







Notifiable Diseases Information System and human poisoning by pesticides in Brazil

Sistema de Informação de Agravos de Notificação e as intoxicações humanas por agrotóxicos no Brasil

Paulo Roberto Queiroz^I , Kenio Costa Lima^{II} ,
Tamires Carneiro de Oliveira^I , Marquiony Marques dos Santos^{II} ,
Jadson Ferreira Jacob^{III} , Andréa Maria Brandão Mendes de Oliveira^{IV} 

ABSTRACT: *Objective:* To analyze trends in pesticide poisoning incidence rates in Brazilian regions, according to sex and circumstances of poisoning, between 2001 and 2014. *Method:* Ecological time-series study, with data from the national Notifiable Diseases Information System (SINAN). The incidence rates were calculated by dividing the number of confirmed new cases of pesticide poisoning by the total resident population in the same period and location. Both Polynomial regression analysis and Mann-Whitney and Kruskal-Wallis tests were performed. When significant differences were found, these tests were followed by the Bonferroni penalty, in order to identify the difference more precisely. *Results:* In Brazil, 80,069 notified poisoning cases were recorded from 2001 to 2014. There was a steadily increasing growth of pesticide poisoning in this population, whose growth trend was 0,377 for 100,000 inhabitants per year. The highest incidence of poisoning occurred in the South and Midest Regions. Regarding sex, no significant differences were found ($p < 0,347$), and attempted suicide was the most significant circumstance of poisoning ($p < 0,001$). *Conclusion:* The incidence of pesticide poisoning in Brazil has been continuously increasing in the twenty-first century.

Keywords: Pesticide. Pesticide exposure. Health information system.

^IGraduate Program in Public Health, Universidade Federal do Rio Grande do Norte – Natal (RN), Brazil.

^{II}Graduate Program in Health Sciences, Universidade Federal do Rio Grande do Norte – Natal (RN), Brazil.

^{III}Production Engineering, Universidade Federal do Rio Grande do Norte – Natal (RN), Brazil.

^{IV}Universidade Federal de Campina Grande – Pombal (PB), Brazil.

Corresponding author: Paulo Roberto Queiroz. Rua dos Pintassilgos, 70, bloco A, apto. 1.201, Pitimbu, CEP: 59067-300, Natal, RN, Brasil. E-mail: enfpaolorq@gmail.com

Conflict of interests: nothing to declare – **Financial support:** none.

RESUMO: *Objetivo:* Analisar as tendências das taxas de incidência da intoxicação por agrotóxicos nas regiões brasileiras, de acordo com sexo e circunstância da intoxicação, no período de 2001 a 2014. *Método:* Estudo de séries temporais, com dados do Sistema de Informação de Agravos de Notificação (SINAN). As taxas de incidência foram calculadas por meio da razão entre o número de casos novos confirmados de intoxicações por agrotóxicos e a população residente no mesmo período e local. Foram realizadas análise de regressão polinomial e testes de Mann-Whitney e Kruskal-Wallis. Quando encontradas diferenças significativas, os testes foram seguidos pela penalização de Bonferroni com a finalidade de identificar onde residia a diferença. *Resultados:* No Brasil, foram registrados 80.069 casos de intoxicação nesse período. Houve um crescimento linear de notificações de intoxicação por agrotóxico, cuja taxa de tendência de crescimento encontrada foi de 0,377 por 100 mil habitantes/ano. As regiões Sul e Centro-Oeste apresentam as maiores taxas de intoxicação. Em relação ao sexo, não foram encontradas diferenças significativas ($p < 0,347$), sendo a tentativa de suicídio a circunstância de intoxicação mais significativa ($p < 0,001$). *Conclusão:* A incidência de intoxicação por agrotóxico no Brasil segue em aumento no século XXI. *Palavras-chave:* Agrotóxico. Exposição a praguicidas. Sistema de informação em saúde.

INTRODUCTION

Human exposure to pesticides is currently an important national public health problem¹. To Carneiro et al.^{2,3}, The agro-dependent chemical production model is responsible for promoting intoxications among workers and the population, as well as polluting the environment. Nasralla Neto et al.⁴ state that the production model adopted in Brazil has contributed to a rapid expansion of the national agrochemicals market in the last decade (190%), with a growth rate of more than double that of the global market (93%). These numbers, however, do not correspond to the health condition of the rural worker or the population⁵, as the production process generates several risk situations to the production environment.

