EPIDEMIOLOGICAL PROFILE AND TEMPORAL INCIDENCE OF REPORTS OF EXOGENOUS PESTICIDES POISONING IN COLATINA/ESPÍRITO SANTO FROM 2007 TO 2019

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ABSTRACT

Introduction: Brazil is the largest consumer of pesticides in the world and Espírito Santo has the highest incidence of pesticide poisoning per person, with Colatina being the largest city in the northwestern region of the state. Purpose: To characterize the epidemiological profile and analyze the incidence of exogenous pesticide poisoning notifications in Colatina (ES), from 2007 to 2019. Materials and Methods: Descriptive study with data extracted from the Notifiable Diseases Information System and time series analysis using the Joinpoint Regression Program®. Results: There was a higher incidence among males (59.2%), in the 15-39 age group, and more records in 2013. With regard to the toxic agent, there was a higher incidence of agricultural use among men, and of rodenticide use among women. Circumstances: attempted suicide accounted for 53.1% of cases, especially among women, followed by accidental suicide (27.3%) and exposure at work (12.4%). In the temporal evaluation, there was a significant variation in the percentage of annual changes for Colatina and in the suicide attempt circumstance. Conclusion: Although toxicological incidents with pesticides have decreased over the years, their exposure results in health-damaging complications such as intoxication, especially in attempted suicide.

Key words: Agrochemicals; poisoning; suicide; health surveillance.

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1 INTRODUCTION

With a vast area of land available for planting, Brazil has become one of the main agricultural producers in the world, which acts positively on the country's economy due to large productions and massive exports (Dias *et al.,* 2021). In this sense, Brazil has become the largest consumer of pesticides in the world since 2008. Even with the economic crisis of 2014, the trend continued to grow, reaching the 500,000 tons per year mark (Tavares *et al.,* 2020). According to the Municipal Agricultural Production (IBGE, 2021), around 83.4 million hectares corresponded to areas with plantations in Brazil in 2019, which resulted in 621.02 tons of pesticides consumed in the country (IBAMA, 2021).

Although the use of pesticides is necessary for large-scale production, their toxic effect on the environment and human health is worrying (Silva *et al*., 2020). The exacerbated use of pesticides is an important source of contamination of different environmental compartments, such as water, soil, sediments and air. In addition, its inadequate and abusive use is eminently harmful to human health (Dias *et al.,* 2021), and can lead to poisoning and death (Carvalho *et al.,* 2022). Exposure to pesticides has been associated with the development of different types of cancer (Han; Kim; Song, 2019), lung diseases (Pourhassan *et al.,* 2019), reproductive damage and male infertility (Giulioni *et al.,* 2021), as well as neurodegenerative and neurodevelopmental diseases (Arab; Mostafalou, 2022). Given this scenario, there has been an increase in notifications of exogenous pesticide poisoning in the Notifiable Diseases Information System (SINAN) (Freitas; Garibotti, *et al*., 2020). Exogenous intoxication, also known as poisoning, can be attributed to the interaction of a toxic agent with the skin, eyes or mucous membranes, which causes damage to human health. This form of poisoning is usually associated with emergency situations resulting from a single or short-term exposure, and is characterized as acute. This condition can occur either accidentally or intentionally and often manifests itself with serious, life-threatening clinical signs (Romão; Vieira, 2004).

Monitoring notifications of exogenous pesticide poisoning is extremely important for public health, as a way of helping to plan public policies and define intervention priorities (Carvalho *et al.,* 2022). However, although the state of Espírito Santo has one of the highest incidences of pesticide poisoning per inhabitant (Carvalho *et al.,* 2022), analysis of the epidemiological profile of these occurrences in the state's

municipalities is still scarce. Considering that Colatina is the largest municipality in the northwest mesoregion of Espírito Santo, the aim of this study was to characterize the epidemiological profile and temporal incidence of exogenous pesticide poisoning notifications in Colatina (ES), from 2007 to 2019.

