304	97077	319.3	Santa Helena de Goiás	21	38563	1836.3
Goiatuba	104	34179	328.6	Inhumas	28	51932	1854.7
Paraúna	34	11210	329.7	São Luiz de Montes Belos	17	32808	1929.9
Leopoldo de Bulhões	17	7758	456.3	Cristalina	28	54337	1940.6
Goianápolis	23	11460	498.3	Goianira	19	40338	2123.0
Maurilândia	23	13170	572.6	Posse	16	35128	2195.5
Barro Alto	17	10235	602.0	Porangatu	20	45055	2252.7
Piracanjuba	39	24830	636.7	Anápolis	155	370875	2392.7
Pontalina	19	17933	943.8	Quirinópolis	16	47950	2996.9
Formosa	114	114036	1000.3	Caldas Novas	26	83220	3200.8
Ceres	22	22035	1001.6	Goianésia	16	66649	4165.6
Mineiros	56	61623	1100.4	Itumbiara	21	101544	4835.4
Minaçu	28	30862	1102.2	Senador Canedo	18	102847	5713.7
Bela Vista de Goiás	25	28077	1123.1	Goiânia	249	1448639	5817.8
Silvânia	18	20357	1130.9	Trindade	22	140930	6405.9
São Simão	16	19407	1212.9	Aparecida de Goiânia	64	532135	8314.6
Rio Verde	157	212327	1352.4	Luziânia	18	196864	10936.9

Source: CIT/ SUVISA (2016); IBGE[17].

ricultural monocultures such as soy, corn and sugar cane, which together were the three sectors that most consume pesticides in Brazil, with about 65% of pesticides sold in the country, according to Theisen[18] and SINDAG[19].

Types of poisoning agents

Pesticides can be classified by the pest to be controlled (insecticides, herbicides, fungicides, among others), chemical group (organophosphates, carbamates, organochlorines, pyrethroids, bipyridyls, mercurials, among others), acute toxicity (class I, II, III, IV – as per LD50) and the ability to trigger the development of cancer in humans (carcinogenesis). In this sense, as per the classification of the International Agency for Research on Cancer (IARC)[20] linked to the World Health Organization (WHO), several chemical substances, including pesticides, can be classified into 1 - Carcinogenic to humans, 2A - Probably carcinogenic to humans, 2B - Possibly carcinogenic to humans, 3 - Not classifiable as to its carcinogenicity to humans, and 4 - Probably not carcinogenic to humans; and the type of formulation (solvents, adherents, humectants, among others) or presentation (liquid, powder or granulated).

Insecticides are intended for the control of crop-damaging insects, or insects that are part of the epidemiological chain of infectious diseases. Herbicides, on the other hand, are substances designed to control weeds that hinder the development of crops. Moreover, finally, fungicides are substances designed to combat fungi that attack mainly winter crops[21].

