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Epidemiological profile of pesticide poisoning cases in the State of Sergipe, Brazil: a retrospective analysis from 2007 to 2021

Perfil epidemiológico dos casos de intoxicação por agrotóxicos no estado de Sergipe, Brasil: uma análise retrospectiva de 2007 a 2021

Perfil epidemiológico de los casos de intoxicación por plaguicidas en el estado de Sergipe, Brasil: un análisis retrospectivo de 2007 a 2021

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Abstract
We aimed to characterize the epidemiological profile of reported cases of pesticide poisoning in the state of Sergipe between 2007 and 2021. Secondary data were obtained from the National Database of Notifiable Diseases Information System (SINAN) and National Toxicological Information System (SINITOX), through the Department of Informatics of the Unified Health System (DATASUS) and analysis performed using the free tool Google Sheets. During the studied period, 960 cases of exogenous pesticide poisoning were registered in the state. The municipality of Aracaju had the highest percentage of the number of cases. The incidence prevailed in females, in the 20-39 age group, in the brown race and among those with incomplete primary education. The most used toxic agent was rodenticide, suicide attempt predominated as a circumstance of use. Most cases resulted from a single acute exposure, confirmed by the clinical-epidemiological method, and evolved to a cure without sequelae. This study traced the epidemiological profile of the State of Sergipe with regard to the intoxication of the population and, in addition, brought little explored data and information that directly impacts policies aimed at reducing morbidity and mortality resulting from the use of pesticides.
Keywords: Pesticide; Poisoning; Public health.

Resumo
Este estudo teve como objetivo caracterizar o perfil epidemiológico dos casos notificados de intoxicações por agrotóxicos no estado de Sergipe no período de 2007 a 2021. Dados secundários foram obtidos do banco de dados nacional do Sistema de Informação de Agravos de Notificação (SINAN) e do Sistema Nacional de Informações Toxicológicas (SINITOX), por meio do Departamento de Informática do Sistema Único de Saúde (DATASUS) e a análise realizada por meio da ferramenta gratuita Google Sheets. No período estudado, foram registrados 960 casos de intoxicação exógena por agrotóxicos no estado. O município de Aracaju apresentou o maior percentual do número de

casos. A incidência prevaleceu no sexo feminino, na faixa etária de 20 a 39 anos, na raça parda e naqueles com ensino fundamental incompleto. O agente tóxico mais utilizado foi o raticida, predominou a tentativa de suicídio como circunstância de uso. A maioria dos casos resultou de uma única exposição aguda, confirmada pelo método clínico-epidemiológico, e evoluiu para cura sem sequelas. Esse estudo traçou o perfil epidemiológico do Estado de Sergipe no que tange a intoxicação da população e, para além disso, trouxe dados e informações pouco exploradas que geram impacto direto nas políticas voltadas à redução da morbimortalidade por agrotóxicos.
Palavras-chave: Pesticida; Envenenamento; Saúde pública.

Resumen
Este estudio tuvo como objetivo caracterizar el perfil epidemiológico de los casos notificados de intoxicación por plaguicidas en el estado de Sergipe en el período de 2007 a 2021. Los datos secundarios se obtuvieron de la base de datos nacional del Sistema de Informação de Agravos de Notificação (SINAN) y del Sistema Nacional de Informações Toxicológicas (SINITOX), a través del Departamento de Informática do Sistema Único de Saúde (DATASUS) y el análisis se realizó utilizando la herramienta gratuita Google Sheets. En el período estudiado, se registraron 960 casos de intoxicación exógena por plaguicidas en el estado. El municipio de Aracaju presentó el mayor porcentaje del número de casos. La incidencia fue mayor entre las mujeres, de 20 a 39 años, mestizas y con enseñanza primaria incompleta. El agente tóxico más utilizado fue el rodenticida, y la tentativa de suicidio fue la circunstancia predominante de uso. La mayoría de los casos fueron resultado de una única exposición aguda, confirmada por el método clínico-epidemiológico, y evolucionaron hacia la curación sin secuelas. Este estudio trazó el perfil epidemiológico del Estado de Sergipe en relación a la intoxicación de la población y, además, aportó datos e informaciones poco exploradas que impactan directamente en las políticas dirigidas a la reducción de la morbilidad y mortalidad por plaguicidas.
Palabras clave: Plaguicida; Intoxicación; Salud pública.