2 MATERIALS AND METHODS

This is a descriptive study and time series analysis of reports of exogenous pesticide poisoning in Colatina (ES) from 2007 to 2019. This is information from compulsory notifications that are recorded in SINAN, and therefore the data was collected from Tabnet, the tabulator of the Department of Informatics of the Unified Health System (DATASUS).

The epidemiological profile of reports of exogenous pesticide poisoning was characterized according to the following variables: distribution by sex (female and male); age group (in years: < 14, 15-39, 40-59 and > 60); race (white, black, yellow, brown and indigenous); toxic agent (agricultural pesticides, domestic pesticides, public health pesticides and rodenticides); and circumstance (accidental, attempted suicide and occupational exposure).

In addition to the descriptive analysis, the temporal incidence of notifications of exogenous pesticide poisoning in Colatina from 2007 to 2019 was also evaluated using the statistical regression software *Joinpoint*® (version 4.9.1.0). Annual incidence rates were then assessed using statistical regression analysis using inflection point analysis. The *t* test *Student* was used to compare the percentages of annual changes (APCs), which were considered statistically significant when $p < 0.05$. The regression model checks the percentage variation that occurs over the years through the APCs. All calculations were carried out with two inflection points.

It was not necessary to submit this research project to the Research Ethics Committee, since the study was carried out exclusively with secondary data obtained from a publicly accessible database, without identifying the individuals.

3 RESULTS

With regard to the epidemiological profile of exogenous pesticide poisoning notifications, Table 1 shows that the majority of cases were male, totaling 197 cases

(59%), while females accounted for 136 cases (41%). In terms of age group, there were 41 cases (12.3%) between 0 and 14 years old, 185 cases (55.5%) between 15 and 39 years old, 91 cases (27.3%) between 40 and 59 years old and 16 cases (4.8%) over 60 years old. The 15-59 age group had the highest frequency of notifications, with 82.8%. Race was another characteristic analyzed in this study, in which the highest incidence was observed in the white population, since of the 333 reported cases, 288 (86.5%) were people of this color. In addition, 13 reported cases were of people whose color was unknown, 6 cases of black people, 2 cases of yellow people and 23 cases of indigenous people.

With regard to the toxic agent, the study covered four types, shown in Table 1, according to the disposition of the relationship between exposure and sex. Toxic agents for agricultural use (57.6%) were the most common, with 51 cases in women and 141 in men. In addition, rodenticide use (32.4%) had 68 cases in women and 40 cases in men, domestic use (9.6%), 17 cases in women and 15 in men, and public health use (0.3%) with only 1 case.

In addition, it was found that men (71.6%) are more intoxicated than women (37.5%) by agricultural pesticides. On the other hand, when it comes to rodenticide use, 50% of women get intoxicated, while 20.3% of men do.

In addition, the circumstances of the notifications were also analyzed. Of the 333 cases notified on SINAN between 2007 and 2019 (Table 1), three categories stand out: attempted suicide (53.1%), accidental (27.3%) and exposure at work (7.2%), accounting for 309 (87.6%) of the total cases notified. Attempted suicide was the category with the most notifications, with 177 of the 309 cases (Table 1).

TABLE 1: CHARACTERISTICS OF CASES OF EXOGENOUS PESTICIDE POISONING IN COLATINA/ES, FROM 2007 TO 2019

Criteria	Female		Male		Total	
Age group (years)	**N**	%	**N**	%	**N**	%
0 a 14	24	7.2	17	5.1	41	12.3
15 a 39	77	23.1	108	32.4	185	55.6
40 a 59	29	8.7	62	18.7	91	27.3
60 or more	6	1.8	10	3.0	16	4.8
Race/color						
Ign/ white	4	1.2	9	2.7	13	3.9
White	119	35.7	169	50.8	288	86.5
Black	3	0.9	3	0.9	6	1.8
Yellow	0	0.0	2	0.6	2	0.6
Brown	10	3.0	13	3.9	23	6.9
Indigenous	0	0.0	1	0.3	1	0.3
Toxic Agent						
Agricultural use	51	15.3	141	42.4	192	57.6
Domestic use	17	5.1	15	4.5	32	9.6
Public health use	0	0.0	1	0.3	1	0.3
Use of rodenticide	68	20.4	40	12.0	108	32.5
Circumstances						
Accidental	28	8.4	63	19.0	91	27.3
Suicide attempt	95	28.5	82	24.6	177	53.1
Exposure to work	5	1.5	36	10.8	41	12.4
Others	8	2.4	16	4.8	24	7.2
Total	**136**	**40.8**	**197**	**59.2**	**333**	**100**