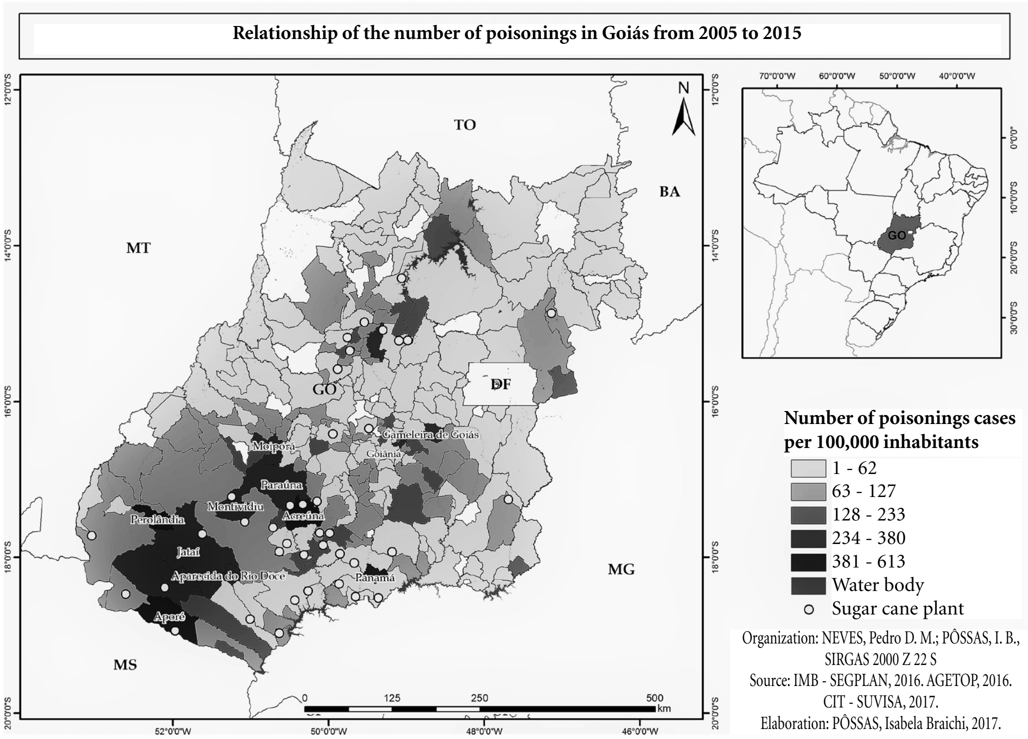

Figure 2. Map of notification of agricultural pesticide poisoning compared to the number of inhabitants in the state of Goiás (2005-2015).

Source: CIT/SUVISA (2016).

Table 2 shows a higher incidence of herbicides and insecticides used in Goiás and a minimal occurrence of fungicides.

An increased number of herbicide poisoning notifications is observed from 2005 to 2015, and, consequently, a greater use of this type of pesticide may have occurred. According to a study available in the "ABRASCO Dossier: a warning about the impacts of pesticides on health"[21], the introduction of transgenics in Brazilian crops, reaching about 50% of the 74 million hectares cultivated in Brazil[22] and are herbicide-tolerant, caused an elevated use of this pesticide.

As per the same document[21], 93% of the cultivated area of corn, soybeans, and cotton are of transgenic seeds, whereas sugarcane did not have transgenic varieties until 2016. However, the National Technical Commission of Biosafety (CTNBio) approved the planting of transgenic sugarcane in June. Thus, herbicide use and consequent poisoning tend to increase, requiring more in-depth monitoring and research.

The descriptions in the investigated forms reveal an incidence of products that were ignored in these compulsory notifications. Possibly, the erroneous completion is due to the unpreparedness and lack of knowledge of the professionals assigned to this task, and also people's unawareness concerning the pesticides that come into contact with them daily. This requires the immediate training of civil servants who address the subject so that they pay attention to the health problems caused by these toxic products, and, thus, resort to the health authorities, which should adopt appropriate intervention measures. On the other hand, we should value massive educational campaigns for consumers and workers handling these products, such as storage, product dilution, handling, use of personal protective equipment, among others.

Ciência & Saúde Coletiva, 25(7):2743-2754, 2020

Table 2. Distribution of patients poisoned by pesticides by the purpose of the pesticide in Goiás (2005-2015).

Year	Insecticide	Herbicide	Formicide	Ignored	Fungicide	Rodenticide	Acaricide
2005	112	61	76	51	6	8	4
2006	84	75	53	43	3	2	7
2007	57	63	47	10	6	2	3
2008	72	77	43	45	7	2	1
2009	65	90	34	45	15	3	6
2010	62	87	48	73	18	0	3
2011	48	70	30	50	19	1	1
2012	82	142	29	34	5	0	0
2013	130	147	25	31	9	1	2
2014	86	150	30	52	16	2	0
2015	64	112	16	23	11	0	0
Total	862	1074	431	457	115	21	27

Source: CIT/ SUVISA (2016).

Data on pesticide poisoning notifications evidenced a higher number of notifications in men compared to women (mainly in occupational notifications), and this is because pesticides are applied predominantly by male workers.

Circumstance of poisoning

Exposure to pesticides occurs from contact with skin, mucous membranes, breathing, or even the ingestion of pesticides or intoxicated foods, as in several cases presented by the Dossier ABRASCO[21] on the impacts of pesticides on health. Poisoning may be occupational, accidental, or intentional (attempted suicide or homicide).

Occupational exposure refers to professional groups that have contact with pesticides. For the cases presented in the poisoning notification forms at CIT-GO, we have farmers, employees of rural companies, and even endemic disease workers, such as the professionals spraying poison to fight against Aedes aegypti. Such exposure can occur during dilution, the preparation of the syrup, the application of pesticides, and also due to the entry into the fields after the application of the products. In aerial applications, agricultural pilots and their assistants are also considered a risk group.