In Brazil, according to data from the National System of Toxic-Pharmacological Information (SINITOX), 7,511 cases of poisoning by pesticides were registered in 2014, of which 0.97% evolved to death⁶. According to Scardoelli et al.⁷, these figures may be underestimated, since these events are highly underreported. According to Bochner¹, for each case registered, another 50 are not notified.

Poisoning by agrochemicals represents a serious national public health problem, and the increase in the consumption of these compounds and in the reporting of intoxication in Brazil makes the issue even more difficult, and its control by health authorities poses a challenge^{1,8-10}.

Thus, it is imperative to know if this condition is capable of producing significant trends in all Brazilian regions, as well as the magnitude and distribution of the event. Thus, this study aimed to analyze the trends of the incidence rates of pesticide poisoning in the Brazilian regions, as well as the incidence rates according to sex and the circumstances of the poisoning in Brazil, from 2001 to 2014.

METHOD

This is a time-series study based on the survey of pesticide poisoning cases in all Brazilian regions, from 2001 to 2014, available in the SINAN database. The choice of this time cut was best indicated because of the better consistency of the data for the construction of a robust historical series, as they represent the totality of the available data until the date of the collection.

Regarding the collection of the population data for the reported cases, the following notification methods were considered in the period studied: poisoning by pesticides from 2001 to 2006; and exogenous poisonings from 2007 to 2014. It is worth noting that until 2006, all notification events involving human poisoning by pesticides were registered in SINAN only as poisoning by pesticides, without any subclassification of the types of poisoning. However, as of 2007, other categories were created, within which pesticide poisonings were grouped and other forms of poisoning started to be considered. In the study from 2007 to 2014, it was then decided to use the categories of poisoning that were already present in the records from 2001 to 2006. Thus, in this second cut, due to the changes in the categorization by SINAN itself, the following poisoning notifications were considered: by agricultural pesticide, by domestic pesticide, by public health pesticide, and by rat poison.

The linear model parameter estimates for the rates will be presented by region, in incidence, and the poisoning rates will be stratified by sex and circumstances of poisoning in the population of 100,000 inhabitants. The circumstances of poisoning were divided into two blocks: the first one is subdivided into 13 categories (customary use, accidental, environmental, therapeutic use, medical prescription, administration error, self-medication, abuse, food intake, suicide attempt, abortion attempt, violence/homicide and others), and the second, in 6 (work accident, environmental, suicide attempt, accidental, contaminated food product and criminal), providing the possibilities of circumstances in which poisoning occurred.

The rates produced will be the result of the ratio between the incidence, defined by the number of new confirmed cases of poisoning by pesticides, and the resident population in the same period and place. Population data were obtained by the Brazilian Institute of Geography and Statistics (IBGE) through census, projections and demographic estimates of the study periods¹¹.

In order to characterize the population regarding the incidence of pesticide poisoning by region, a polynomial regression analysis was performed. It started with the simplest model, with the linear function of the first degree ($Y = \beta_0 + \beta_1 X$), and followed by the second order models ($Y = \beta_0 + \beta_1 X + \beta_2 X^2$). The simplest model that was able to explain its adequacy by means of the strength of the adjustment of the line by the coefficient of determination (R^2) and by its statistical significance ($p < 0.05$) was maintained in the results. Regarding sex and factors associated with pesticide poisoning, the data were cross-checked with the number of poisonings recorded in the period through the Mann-Whitney and Kruskal-Wallis tests, followed by the Bonferroni penalty when significant differences were found, in order to identify them. For these data, a significance level of 5% was adopted. For data extraction, software TabWin 3.6b was used, and analyzes were performed in the specific statistical program.

This study accessed secondary information provided by SINAN on May 29, 2015. Due to it being a public access database, without identification of the participants, an assessment by the Research Ethics Committee, as per Resolution 466 of the National Health Council (CNS), from December 12, 2012, was not necessary.

RESULTS

In the period from 2001 to 2014, 80,069 cases of pesticide poisoning were reported in Brazil. In this period, there was a linear increase in poisoning by pesticides, and the linear equation that best described this behavior was $y = 0.377x + 0.2448$, where 0.377 represents the growth rate of the line in the period; y, the rate of intoxications; and x, the time in years for $R^2 = 0.952$ (Figure 1).

