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INCIDENCE OF PESTICIDE POISONING IN BRAZIL BETWEEN 2014 AND 2024

INCIDÊNCIA DE INTOXICAÇÕES POR AGROTÓXICOS NO BRASIL ENTRE 2014 E 2024

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Abstract

Brazil is the world leader in pesticide consumption, with more than 700,000 tons per year, which increases the risk of poisoning, especially among agricultural workers. This study analyzed the incidence of exogenous pesticide poisoning in Brazil between 2014 and 2024, identifying the most vulnerable groups and the regions with the highest number of cases. This retrospective ecological study, with a quantitative approach, was based on secondary data from the Notifiable Diseases Information System collected in January 2025. Geographic region, gender, race/skin color, age, educational level, occupation, and case evolution were analyzed. The study recorded 76,435 cases of pesticide poisoning between 2014 and 2024; most were concentrated in the Southeast (26.2%) and South (22.6%). Men (64.0%), individuals of brown skin color (42.8%), and agricultural workers (31.2%) were the most affected. Individuals aged between 20 and 39 represented 42.6% of occurrences. The study identified 584 cases of pesticide poisoning in pregnant women, with a higher incidence in the first trimester. Therefore, this study reinforces the need to control the use of pesticides, in addition to reinforcing training programs for agricultural workers, especially those in the most affected regions, such as the Southeast and South.
Keywords: Pesticides, Brazil, Public health, Epidemiological profile.

Resumo

O Brasil lidera o consumo mundial de agrotóxicos, com mais de 700 mil toneladas aplicadas anualmente, o que o que implica em riscos potenciais à saúde humana, especialmente entre os trabalhadores rurais. Este estudo teve como objetivo analisar a incidência de intoxicações exógenas por agrotóxicos no Brasil entre 2014 e 2024, identificando os grupos mais vulneráveis e as regiões com maior número de casos. Trata-se de um estudo ecológico retrospectivo, com abordagem quantitativa, baseado em dados secundários do Sistema de Informação de Agravos de Notificação (SINAN), coletados em janeiro de 2025. Foram analisadas variáveis como região geográfica, sexo, raça/cor, faixa etária, escolaridade, ocupação e evolução do caso. Entre 2014 e 2024, foram registrados 76.435 casos de intoxicação, com maior concentração nas regiões Sudeste (26,2%) e Sul (22,6%). Homens (64%), pessoas pardas (42,8%) e trabalhadores agropecuários (31,2%) foram os mais afetados. 42,6% dos casos ocorreram em indivíduos entre 20 e 39 anos. Também foram notificadas 584 intoxicações em gestantes, com maior incidência no primeiro trimestre gestacional. Conclui-se que as intoxicações por agrotóxicos no Brasil evidenciam um importante problema de saúde pública, associado a desigualdades regionais e sociais. Homens jovens, pardos, com baixa escolaridade e trabalhadores rurais são os mais vulneráveis. Além disso, as exposições indiretas e os efeitos sobre gestantes denotam riscos multigeracionais, o que exige uma abordagem sistêmica, com políticas que integrem regulação sobre o uso dos agrotóxicos, capacitação dos trabalhadores e vigilância dos casos de intoxicações, bem como o efetivo monitoramento ambiental, ocupacional e epidemiológico.
Palavras-chave: Agrotóxicos, Brasil, Saúde pública, Perfil epidemiológico.

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INTRODUCTION

According to the Food and Agriculture Organization of the United Nations, in 2021, Brazil was the largest consumer of pesticides worldwide, with about 720,000 tons applied in agriculture, which is 60% higher than the United States, the second-largest consumer (FAO, 2023).

The high level of pesticide use in Brazil is related to an intensive agricultural production model that seeks to maximize productivity. Additionally, climatic conditions, such as high temperatures and humidity, favor the proliferation of pests and weeds and increase the demand for pesticides (FRANCO et al., 2021; RIBEIRO et al., 2022).

According to the Center for Advanced Studies in Applied Economics in Brazil, the employment in the Brazilian agribusiness sector reached 28.6 million people in the first quarter of 2024, a 3% increase compared with the same period in 2023 (CEPEA, 2024). Most of these people are agricultural workers who experience direct contact with pesticides (NOGUEIRA et al., 2020). Exposure to these substances may cause the development of health conditions and poisoning, whether acute or chronic. The literature describes various types of pesticide-related toxicity, such as neurotoxicity, genotoxicity, endocrine disruption, and carcinogenicity (AHMAD et al., 2024). The risks are exacerbated in agricultural regions where regulatory surveillance of pesticide use is inadequate (PIGNATI et al., 2022; ROCHA; ALVAREZ, 2023).