N: number of cases; %: percentage.
Source: Datasus, 2022

Figure 1 shows that there were wide variations over the years, with 2009 (2 cases) and 2013 (29 cases) having the lowest and highest number of cases, respectively. In contrast, in 2010, it was the only notification under the accidental category. All the other cases in the period studied were higher for this type of poisoning (Figure 1).

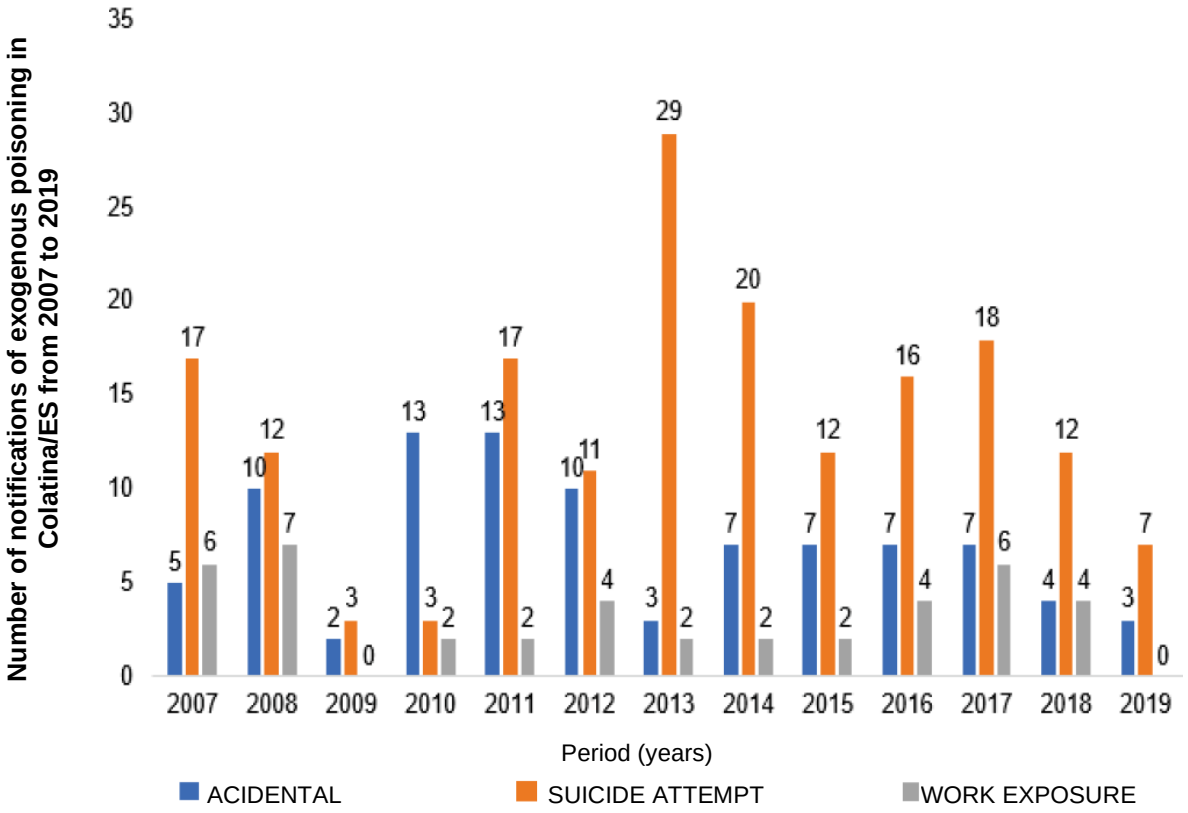

Figure 1: Number of notifications of exogenous pesticide poisoning according to the circumstances of attempted suicide, accidental suicide and occupational exposure in Colatina/ES, 2007-2019
Source: Datasus, 2022