1. Introduction

Pesticides cover a range of products commonly used in agriculture to prevent or control pests and diseases that can harm the plantation. They can be classified based on chemical composition, mode of action, toxicity, target organisms and source of origin (Akashe et al., 2018; Lushchak et al., 2018).

Over the last years, global pesticide use has increased dramatically. Brazil is one of the top ten pesticide consumers in the world (Sharma et al., 2019). It estimated that each Brazilian habitant consumes 7.3 liters of pesticide per year (ABRASCO, 2018). According to Department of Agriculture, over the last 10 years (2012-2022), the number of pesticides registered in Brazil has been increasing, especially in the last three years, once 1.530 pesticide products have been approved since 2019 January until 2021, some of them prohibited in other countries due their high toxicity (Brasil, Ministério da Agricultura, 2022).

Pesticide poisoning has become a major public health problem worldwide. It is believed that for each notified pesticide poisoning case, there are at least 50 sub-notified cases[4]. According to the National Toxicological Information System (SINITOX), pesticides, from agricultural and domestic use, are the third highest cause of poisoning in the country, just after medicines and household cleaning products (Caldas, 2016).

In the state of Sergipe, the smallest Brazilian state, the use of pesticides is frequent in the rural production system, as well as in domestic environments, which can increase the risk of contamination and cause short- and long-term adverse health effects. However, data on prevalence and the epidemiological profile of pesticides poisoning in Sergipe is still scarce. In this way, it is possible to describe the prevalence of pesticide poisoning in the period from 2007 to 2021, to analyze the epidemiological profile of the population, in addition to exploring the impact of these factors in the State of Sergipe.

2. Methodology

This is a cross-sectional study, with descriptive, analytical, and quantitative approach (Aggarwal & Ranganathan, 2019) based on secondary data on pesticides poisoning in the state of Sergipe, Brazil. The data were extracted from the Department of Informatics of the Brazilian Unified Health System (DATASUS), which provides public epidemiological data from Notifiable Diseases information System (SINAN) database. SINAN is responsible for records of exogenous poisoning data, including

pesticide poisoning cases since 2007(Brasil, 2011). Thus, we analyzed data from confirmed cases of pesticides poisoning of the population of the state of Sergipe in the period from 2007 to 2021.

Regarding the collection of data, we used the option of exogenous pesticide intoxication retrieved of DATASUS database, with the following variables: sociodemographic characteristics of (age, sex, race, municipality of residence, education level), as well as variables related to the epidemiological profile of intoxications (toxic agent group, intoxication circumstances, type of exposure, poisoning confirmation criteria and case evolution).

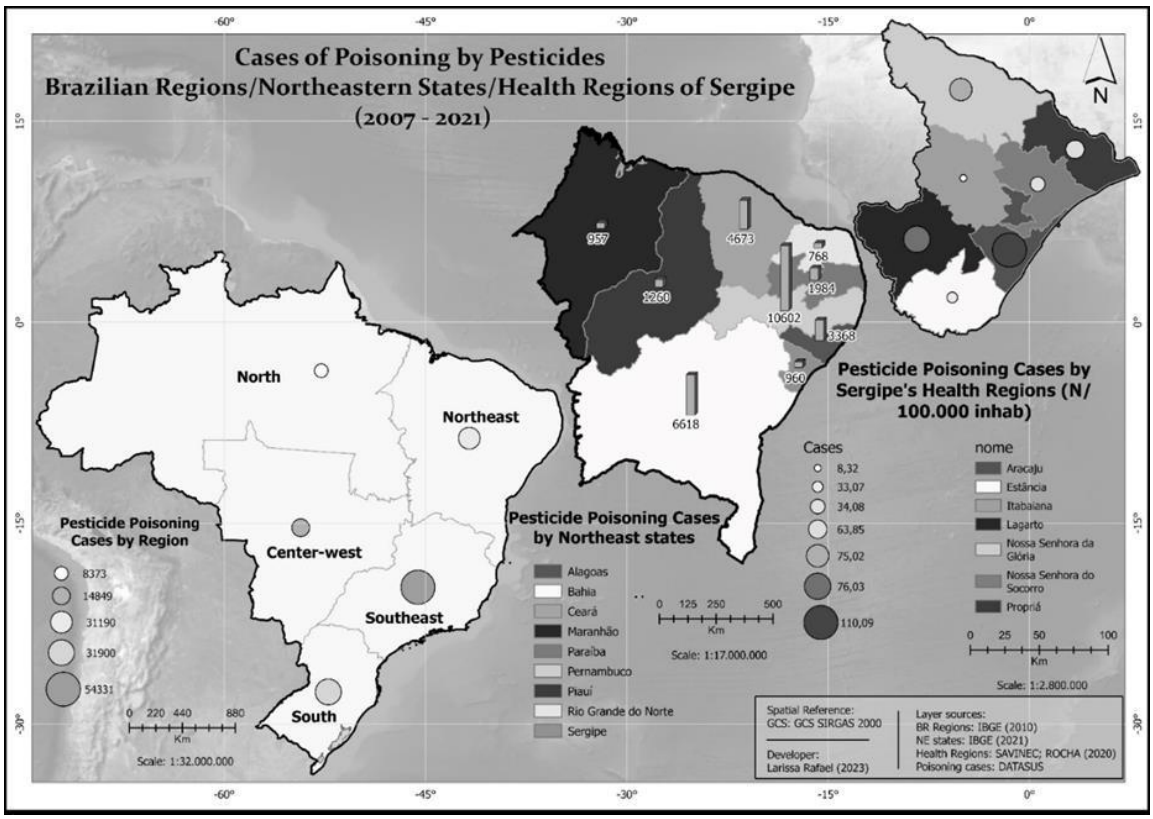
Data analysis was performed using Microsoft Office Excel version 2010, where calculations of absolute and relative frequencies were performed.