Sobreira and Adissi[3] believe that one of the causes leading to the higher number of poisoning cases is the large scale use of pesticides, resulting in a large number of deaths and illnesses of workers inhaling the product inadvertently during the application or through skin contact. Thus, pesticides affect both nature and collective health conditions, since pesticide residues can be ingested through food, as these compounds are potentially toxic to humans.

In a research on the effects of pesticides on health, work and environment for Brazilian municipalities, Pignati et al.[23] presented mean data on pesticide use in the state of Mato Grosso of 10 liters per hectare, and this excessive consumption makes Brazil the pesticide consumption world champion, consequently generating poisoning in the environment and the health of the population.

Accidental exposure includes poisoned people who may come into contact with pesticides in domestic environments by repelling insects when people reuse the product bottle by introducing some other substance, causing domestic accidents with packaging confusion, especially concerning children and older adults.

The drift effect is also included in this type of exposure, which is the aerial transport of pesticide particles to areas other than their application sites, such as homes next to sugarcane, soy or corn crops.

As for the intentional exposure, which is divided into attempted suicide and attempted homicide in this study, we find poisonings caused by the intention of taking one's own life, or someone else's. Poisoning by attempted suicide has the highest lethality rates.

The analysis should not be hasty. A higher number of suicide poisonings is serious and should be treated besides a fortuitous situation or domestic accident. In Table 2, we can identify the main circumstances of poisoning in Goiás from 2005 to 2015.

Regarding the circumstance of poisoning notifications, Table 3 shows the attempted suicide as the most frequent poisoning (36.4% of the notifications - 1,086 cases), deserving future studies on this health problem, since discussion should be further expanded, bringing elements about the individual's health care model and the psychosocial care network.

Nevertheless, this result is linked to chronic poisoning due to years of exposure to the application of pesticides, which causes immunological, hematological, hepatic, neurological problems, congenital malformations, tumors. It is assumed that these health problems can lead to depressive symptoms, along with high levels of suicide attempts.

Another important aspect to understand the greater number of pesticide poisoning-related suicides concerns psychic disorders caused by exposure to pesticides, especially organophosphates, although they are not the only ones, among which are depression and anxiety[13,24].

Some case studies conducted in Brazil indicate this perspective. Part of these studies weaves this correlation preliminarily, as is the case of the work "Incidence of suicides and use of pesticides by rural workers in Luz (MG), Brazil"[24].

When carrying out a study on pesticide exposure among peasants in Nova Friburgo (RJ), Araújo et al.[13] identified a direct relationship between this use and psychiatric disorders.

Scientific evidence shows that exposure to pesticides can lead to health damage, often irreversible, such as the case of late neuropathy due to overexposure to organophosphates. The neurotoxic consequences of acute exposure to high concentrations of pesticides are also well established, whether the effects are muscarinic, nicotinic, and on the central and peripheral nervous system[13](p.116).

The study by Araújo et al.[13] explains the high number of suicide-related poisoning notifications. Chronic poisoning due to years of exposure to pesticides, both occupationally and environmentally and by their (accidental) ingestion, causes severe damage to mental and cardiovascular health, resulting in depression of the subject who is no longer able to work due to cardiovascular harm, or even his depression directly generated by poisoning.

Occupational poisonings totaled 1,078 notifications (36.1% of notifications), and as already addressed, such poisonings may in the future lead to possible notifications for suicide, since poisoned workers end up with chronic diseases.

As for occupational and accidental circumstances, we can highlight two data from the 2006 Agricultural Census[22], of which part of rural producers are illiterate, and 51% are illiterate in the state of Goiás. We cannot assume, a priori, that low education means poor knowledge. In essence, there is extensive and fruitful popular and traditional knowledge (know-how) among the different groups of rural workers, but not exactly regarding pesticides, a product of an urban-industrial western civilization that requires technical assistance and proper handling.

Another important fact is that technical assistance remains very limited, and occurs in only 22% of rural establishments – whose mean area is 228 hectares. The 2006 Agricultural Census[22]

Table 3. Poisoning circumstance in Goiás (2005-2015).