The Food and Agriculture Organization of the United Nations, the International Labour Organization, and the United Nations emphasize that pesticide poisoning may occur under various circumstances, including during handling, dilution, mixing, application, or disposal of the product. Additionally, workers may be exposed by entering recently sprayed fields, cleaning equipment (e.g., sprayers), or washing contaminated clothing (FAO, 2020; WHO, 2020; ILO, 2022).

In Brazil, cases of pesticide poisoning are reported by the Health Information Department of the Unified Health System (DATASUS) through the Notifiable Diseases Information System (SINAN). This system is crucial for monitoring poisoning cases, identifying vulnerable groups, and analyzing occurrence patterns across different regions of the country (QUEIROZ et al., 2019).

Investigating the variables related to pesticide poisoning in SINAN is crucial for informing public policies aimed at preventing and controlling this issue. Data analysis helps identify reporting gaps, assess the quality of recorded information, detect potential underreporting, and support the development of more effective strategies for protecting the health of workers and the population exposed to pesticides (BRASIL, 2018). Thus, this study aimed to examine the incidence of exogenous pesticide poisoning in Brazil between 2014 and 2024.

MATERIAL AND METHODS

A retrospective ecological study with a quantitative approach was conducted using secondary data on exogenous pesticide poisonings in Brazil from 2014 to 2024. Data were extracted from SINAN (available by DATASUS), last updated in December 2024. Data collection occurred in January 2025, based on records of hospitalizations due to pesticide-related poisonings.

The variables analyzed encompassed geographic region (North, Northeast, Southeast, South, and Midwest); year of notification (2014 to 2024); occupation (top 10 occupations with the highest number of cases); gender (male, female, and unknown); race/skin color (white, black, brown, yellow, indigenous, and unknown), age (divided into 11 categories, ranging from under one to over 80 years), educational level, and case outcome (recovery with or without sequelae, death due to poisoning or other causes, loss to follow-up).

The diagnoses followed the International Statistical Classification of Diseases and Related Health Problems (ICD-10) using codes X48.0 to X48.9, which correspond to accidental poisoning and exposure to pesticides. Data were organized in tables and analyzed descriptively using absolute and relative frequencies. Proportions were calculated to identify the distribution of cases according to the variables analyzed.