The study was carried out using secondary data, which is available on an online database with public access (DATASUS), without identifying the subjects, guaranteeing the confidentiality and anonymity of the reported cases. According to the current Brazilian resolution, Resolution No. 510, of April 07, 2016, this type of study does not require authorization from the Research Ethics Committee, as provided for under Law No. 12.527, of November 18, 2011(Brasil, 2016).

3. Results

In the period between 2007-2021, a total of 140.643 cases of pesticide poisoning were reported in Brazil, 31.190 cases (22.18%) of them were reported in the Northeast region, where is the state of Sergipe, which had 960 cases reported, corresponding to 3.08% of total cases of northeast region and 0.68% of total cases of Brazil. The geographical distribution of notifications can be observed in Figure 1.

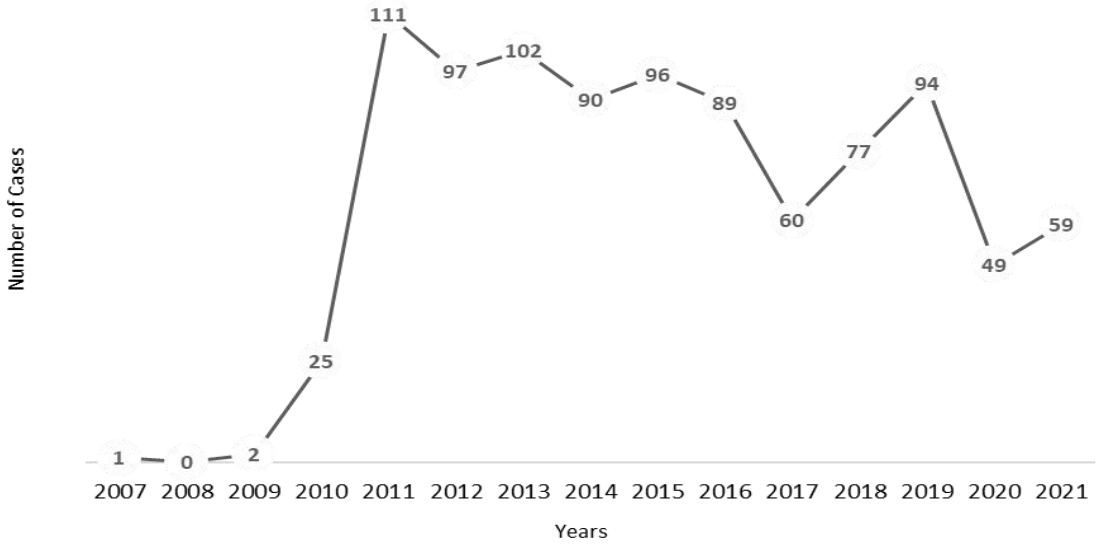
Figure 1 - Cases of Poisoning by Pesticides - Brazilian Regions/Northeastern States/Health Regions of Sergipe (2007 - 2021).