Suicide attempts through exogenous pesticide poisoning were predominantly among women, with the exception of the 40-59 age group, as shown in Table 2. In addition, in the accidental condition, there was a higher occurrence of cases among men (69.2%), who accounted for 63 of the 91 notifications (Table 2). However, there has been a significant decline since 2011, from 13 to 3 cases in 2 years. Although there was an increase in the following years, in 2019 there were only 3 notifications (Figure 1).

Finally, in relation to exposure to work (Table 2), there was a pattern similar to the general aspect, since the highest occurrence was among men, 36 cases out of the 41 recorded, and in the 15-39 age group, 26 cases in total. Poisoning occurred predominantly in the 40-59 age group, accounting for 31.7% of cases, with 11 occurrences among men and 2 among women. The 0-14 age group did not report any cases of this exposure and the over-60 age group only reported 2 cases for women (Table 2).

TABLE 2: DISTRIBUTION OF CASES OF EXOGENOUS PESTICIDE POISONING ACCORDING TO THE CIRCUMSTANCES OF ATTEMPTED SUICIDE, ACCIDENTAL SUICIDE AND OCCUPATIONAL EXPOSURE IN COLATINA (ES), 2007-2019 (DATASUS, 2022).

Suicide attempt						
			Sex			
Age group	**Female**			**Male**	**Total**	
(years)	**N**	%	**N**	%	**N**	%
0 a 14	6	3.4	4	2.3	9	7.9
15 a 39	61	34.3	45	25.4	67	58.8
40 a 59	23	13	30	17	33	29
60 or more	5	2.9	3	1.7	5	4.3
Total	95	53.6	**82**	**46.4**	**177**	100
			Accidental			
			Sex			
Age group	**Female**			**Male**	**Total**	
(years)	**N**	%	**N**	%	**N**	%
0 a 14	16	17.5	12	13.2	28	30.8
15 a 39	9	9.8	34	37.6	43	47.2
40 a 59	3	3.2	14	15.4	17	18.7
60 or more	0	0	3	3.3	3	3.3
Total	28	30.5	63	69.5	**91**	100
			Exposure to work			
			Sex			
Age group	**Female**			**Male**	**Total**	
(years)	**N**	%	**N**	%	**N**	%
0 a 14	0	0	0	0	0	0
15 a 39	1	2.4	25	61	26	63.4
40 a 59	2	4.9	11	26.8	13	31.7
60 or more	2	4.9	0	0	2	4.9
Total	5	**12.2**	36	**87.8**	**41**	100

N: number of cases; %: percentage.
Source: Datasus, 2022

In the temporal analysis using *Joinpoint®,* the trend of the indicator was calculated (stationary, increasing or decreasing), as well as the change that occurred at the two inflection points for the period from 2007 to 2019. The APC in Colatina (ES) (Figure 2A) has decreased by 15.53% since 2012 (p = 0.04). However,

2013 saw a peak with 57 (17%) cases, which is around 47.4% more than the previous year. Figure 2B shows that, in the case of attempted suicide, there was a significant increase ($p < 0.001$) in notifications of exogenous pesticide poisoning from 2009 to 2013, followed by a downward trend in notifications from 2013 onwards. On the other hand, in the accidental circumstance (Figure 2C), there was no significant difference ($p = 0.72$) in APC. However, in the occupational exposure scenario (Figure 2D), the APC showed an upward trend ($p = 0.07$) in notifications from 2009 to 2017.