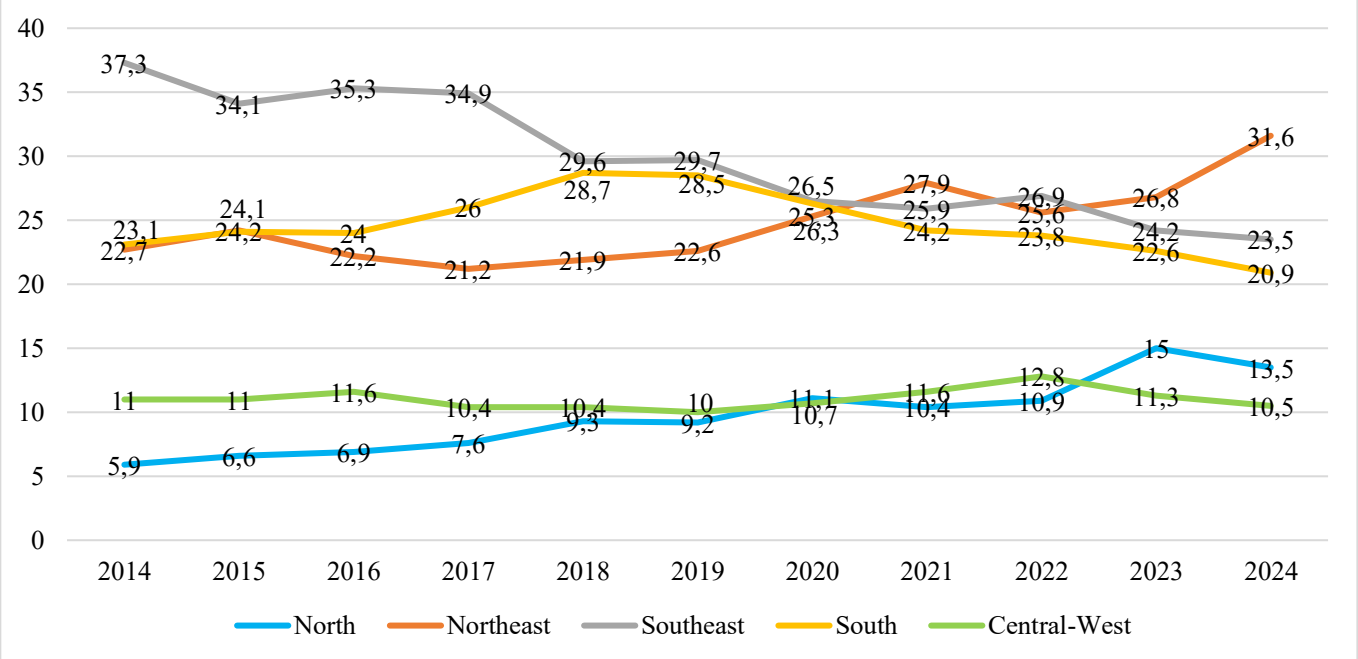
Some limitations inherent to the use of secondary data from DATASUS should be highlighted. The underreporting of pesticide poisoning hinders the accurate estimation of cases. Additionally, the quality of the data may vary across the five regions and depend on the training of local health teams in completing the notification forms. The absence of laboratory data to confirm poisoning also restricts the accuracy of the diagnosis. Furthermore, the quantitative and secondary pattern of the data prevents the acquisition of relevant qualitative information, such as the context of exposure, type of pesticide, duration of exposure, and measures taken following the poisoning incident.

This study used secondary data available from SINAN and did not require ethical approval from the research ethics committee, as per Resolution No. 510 of April 7, 2016, issued by the Brazilian National Health Council.

RESULTS AND DISCUSSION

A total of 76,435 cases of pesticide poisoning were reported in Brazil between 2014 and 2024. Figure 1 presents data on notifications of exogenous pesticide poisoning across the five Brazilian regions during this period. The Southeast and South recorded the highest numbers of notifications, with 20,061 and 17,272 cases, respectively. The highest number of notifications was registered in 2023, with 9,058 cases. Pesticide poisoning rates were significantly increased between 2014 and 2024, particularly in the North, where the proportion rose from 5.9% in 2014 to 15.0% in 2023. In the Northeast, the percentages rose from 21.2% in 2017 to 31.6% in 2024.

Figure 1. Percentage of reported cases of exogenous pesticide poisoning from 2014 to 2024 by Brazilian regions and their respective annual percentages.



Source: Ministry of Health – Brazilian Unified Health System Hospital Information System (SIH/SUS).

Between 2014 and 2024, the states of Paraná (PR), São Paulo (SP), and Minas Gerais (MG) recorded the highest numbers of pesticide poisoning (16.89%, 16.82%, and 14.74% of total

cases, respectively). Among other states, Bahia (BA) exhibited notable variation, with the number of cases increasing from 298 in 2014 to 604 in 2024, representing a 102.7% increase over the period (Table 1).

Table 1. Distribution of pesticide poisoning notifications in the ten Brazilian states with the highest incidence from 2014 to 2024.

Ano	CE	ES	SC	GO	BA	RS	PE	MG	SP	PR
2014	252	457	405	414	298	194	587	864	1,078	946
2015	312	381	434	285	343	228	606	770	945	888
2016	210	465	391	350	243	350	646	726	969	787
2017	184	544	464	419	253	531	710	854	1.131	964
2018	184	567	484	494	402	613	738	800	921	1.244
2019	211	593	544	500	398	765	787	842	997	1.139
2020	220	3	305	351	300	443	637	714	785	859
2021	220	-	262	371	364	402	591	654	725	735
2022	251	-	250	369	355	410	473	767	731	772
2023	425	-	368	502	804	659	657	1.067	993	1.024
2024	253	-	251	249	604	348	440	626	638	593
Total	2.722 (4.62%)	3.010 (5.11 %)	4.158 (7.06 %)	4.304 (7.31 %)	4.364 (7.41 %)	4.943 (8.39 %)	6.872 (11.66 %)	8.684 (14.74 %)	9.913 (16.82 %)	9.951 (16.89 %)

Source: Ministry of Health – Brazilian Unified Health System Hospital SUS Information System (SIH/SUS). CE: Ceará; ES: Espírito Santo; SC: Santa Catarina; GO: Goiás; BA: Bahia; RS: Rio Grande do Sul; PE: Pernambuco; MG: Minas Gerais; SP: São Paulo; PR: Paraná.