Source: Authors.

Sergipe state shows an increase in the number of notified cases of pesticide poisoning over the years, with the highest number observed in 2011, with a noticeable increase compared to the previous year, as shown in Figure 2. Sergipe has seven health regions: Nossa Senhora da Glória, Propriá, Itabaiana, Lagarto, Nossa Senhora do Socorro, Aracaju and Estância. Data from period considered in our study (2007-2021), we observed that Aracaju region, represented 76.25% of cases of Sergipe, showing a notification rate of 110 cases per 100.000 inhabitants, followed by Lagarto and Nossa Senhora do Socorro with 8.33% and 6.46% of cases, respectively Figure 1.

Figure 2 - Number of notifications of exogenous pesticide poisoning in the state of Sergipe, 2007-2021.



Source: Authors.

We observed a broad age range among the victims, ranging between <1 year to 80+ years, but most of the notified pesticide poisoning cases occurred in persons with age ranging 20-39 years old, corresponding to 446 cases (46.5%). Regarding sex, 492 victims (51.3%) were female. Most of the cases did not have their racial group identified (53.8%), but among those identified, the predominant racial group was brown race (36.4%). About the educational level, most of the cases (68.6%) did not have the level identified or had lower education levels (22.39%). The socio-demographic characteristics of cases are shown in Table 1.

Table 1 - Sociodemographic characteristics of pesticide poisoning cases in Sergipe, 2007-2021.

Population Characteristics	Total (n = 960)	
	N	%
Gender		
Male	468	48.8
Female	492	51.3
Age group		
<14	158	16.5
15-19	145	15.1
20-39	446	46.5
40-59	172	17.9
60+	39	4.1
Race		
White	64	6.7
Black	30	3.1
Yellow	1	01
Brown	349	36.4
Ignored	516	53.8
Education		
Illiterate	7	0.7
Did not finish primary level	51	5.3
Finished primary level	17	1.8
Did not finish secondary level	65	6.8
Finished secondary level	32	3.3
Did not finish high school	43	4.5
Finished high school	60	6.3
Did not finish higher level	13	1.4
Finished higher level	13	1.4
Ignored	659	68.6

Source: Authors.

The pesticides associated with poisoning cases were classified by database into four categories, in order of frequency: rodenticide (64.69%), agricultural pesticide (18.96 %), household pesticide (15.31%) and public health pesticide (1.04%). Regarding the circumstances, in the most cases, intoxication occurred due suicide attempts (73.23%), followed by accidental use (17.19%) and habitual use (5.73%). There were also cases of environmental poisoning (2.81%), Violence/Homicide (0.83%) and abortion attempts (0.21%). It is noted that, out of 960 pesticide poisoning cases, 739 (76.97%) resulted from single acute exposure, 104 (10.83%) from repeated acute exposure, 13 (1.35%) from chronic exposure and 4 (0.42%) acute-on-chronic toxicity. In 100 cases (10.42%), the criteria of exposure were ignored (Table 2).

Table 2 - Epidemiological profile of pesticides poisoning cases in state of Sergipe, 2007-2021.

Variables	Total (n = 960)	
	N	%
Toxic Agent		
Agricultural	182	18.96
Household	147	15.31
Public health pesticide	10	1.04
Rodenticide	621	64.69
Intoxication circumstances		
Habitual Use	55	5.73
Accidental	165	17.19
Environmental	27	2.81
Suicide Attempt	703	73.23
Abortion Attempt	2	0.21
Violence/Homicide	8	0.83
Exposure		
Acute–single	739	76.97
Acute–repeated	104	10.83
Chronic	13	1.35
Acute over chronic	4	0.42
Ignored	100	10.42
By case evolution		
Cure without sequelae	754	78.54
Cure with sequelae	21	2.19
Death from exogenous intoxication	62	6.46
Death from another cause	2	0.21
Loss of follow-up	2	0.21
Ignored	119	12.39
Confirmation method		
Clinical-laboratory	22	2.29
Clinical-epidemiological	550	57.29
Clinical	322	33.5
Ignored	66	6.8

Source: Authors.

Methods to confirm pesticide poisoning included clinical-epidemiological method (57.29%), clinical evaluation (33.5%) and clinical-laboratory evaluation (2.29%). In 66 cases (6.87%), the criteria of confirmation were ignored. Regarding the development of pesticides poisoning cases notified between 2007 and 2021 in the state of Sergipe, 754 people (78.54% of total cases) were cured with no sequelae, 62 (6.46%) died from intoxication and 21 (2.19%) were cured with sequelae (Table 2).