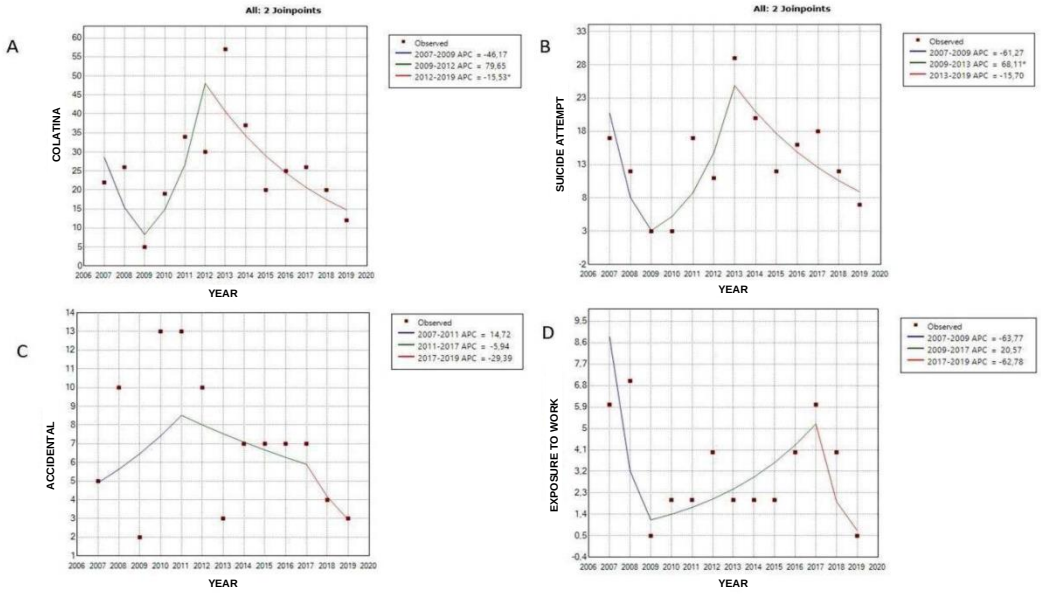

Figure 2: Temporal analysis of the incidence of exogenous pesticide poisoning notifications in Colatina (ES) (3A), in the circumstances of attempted suicide (3B), accidental (3C) and occupational exposure (3D), from 2007 to 2019.

*Indicates that the change in the annual percentage change (APC) is significantly different from zero at the alpha = 0.05 level.

Source: Datasus, 2022

4 DISCUSSION

The incidence of notifications of exogenous pesticide poisoning in Colatina was significant, although it has shown a downward trend over the years. Among the records, there is more data among men compared to women, especially in cases of accidental circumstances and exposure at work. This may be due to the higher prevalence of men working in rural areas (Silva *et al.,* 2017), associated with the refusal to use personal protective equipment, on the grounds of discomfort and heat (Vieira *et al.,* 2018). This can have a significant impact on the late onset of health

problems, since pesticides have the characteristics of slow-acting neurotoxins (Kós *et al*, 2013). Thus, mild symptoms, such as headache and nausea, are not seen as intoxication, which leads to the exacerbated use of agricultural inputs (Silva *et al.,* 2017).

In terms of age distribution, there is a higher incidence in the age group corresponding to the economically active population (15 to 39 years). Therefore, there is a constant concern from the economic and health spheres, since it implies higher expenses with treatments and loss of labor (Carvalho *et al*., 2022). When the race of the population of Colatina is analyzed, there is a higher frequency of white people in all circumstances. This can be explained by the fact that the municipality was colonized by migrating Italians and Germans in the 19th century (PROATER, 2023).

With regard to the toxic agent, the predominance of rural work makes workers, especially men, more exposed to poisoning. Silva *et al*. (2017) corroborate this fact, while at the same time, in their study, they make it clear that the proportion of men working in the field compared to women leads to more cases of contamination. However, the domestic environment is also a target for contamination, due to the indiscriminate use of insecticides, such as Baygon®, an organophosphate present in the daily lives of the population (Dias *etal.,* 2021). As a result, children become targets for rodenticide poisoning due to the ease of access at home, and are therefore more vulnerable (Pascale; Laborde, 2020).