According to the literature, the predominance of pesticide poisoning cases in the Southeast and South (particularly in Paraná, São Paulo, and Minas Gerais states) is associated with the high volume of pesticide sales in these areas. According to Landau and Guimarães (2020), the Southeast and South accounted for the largest pesticide sales in the country, totaling over 120,000 tons of active ingredients between 2000 and 2010.

Although the average land area of agricultural establishments in the Southeast and South is smaller than in other regions (Midwest and North), producers in these regions benefit from better infrastructure and higher income, facilitating the acquisition of agricultural inputs, such as pesticides (EMBRAPA, 2023).

Among the pesticide poisoning notifications in Brazil between 2014 and 2024, most cases occurred among males (64.0%), individuals of brown skin color (42.8%), and those aged between 20 and 39 years (42.6%). Pesticide poisonings were also more common among individuals with incomplete elementary education (43.1%) and in agricultural workers (31.2%) (Table 2).

The highest percentage of poisonings among men is consistent with the literature, which indicates that they are more often exposed to these substances, especially agricultural workers. The high level of exposure to pesticides, irregularities in their use, and improper handling of personal protective equipment increase vulnerability among men (ROCHA & OLIVEIRA, 2016; RISTOW et al., 2020). Bochner and Freire (2020) also

observed higher lethality due to pesticide poisoning among men.

Table 2. Characterization of pesticide poisoning cases in Brazil between 2014 and 2024.

Sex	**Total Cases (%)**
Male	48.929 (64)
Female	27.499 (36)
Race/Color	
Brown	32.675 (42.8)
White	29.476 (38.6)
Black	4.572 (6.0)
Indigenous	352 (0.5)
Age Group (years)	
<1 year	1.250 (1.6)
01–09	7.636 (10.0)
10–19	7.810 (10.2)
20–39	32.519 (42.6)
40–59	21.077 (27.6)
60–79	4.151 (5.4)
80+	500 (0.7)
Education Level	
Incomplete Primary Education	18.161 (43.1)
Completed Secondary Education	10.222 (24.3)
Illiterate	1.114 (2.6)
Occupation	
General agricultural producer	9.281 (31.2)
Farm caretaker	1.024 (3.4)
Not reported	1.159 (3.9)
Multipurpose crop producer	1.497 (5.0)
Chronically unemployed or occupation not reported	1.594 (5.4)
Retired/pensioner	2.024 (6.8)
Housewife	3.666 (12.3)
Migrant agricultural worker	4.005 (13.5)
Student	4.653 (15.7)

Source: Ministry of Health – Brazilian Unified Health System Hospital SUS Information System (SIH/SUS).

Freitas and Garibotti (2020) demonstrated that most pesticide poisoning cases in Southern Brazil were linked to the indiscriminate use of these substances and the strong presence of agribusiness, disproportionately affecting agricultural workers.

The higher prevalence among individuals of brown skin color, between 20 and 39 years old, and with low educational levels corroborated the findings of Freitas and Garibotti (2020), Buralli et al. (2021), and Bedor et al. (2022).

Education plays a crucial role in adopting safety and health prevention measures (BURALLI et al., 2021). Low educational levels hinder the understanding of instructions related to the safe use of pesticides. Furthermore, the information provided on pesticide labels often employs technical and complex language, which family farmers may not understand, necessitating training

initiatives for adequate communication of pesticide risks to agricultural workers.

Social determinants play a crucial role in the vulnerability of agricultural workers to pesticide poisoning (PERES et al., 2016). Exposure to these substances is a result of improper technical use and is influenced by low educational levels, social exclusion, limited access to information and healthcare, and inadequacies in public health surveillance policies.

According to Varona et al. (2016), the most severe cases of pesticide poisoning are associated with low educational levels, limited participation in the social security system, and the presence of comorbidities, such as cardiovascular diseases, diabetes, and chronic infections. Moreover, the exclusion of farmers from formal protection mechanisms, such as occupational health surveillance systems and risk monitoring, combined with informal labor relations and structural poverty, contributes to the persistence of unsafe pesticide practices.