4. Discussion

In the state of Sergipe, the smallest Brazilian state, pesticide use is frequent in agriculture, as well as to control domestic pests and disease vectors. The indiscriminate and widespread use of pesticides has been associated with an increase of poisoning cases. However, the epidemiological profile of pesticide poisoning cases in Sergipe state is still unclear. Taking this into account, we conducted a screening of pesticide poisoning notifications, between 2007 and 2021, that aimed to provide an epidemiological profile of these cases in the state of Sergipe.

In Brazil, pesticide poisoning was associated with 140.643 cases of exogenous intoxication, between 2007 and 2021. The Southeast and South regions showed the highest number of pesticides poisoning cases, with 38.63% and 22.68%, respectively Figure 1. These regions have high agricultural productivity and high population density, and they are the biggest consumers of pesticides of Brazil (Nascimento et al., 2020), which can explain the largest number of pesticides poisoning cases. The Northeast region occupied the third position on country ranking of pesticide poisoning cases, with 22.18% of the total cases. Among the Northeast states, we observed that the highest percentages of poisoning were found in Pernambuco (33.99%), Bahia (21.22%), Ceará (14.98%) and Alagoas (10.8%). In the state of Sergipe, we observed a total of 960 cases in the period included in our study, corresponding to 3.08% and 0.68% of total cases in the Northeast region and Brazil, respectively Figure 1. As we can observe in Figure 2, the number of cases is increasing over the years, with a peak of notifications in 2011 when the notifications of exogenous pesticide poisoning became compulsory (Brasil, 2011; Caldas, 2016). Although there appears to have been a trend of decline of notifications in the last two years, 2020 and 2021, we believe this reduction was driven by a complex combination of factors caused by COVID-19 pandemic, which may contribute to a substantial underestimation of the pesticide poisoning notified cases.

It is noteworthy that the state of Sergipe (SE), the smallest state in Brazil by geographical area, showed a higher (3.08%) poisoning percentage when compared to other states with a greater territorial area, such as Rio Grande do Norte (RN). However, SE has a higher demographic density (94.35 inhabitants/ km^2) when compared to RN (59.99 inhabitants/km^2)(IBGE, 2022). In addition, in 2019, SE traded 1.292 tons of pesticides compared to 395 tons traded by RN state (Panis et al., 2022). Also analyzing the municipalities of Sergipe that have notified pesticide poisoning we observed that Aracaju presented 76.89% of the pesticide poisoning notified cases of the state, from 2007 to 2021, which corresponded to 110 cases per 100.000 inhabitants Figure 1.
About the age range among the victims, the most of the notified pesticide poisoning cases occurred in persons with age ranged 20-39 years old (46.5%), with 446 cases, followed by 40-59 age ranged with 172 cases, evidencing the idea that pesticide poisoning is more frequent in active adults, which was also reported by previous studies (Bochner & Freire, 2020; Freitas & Garibotti, 2020). Usually, male are more susceptible to pesticide exposure, especially regarding occupational exposure (Buralli et al., 2020), what may explain the higher incidence of pesticide poisoning in males in other studies (Bochner & Freire, 2020; Freitas & Garibotti, 2020; Ramos et al., 2020). In contrast, our results showed a predominance of poisoning in females, 492 victims (51.3%), which was supported by other studies (Albuquerque et al., 2015; Lima et al., 2009). The gender differences observed in the prevalence of pesticides intoxications may be attributed to several factors, including the toxic agent characteristics, contamination circumstances and type of exposure.

Looking at the characteristics of pesticide poisoning in table 2, in Sergipe, the highest number of poisonings was due to rodenticide (64.69%) followed by agricultural (18.96%) and household pesticide (15.31%). Rodenticides or “rat poisons” are chemical agents used to eradicate small rodents, which also are among the most common household pesticides (Ramchandra et al., 2019). Agricultural pesticides consist of a wide range of formulations of insecticides, herbicides and fungicides used to pest control and agricultural output (Aktar et al., 2009). Although in our retrievable database, it was not possible to identify the type of pesticides based on their chemical composition, our results are similar to previous studies. A retrospective study conducted in

India analyzed data over thirteen years of 4.929 cases of pesticide poisoning and showed that the household pesticides consisted of 59.38% and agricultural pesticides comprised 40.61% of cases. Amongst the household pesticides, the highest incidence was due to pyrethroids and rodenticides (Peshin et al., 2014). In another study conducted in the Rio Grande do Sul, agricultural pesticide and rodenticide were responsible for the most cases of exogenous pesticides poisoning (Freitas & Garibotti, 2020).