Year	Accidental	Occupational	Suicide	Homicide	Food
	Total in %	Total in %	Total in %	Total in %	Total in %
2005	22	31	44	0.6	1.6
2006	29.2	22	47.8	0.3	0.3
2007	26	32	41	0	1
2008	35.2	29.1	33.6	0	2
2009	31	26.7	41	0	1.1
2010	28.8	35.7	33.6	0.3	1.4
2011	14.6	50	34.2	0	0.9
2012	25.6	39.1	33.5	1	0.7
2013	31.4	33.4	31.1	0.6	3.5
2014	14.9	54.6	30.1	0.3	0
2015	25.2	41.6	32.7	0	0.4
Total	25.8	36.1	36.4	0.3	1.2

Source: CIT/ SUVISA (2016).

shows that more than half of the establishments in Brazil where pesticides were used did not receive technical guidance (785,000 or 56.3%). The backpack sprayer, which is the application equipment with the greatest potential for exposure to pesticides, is used in 973,000 establishments. Empty packages are burned or buried in 358,000 establishments, and 296,000 establishments did not use any personal protective equipment. Most adopted only boots and hats in the establishments that used PPEs.

Analyzing these data, we can understand some of the observations in the poisoning notification forms that report poisoning due to the intake of soft drinks in a container that was contaminated by pesticides or pesticide consumption when mistaken for any drink.

Table 4 highlights pesticides that were the agents with the highest incidence of poisoning. First is Roundup (Glyphosate), with 725 cases, followed by Furadan (Carbofuran), with 337 cases, 2,4-D (Dichlorophenoxyacetic acid), with 116 cases, Regent (Phenylpyrazole), with 64 cases, Aldrin (Organochlorine) with 51 cases, and Furazin (Carbamate), with 34 cases.

The clinical effects of the poisoned individual when coming into contact with any of the pesticides mentioned above may range from mucosal irritation to the development of cancer. In research by Samsel and Seneff[25], tests indicate that glyphosate, Roundup's active ingredient, will cause 50% of autism in children by 2025, and other modern diseases such as depression, infertility, Alzheimer's, cancer and heart disease.

Corroborating these predictions, the Guide for the Prevention, Notification, and Treatment of Poisoning by Pesticides[26] considers that pesticides with the active ingredient Carbamate, such as Furazin and Furadan (Carbofuran), can cause pulmonary edema, depression, respiratory paralysis, memory loss and even motor difficulties in the poisoned.

Organochlorine insecticides, such as Aldrin, can cause vertigo, corneal clouding, respiratory failure, testicular atrophy and consequent infertility, and cancer. Furthermore, 2,4-Dichlorophenoxyacetic acids (2,4-D) cause anything from irritation in the eyes and mucous membranes to cardiorespiratory arrest. It is important to note that insecticide Aldrin was banned in Brazil from 1985. However, as can be seen, it is still in use.

Development of exposure situations

Regarding the development of poisoning cases, we have some nomenclatures, such as death, death from another cause, cure (in which the poisoned person died from another occurrence, such as murder or suicide), cure with sequelae (in which the poisoned person acquired some sequel, such as neurological or pulmonary disease, among others). We can analyze Table 5 to identify the development of poisoning cases in the State of Goiás.

Although occupational deaths represent a small proportion, each of these fatalities carries much information, since, behind each death, several workers are living under the same conditions, and exposed to the same risk factors. Thus, it can be said that "little means a lot"[27], that a lost life must be considered and never neglected.

Table 4. Pesticides that cause more poisoning notifications in Goiás (2005-2015).

Toxic agent	Nº of notifications	Percentages
Roundup	725	24.3%
Furadan	337	11.3%
2,4-D	116	3.9%
Regent	64	2.1%
Aldrin	51	1.7%
Furazin	34	1.1%

Source: CIT/ SUVISA (2016).

Table 5. Progress of the poisoning cases in Goiás (2005-2015).

Year	Death	Cure	Cure w/ sequelae	Death from other causes
2005	16	286	16	0
2006	16	231	20	0
2007	9	164	14	1
2008	6	234	7	0
2009	20	230	8	0
2010	13	262	16	0
2011	9	205	4	1
2012	4	286	2	0
2013	3	339	3	0
2014	8	322	6	0
2015	9	215	2	0
Total	113	2774	98	2

Source: CIT/ SUVISA (2016).