A significant concern in environmental health is the vulnerability of household and family members who are not directly involved in pesticide application but share the same environment as exposed individuals. The contact with contaminated clothing, often handled by women during domestic work, is among these secondary exposure routes. Even after conventional washing processes, pesticide residues may remain in textile fibers, representing a continuous source of indirect exposure for other family members, including children and older adults. Furthermore, the presence of adjuvants and inert ingredients in commercial pesticide formulations may hinder the complete removal of these substances, increasing the risk of unintentional acute poisonings (ASMARE et al., 2022; KAPELEKA et al., 2025).

The progression of pesticide poisoning cases in Brazil between 2014 and 2024 is presented in Table 3. The available outcome categories were "unknown" (or "blank unknown"), recovery without sequelae, recovery with sequelae, death due to poisoning, death from other causes, and loss to follow-up. Reports of pesticide poisonings classified as "unknown" (or "blank unknown") and those with loss to follow-up showed the highest percentages (77.5% and 14.7%, respectively), which hampered the determination of the outcomes of these cases. Recovery with sequelae was the most common outcome, with 1,932 cases (3.0%).

Table 3. Trends in reported cases of pesticide poisoning in Brazil from 2014 to 2024.

Year	Ign Blank	Recovery without sequelae	Recovery with sequelae	Death due to poisoning	Death from other causes	Loss to follow-up
2014	5.528 (82,5%)	125 (1,9%)	186 (2,8%)	15 (0,2%)	110 (1,6%)	734 (10,9%)
2015	5.106 (79,4%)	105 (1,6%)	210 (3,3%)	16 (0,2%)	118 (1,8%)	885 (13,8%)
2016	4.949 (77,6%)	131 (2,1%)	221 (3,5%)	17 (0,3%)	109 (1,7%)	942 (14,8%)
2017	6.007 (79,6%)	146 (1,9%)	195 (2,6%)	26 (0,3%)	93 (1,2%)	1.082 (14,3%)
2018	6.620 (81,1%)	147 (1,8%)	228 (2,8%)	21 (0,3%)	144 (1,8%)	988 (12,1%)
2019	7.035 (81,8%)	137 (1,6%)	176 (2,1%)	21 (0,2%)	181 (2,1%)	1.042 (12,1%)
2020	4.817 (79,0%)	94 (1,5%)	135 (2,2%)	16 (0,3%)	162 (2,7%)	876 (14,3%)
2021	4.449 (77,1%)	104 (1,8%)	169 (2,9%)	13 (0,2%)	153 (2,7%)	887 (15,4%)
2022	4.615 (76,8%)	125 (2,1%)	139 (2,3%)	19 (0,3%)	77 (1,3%)	1.035 (17,2%)
2023	6.930 (76,5%)	151 (1,7%)	162 (1,8%)	29 (0,3%)	165 (1,8%)	1.621 (17,9%)
2024	4.457 (78,4%)	89 (1,6%)	110 (1,9%)	7 (0,1%)	83 (1,5%)	950 (16,7%)
Total	49.057 (77,5%)	1.223 (1,9%)	1.932 (3,0%)	180 (0,3%)	1.235 (1,9%)	9.362 (14,7%)

Source: Ministry of Health – Brazilian Unified Health System Hospital SUS Information System (SIH/SUS).

The high percentage of "unknown" cases and loss of follow-up suggest important gaps in data collection. These data fail to generate meaningful information, highlighting the importance of conducting systematic evaluations and developing mechanisms to integrate health information

systems. Challenges persist regarding the need to enhance data quality despite the recent improvements to these systems. These improvements are crucial for providing reliable information to inform public policies and health actions (SANTOS et al., 2013; ALBUQUERQUE et al., 2015).

The gaps in the recording of pesticide poisoning case outcomes may limit the understanding of the magnitude of the problem. On the other hand, recovery with sequelae accounted for 3.0% of cases, a low number that reveals pesticide poisoning may not be only acute but also lead to chronic consequences or long-term sequelae, including neurological, hepatic, respiratory, or cardiac damage, sepsis, or other adverse health effects; although not initially perceived, they may impair the quality of life of exposed individuals (OKUYAMA et al., 2017; NEVES et al., 2020).