With regard to the circumstance of attempted suicide, the analysis using *Joinpoint*® showed a statistically significant relationship, with an emphasis on females, who had a higher number of notifications on SINAN. Vieira *et al.* (2015) reinforce these findings by reporting that women attempt suicide by exogenous intoxication four times more often than men, but that men reach the favorable event three times more often than women. In this context, an association has been identified between this event and depressive disorders, which occupy one of the top four positions among the causes of disability in Brazil, with a higher incidence in women (Bonadiman *et al.,* 2020). Allied to this is the fact that women use more medication and less painful alternatives, while men seek more lethal and effective means, such as hanging (Calixto Filho; Zerbini, 2016). On a global scale, suicide is the 4th cause of death among young people aged 15 to 29 (WHO, 2019). Thus, suicidal ideation and suicide attempts are strong predictors of suicide deaths, which

can result in consequences or even sequelae such as injuries, hospitalization and loss of liberty, in addition to exerting a financial burden of billions of dollars on society (Klonsky; May; Saffer, 2016).

Regarding accidental exposure, the most common cause is the domestic route, which accounts for around 0.4% of lethality and mainly affects children and the elderly due to improper use or inadequate consumption of insecticide (Queiroz *et al.,* 2020), and aldicarb, popularly known as chumbinho, for the extermination of rodents (Burity, 2019). Furthermore, it is known that of the 50 pesticides used in Brazil, 20 are banned in other parts of the world. Therefore, the Ministry of Health points out that approximately 500,000 Brazilians are poisoned by accidental ingestion every year, since food contains more pesticides than recommended for human consumption (Araújo; Oliveira, 2016). From this perspective, the studies by Bernardes *et al.* (2018) agree with studies by Araújo and Oliveira (2016), indicating that 70.3% of food poisoning had no known cause between 2007 and 2016. Thus, although the regression analysis did not indicate significance in our study, it is important to consider this possibility of contagion.

In addition, there is a direct relationship between cases of poisoning at work and the improper use or absence of personal protective equipment in the face of worker resistance (Silva *et al.,* 2020). Furthermore, it should be noted that the labor sphere that has access to pesticides goes beyond rural workers who work in the fields. Endemic agents and aerial applicators also make up the risk group for this type of poisoning (Neves *et al.,* 2020), requiring managerial attention.

However, given these findings, it is important to note that this study has some limitations. These limitations include the possibility of incorrectly filling in information on notification forms; a possible occurrence of underreporting, especially in relation to poisoning due to attempted suicide, due to a lack of knowledge; restrictions on users' access to health services, especially in rural areas; challenges faced by health professionals in making accurate diagnoses and the tendency for exposure to normalize.

Although there are limiting aspects, this study lends itself to directing health actions and interventions in the region. Evaluating and measuring cases of exogenous intoxication is an important epidemiological tool, enabling analysis of the factors involved, as well as the populations most affected (Diógenes *et al.,* 2022). Information on epidemiological data on exogenous poisoning by pesticides is

therefore necessary for the development of public policies aimed at reducing these problems. These policies can encompass programs aimed at improving surveillance; identifying vulnerable groups and improving the assessment of such circumstances; raising awareness and disseminating knowledge, as well as increasing access to health services for vulnerable groups (Diógenes *et al.,* 2022).

5 CONCLUSION

Although toxicological incidents involving pesticides have decreased over the years, exposure to this toxic agent results in complications that are harmful to human health, such as poisoning, especially in the attempted suicide category. Based on this, as the use of pesticides in the country is long-lasting, with an emphasis on agricultural municipalities, it is necessary to study alternative ways of reducing exposure and the risks associated with these substances in Brazil. An alternative would be agroecology to provide a minimally sustainable environment.

Finally, data collection limited to public domain platforms was seen as a limiting factor for this study, which, because they are fed by the health services, are subject to the loss of information relevant to the research, making an active search necessary.

FINANCING

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