In addition, of the total number of poisoning cases, 73.23% intentional poisoning due suicide attempts, followed by accidental circumstances, in consonance with other studies (Kamaruzaman et al., 2020; Kim et al., 2017; Neves et al., 2020; Peshin et al., 2014; Veras & Katz, 2011). Suicide attempts with pesticides has been considered a major contributor to the global burden of suicide, with the proportion of pesticide self-poisoning varying considerably between regions. Nonetheless, pesticide self-poisoning has become a major public health problem worldwide (Mew et al., 2017). The likely contributory factors for intentional pesticide poisoning and high suicides rates could be easy access, careless storage, low socioeconomic status and psychiatric problems (Faria et al., 2014; Peshin et al., 2014). Several studies have been shown an association between pesticide exposure and mental health impairment, which can lead to suicide attempts (Khan et al., 2019; Ong-Artborirak et al., 2022; Yazd et al., 2019)[27–29]. In Brazil, previous studies have shown high rate of suicide and suicide attempts among people exposed to pesticides (Caldas, 2016; Faria et al., 2014).

Our current study showed that 76.97% of the pesticide poisoning cases were caused by acute-single exposure, followed by acute-repeated exposure, which can be associated with the intoxication circumstances. Acute toxicity of a pesticide refers to the effects caused by a single dose or repeated exposure over a short time. Usually, it is reported to be accidental, however, recently acute toxicity with suicidal intent has been highlighted (Bochner & Freire, 2020; Caldas, 2016; Kamaruzaman et al., 2020), which can explain our results, since the suicide attempts was the most common intoxication circumstance.

Pesticide poisoning has been associated with relevant morbidity and mortality (Bochner & Freire, 2020; Cha et al., 2014). Our results showed that 78.54% of poisoning cases evolved with cure without sequelae and 6.46% resulted in death. It's worth mentioning that a significant percentage, 12.39% of cases, had the evolution ignored, which may contribute to a possible higher rate of morbidity and mortality due to pesticide poisoning. Diagnosis of pesticide poisoning is often based on clinical symptoms or signals developed after exposure, which is in accordance with our results, as shown in table 2. There are three main sources of data about pesticide poisoning in Brazil, the National Poisoning Information System (SINITOX), the Disease Notification Information System (SINAM) and the Mortality Information System (SIM). These sources have different objectives and mechanisms of data collection, which can make it difficult to identify the real dimension of the pesticide poisoning problem in Brazil[6]. Moreover, pesticide poisoning is a commonly underdiagnosed illness because some symptoms resemble other health problems. In some cases, patients and even health professionals may overlook the link between symptoms and pesticide exposure, which can contribute to underestimate the number of notified poisoning cases(Caldas, 2016; Kamaruzaman et al., 2020).
Thus, the number of pesticides poisoning in the state of Sergipe can be highly underestimated due to the deficiency of the data collection, which can be considered the main limitation of our study. Another important limitation was the lack of information on specific characteristics of the chemical involved in the poisoning cases, such as the name of the pesticide or its chemical classification, which may restrict the study's scope of depth. Nevertheless, our study may provide us with an insight into the human health problems caused by pesticide use, which reinforce the need of further epidemiological studies to understand the real picture of the relationship between pesticide exposure and health problems in the Brazilian population.

5. Conclusion

The pesticide poisoning is a significant public health problem in the state of Sergipe. Our results revealed that between

2007 and 2021, young female adults had higher prevalence of pesticide poisoning and the suicide attempts stand out as the main intoxication circumstance. Nevertheless, given the lack of data for several regions in the state of Sergipe, the number of pesticides poisoning cases is likely substantially underestimated. Urgent efforts are needed to improve the health surveillance data related to pesticide use to reduce the burden of pesticide poisoning in Brazil. Therefore, develop public health campaigns aimed to promote awareness of health risks of pesticide exposure, training of health professionals on the diagnosis and notification of pesticide poisoning, could be useful to improve the Brazilian pesticide poisoning databases and to reduce the pesticide poisoning cases underreporting.

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