Suicide attempts constitute one of the main factors associated with pesticide poisoning in Brazil. These events often occur impulsively and with little premeditation, being more common among adolescent girls and young adult women. In these cases, the chosen method tends to be the most accessible in the home or family environment (GONDIM et al., 2017).

Data from the National System of Toxic-Pharmacological Information indicates that suicide attempts were responsible for many pesticide poisoning cases in Brazil between 2014 and 2017, accounting for 34.3% in 2014, 29.2% in 2015, 28% in 2016, and 28.1% in 2017.

A study conducted in Fortaleza (Ceará, Brazil) found that pesticides were among the main agents involved in suicide attempts, with particular attention to their lethality. Of the 16 death cases, 15 were due to exposure to these substances (GONDIM et al., 2017).

Neves and Bellini (2013) emphasized that public health policies must include strategies for the surveillance and monitoring of populations exposed to pesticides. Advancing policies beyond the regulation of pesticide use and promoting effective measures are also needed to reduce the use of these compounds, whose toxicity leads to thousands of cases of diseases and death in Brazil and other countries.

Figure 2 presents the distribution of pesticide poisoning cases among pregnant women in Brazil between 2014 and 2024, categorized by gestational trimester. A total of 584 cases were reported, with the highest concentrations in the first (204 cases) and second trimesters (200 cases), which together accounted for about 69.0% of the notifications. In the third trimester, 113 cases were recorded, with 67 cases (11.5%) having an unknown gestational age.

The effects of pesticide exposure during pregnancy have been widely investigated. A study conducted by Ueker et al. (2016) in Mato Grosso (Brazil) observed a significant association between parental exposure to pesticides and congenital malformations in children under five years of age. A higher risk was observed in cases of paternal exposure through agricultural activities, especially when mothers had a low educational level. Additionally, indirect contact, such as washing the contaminated clothing of exposed fathers, was also associated with an increased risk of malformations.

The presence of pesticides in maternal and fetal organisms was confirmed by Prahl et al. (2021); the authors detected pesticide residues in maternal, umbilical cord, and newborn blood. Exposure during pregnancy was shown to directly impact the fetal immune system, with a reduction in CD4 T cells and alterations in immune response, indicating that transplacental transfer may result in long-lasting health effects for the child.

Other studies reinforce the potential perinatal harm associated with pesticide exposure. Exposure to high doses may result in low birth weight and prematurity (MOTHER TO BABY, 2023). Addissie et al. (2020) emphasized that maternal exposure to pesticides increases the risk of holoprosencephaly, a severe brain malformation. Similarly, Felisbino et al. (2024) reported that exposed pregnant women exhibit higher concentrations of pesticides in maternal serum, placental tissue, and umbilical cord, confirming embryonic exposure and highlighting the risks to fetal development.

This study showed that most poisoning cases occurred during the first and second trimesters of pregnancy (critical periods for fetal development). The exposure of pregnant women to pesticides represents a noteworthy risk factor. It underscores the need for protective measures targeting them, especially in agricultural environments, with a focus on continuous monitoring of maternal-fetal health (BLIZNASHKA et al., 2023).