Thus, cases of cure can conceal alarming amounts of chronically poisoned individuals who, over time, may manifest cancers, Alzheimer's, infertility, and heart and respiratory diseases. So what cure are we talking about? Nevertheless, according to the research contained in the "ABRASCO Dossier. Warning about the impacts of pesticides on health. Part 1 - Pesticides, Food Safety, and Health"[28], these chronic effects can occur months, years or even decades after exposure, manifesting in various diseases such as cancers, congenital malformations, endocrine, neurological and mental disorders.

Final considerations

The study presented raised information presented in the CIT-GO Pesticide Poisoning Forms, systematizing indicators such as the period of the year with the highest poisoning levels, the most affected age, development of poisoning cases, and municipalities with the highest incidence of poisonings.

In this analysis, we realized that the proportion of poisoning per inhabitant should be considered so that actual numbers or those closer to reality are presented. Thus, a high incidence of pesticide poisoning is observed in the region of Goiânia (probably due to the number of inhabitants of this municipality), Formosa (major soybean producer) and the Southern Mesoregion of Goiás, a region territorialized by agribusiness, with the massive cultivation of soybeans and corn and with a recent advance in sugarcane agribusiness.

Regarding the item present in the pesticide poisoning notification forms regarding the "case development", which contains information on death, cure, cure with sequelae and death from another cause, of the 2,987 notifications, 113 people died, 98 people were cured with sequelae and 2,774 were diagnosed with "cure". However, it should be noted that the chronic (long-term) effects of pesticides are not recorded, as Bochner[29] points out, even because these effects take time to manifest.

Thus, there is a need to expand knowledge about the chronic health effects of the population exposed to these products, as there may be a false indicator regarding the diagnosis of a cure for poisoning that may manifest itself decades later. However, one must ask what cure is mentioned when the subject is the prognosis of improved initial poisoning symptoms.

Collaborations

PDM Neves worked on the design, analysis, and interpretation of data. MR Mendonça worked on the critical review and drafting of the paper. M Bellini worked on data analysis and interpretation and critical review. IB Pôssas worked on the cartographic elaboration of the research.

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References

1. Alves Filho JP. *Uso de agrotóxicos no Brasil - controle social e interesses corporativos*. São Paulo: Annablume, Fapesp; 2002.
2. Nunes MV, Tajara EH. Efeitos Tardios dos Praguicidas Organoclorados no Homem. *Rev Saúde Pública* 1998; 32(4):372-382.
3. Sobreira AEG, Adissi PJ. Agrotóxicos: Falsas Premissas e Debates. *Cien Saude Colet* 2003; 8(4):985-990.
4. Souza GS, Costa CAC, Maciel AC, Reis FDV, Pamplona YAP. Presença de agrotóxicos na atmosfera e risco à saúde humana: uma discussão para a Vigilância em Saúde Ambiental. *Cien Saude Colet* 2017; 22(10):3269-3280.
5. Neves PDM, Bellini M. Intoxicações por agrotóxicos na mesorregião norte central paranaense, Brasil – 2002 a 2011. *Cien Saude Colet* 2013; 18(11):3147-3156.
6. Espíndola MMM, Souza CDF. Trabalhador Rural: O agrotóxico e sua influência na saúde humana. *Rev Uni Vale Rio Verde* 2017; 15(2):871-880.
7. Silva AM, Alves SMF. Análise dos registros de intoxicação por agrotóxicos em Goiás, no período de 2001 a 2004. *Rev Eletr Farmácia* 2007; 4(2):194-201.
8. Ministério da Saúde (MS). Secretaria da Vigilância em Saúde. *Agrotóxicos na ótica do Sistema Único de Saúde*. Brasília: MS; 2016.
9. Agência Nacional de Vigilância Sanitária (ANVISA). *A regulação e o mercado de agrotóxicos no Brasil.* Brasília: ANVISA; 2012.
10. Arruda TF. *Agrotóxicos e Sistema Penal* [dissertação]. Maringá: Universidade Estadual de Maringá; 2008.
11. Nishiyama P. *Utilização de agrotóxicos em áreas de reforma agrária no estado do Paraná.* [tese]. Campinas: Universidade Estadual de Campinas; 2003.
12. Pignati WA, Machado JMH, Cabral JF. Acidente rural ampliado: o caso das "chuvas" de agrotóxicos sobre a cidade de Lucas do Rio Verde – MT. *Cien Saude Colet* 2007; 12(1):105-114.
13. Araújo AJ, Lima JS, Moreira JC, Jacob SC, Soares MO, Monteiro MCM, Amaral AM, Kubota A, Meyer A, Cosenza CAN, Neves CN, Markowitz S. Exposição múltipla a agrotóxicos e efeitos à saúde: estudo transversal em amostra de 102 trabalhadores rurais, Nova Friburgo, RJ. *Cien Saude Colet* 2007; 12(1):115-130.
14. Conselho Nacional de Secretários de Saúde (CONASS). *Vigilância em saúde. Coleção Progestores – Para entender a gestão do SUS, 6, I*. Brasília: CONASS; 2007.
15. Bombardi LM. *Pequeno Ensaio Cartográfico sore o Uso de Agrotóxicos no Brasil.* São Paulo: Laboratório de Geografia Agrária USP/Blurb (Ebook); 2016.
16. Bombardi LM. *Geografia do Uso de Agrotóxicos no Brasil e Conexões com a União Europeia*. São Paulo: FFLCH-USP; 2017.
17. Instituto Brasileiro de Geografia e Estatística (IBGE). *Estimativas populacionais para municípios e para as Unidades da Federação brasileiras em 2015* [página na Internet]. Disponível em: http://www.ibge.gov.br/home/estatistica/populacao/estimativa2015/estimativa_dou.shtm
18. Theisen G. *O Mercado de agroquímicos* [apresentação na Internet]. 2010. Disponível em: http://www.cnpsa.embrapa.br/met/images/arquivos/15MET/mercadoagroquimico.pdf

19. Sindicato Nacional das Indústrias de Defensivos Agrícolas (SINDAG). *Dados de produção e consumo de agrotóxicos* [página na Internet]. 2011. Disponível em: www.sindag.com.br
20. Agência Internacional de Pesquisa em Câncer (IARC). *Monographs on the Evaluation of Carcinogenic Risks to Humans* [página na Internet]. 2010. Disponível em: http://monographs.iarc.fr/ENG/Classification/
21. Carneiro FF, Rigotto RM, Augusto LGS, Friedrich K, Búrigo AC, organizadores. *Dossiê ABRASCO: um alerta sobre os impactos dos agrotóxicos na saúde*. Rio de Janeiro: Escola Politécnica de Saúde Joaquim Venâncio/ FIOCRUZ; São Paulo: Expressão Popular; 2015.
22. Instituto Brasileiro de Geografia e Estatísticas (IBGE). *Censo Agropecuário 2006*. Brasília/Rio de Janeiro: IBGE; 2010.
23. Pignati WA, Oliveira NP, Silva AMC. Vigilância aos agrotóxicos: quantificação do uso e previsão de impactos na saúde-trabalho-ambiente para os municípios brasileiros. *Cien Saude Colet* 2014; 19(12):4669-4678.
24. Meyer TF, Resende IL, Abreu JC. Incidência de suicídios e uso de agrotóxicos por trabalhadores rurais em Luz (MG), Brasil. *Rev Bras Saúde Ocup* 2007; 32(116):24-30.
25. Samsel A, Seneff S. Glyphosate's Suppression of Cytochrome P450 Enzymes and Amino Acid Biosynthesis by the Gut Microbiome: Pathways to Modern Diseases. *Entropy* 2013; 15(4):1416-1463.
26. Mato Grosso do Sul. Centro Integrado de Vigilância Toxicológica – Centro Estadual de Referência em Saúde do trabalhador. *Guia de prevenção, notificação e tratamento das intoxicações por agrotóxicos*. Campo Grande: CIVITOX/CEREST; 2013.
27. Bochner R. Óbito ocupacional por exposição a agrotóxicos utilizado como evento sentinela: quando pouco significa muito. *Vigil Sanit Debate* 2015; 3(4):39-49.
28. Carneiro FF, Pignati WA, Rigotto, RM, Augusto LGS, Rizollo A, Muller N. *Dossiê ABRASCO*: *Um alerta sobre os impactos dos agrotóxicos na saúde. Parte 1 – Agrotóxicos, Segurança Alimentar e Saúde*. Rio de Janeiro: ABRASCO; 2012.
29. Bochner R. Sistema Nacional de Informações Tóxico-Farmacológicas – SINITOX e as intoxicações humanas por agrotóxicos no Brasil. *Cien Saude Colet* 2007; 12(1):73-89.

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