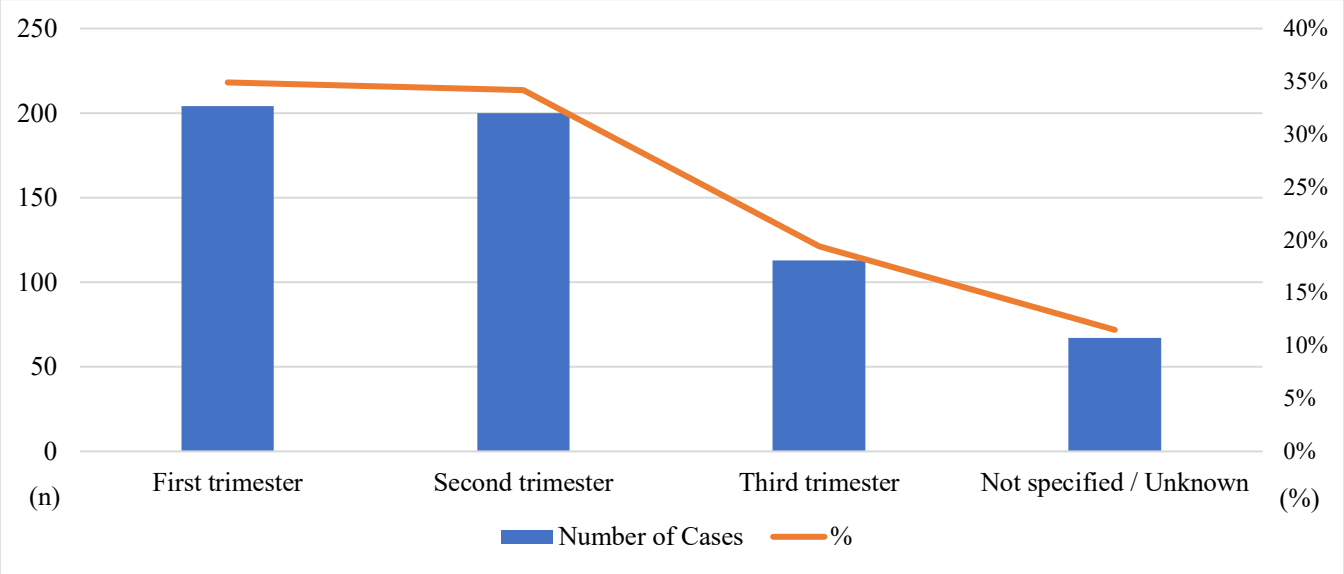
Passive exposure of infants to pesticides poses a notable health risk due to the chemical properties

of these substances, which facilitate their environmental dispersion and bioaccumulation. Lipophilic pesticides can accumulate in adipose tissue and may be transferred to infants through breast milk, whose high lipid content potentially disseminates these contaminants (FIGUEIREDO et al., 2024).

Studies conducted in Latin America since the 1990s have demonstrated the persistence of pesticide residues in breast milk. In Ribeirão Preto (São Paulo, Brazil), the presence of dichlorodiphenyltrichloroethane was detected in 100% of the analyzed samples, with significantly higher concentrations in women with occupational exposure than in those unexposed (MATUO et al., 1992). Similarly, analyses conducted in Mexico found pesticide-derived compounds in 76.0% of the breast milk samples (CHÁVEZ-ALMAZÁN et al., 2020).

Over a thousand chemical compounds currently on the market are estimated to exhibit endocrine-disrupting activity, which is essential for the growth and maturation of the human body. Therefore, the transfer of pesticide residues through breastfeeding is a potential route of early exposure, capable of causing hormonal, neurodevelopmental, and immune dysfunctions in infants (GORE et al., 2014; FIGUEIREDO et al., 2024).

Figure 2. Reported cases of pesticide poisoning in pregnant women in Brazil between 2014 and 2024.



Source: Ministry of Health – Hospital Information System of the Brazilian Unified Health System (SIH/SUS).

CONCLUSION

Data reveal a concerning scenario, with a high number of cases in the Southeast and South. The North also presents a concern, where pesticide poisoning increased, especially in 2023, indicating an expansion into areas that previously reported lower numbers.

Most cases were observed among agricultural workers, particularly individuals of brown skin color, males, between 20 and 39 years old, and with low educational levels. These findings highlight the vulnerability of this group, especially regarding the proper handling of pesticides in agricultural practices. Furthermore, the exposure among pregnant and lactating women underscores the severity of contamination in vulnerable populations, evidencing multigenerational risks. Thus, prevention and safety in agricultural labor are essential to reduce pesticide poisoning cases.

The sociodemographic profiles reveal the increased vulnerability of young men of brown skin color, with low educational levels, working in the agricultural sector. This pattern reflects a direct

relationship between the social determinants of health and the occupational risks associated with pesticide use, highlighting deficiencies in technical training, access to information, social protection, and health surveillance.

Additionally, the high percentage of cases with unknown outcomes (categorized as "unknown" and "loss to follow-up") suggests a potential weakness in the reporting system. It emphasizes the need for improvements in monitoring and follow-up of affected individuals. The presence of sequelae in pesticide poisoning cases emphasizes the severity of these events, which may result in irreversible health damage among those exposed to these substances.

In summary, a systemic approach is needed, with more effective public policies to regulate and supervise pesticide use, promote strategies for worker protection, training, and surveillance of poisoning cases. Additionally, global environmental, occupational, and epidemiological monitoring must be ensured.

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