In the regions, there were different behaviors in the trend analysis for pesticide poisonings (Table 1). The South and Midwest regions showed significant growth, but the largest magnitude of the average annual increase is in the Midwest Region. No significant differences were found between the sexes ($p < 0.347$) (Table 2).

The analysis of the “poisoning circumstances” variable indicated statistically significant differences ($p < 0.001$) for the categories “customary use”, “accidental”, “environmental” and “attempted suicide” from 2007 to 2014, and for “work accident”, “suicide attempt” and “accidental” between 2001 and 2006 (Table 2).

DISCUSSION

The number of cases of poisoning by pesticides has increased considerably in Brazil, pointing to an important problem related to the use and the dissemination of these products.

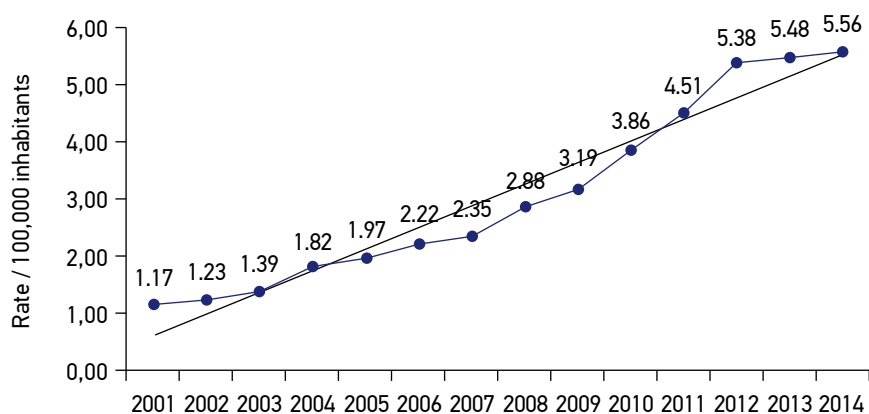


Figure 1. Trend in the incidence of notifications of pesticide poisoning in Brazil, 2001 to 2014. Brazil, 2014.

Table 1. Estimates of parameters of the linear model for the incidence rate of pesticide poisoning according to Brazilian regions, 2001 to 2014. Brazil, 2014.

Regions	β_0	β_1	R^2	p-value
North	1.43	0.17	0.95	< 0.001
Northeast	2.41	0.32	0.92	< 0.001
Southeast	2.69	0.45	0.92	< 0.001
South	5.42	0.29	0.91	< 0.001
Midwest	4.43	0.65	0.95	< 0.001

Values given for the simple linear regression formula $Y = \beta_0 + \beta_1 X$, in which β_0 and β_1 are the intercept (or linear coefficient) and the regression coefficient (or angular), respectively. Although β_2 from the Northern Region resulted in a value of 0.03, all other regions had a null β_2 . Therefore, the β_2 for all regions were not considered in the table. Source: Brazil. Ministry of Health. DATASUS/Notifiable Diseases Information System (SINAN), May 29 2015.

Table 2. Median and quartiles of the variation of incidence rates for sex and the circumstance of poisoning in Brazil, 2001 to 2014. Brazil, 2014.

Variables	Category	Median	Q ₂₅	Q ₇₅	p-value
Sex	Male		33.7	88.54	0.347*
	Female	31.67	27.33	52.67	
Circumstance of poisoning (2007–2014)	Customary use	1.87	1.55	3.89	< 0.001**
	Accidental	7.12	5.59	17.01	
	Environmental	1.17	0.76	2.08	
	Therapeutic use	0.01	0.01	0.02	
	Medical prescription	0	0	0.02	
	Administration error	0.33	0.16	0.51	
	Self-medication	0.04	0.03	0.07	
	Abuse	0.04	0.03	0.07	
	Food intake	0.21	0.17	0.34	
	Suicide attempt	18.48	12.32	22.74	
	Abortion attempt	0.05	0.05	1.4	
Violence/homicide	0.33	0.29	0.4		
Others	0.30	0.25	1.28		
Circumstance of poisoning (2001–2006)	Work accident	2.02	1.43	6.88	< 0.001**
	Environmental	0.43	0.16	0.64	
	Suicide attempt	3.29	1.88	4.74	
	Accidental	1.34	0.73	3.28	
	Contaminated food product	0.09	0.07	0.31	
	Criminal	0.02	0.01	0.08	

Source: Brazil. Ministry of Health. DATASUS/Notifiable Diseases Information System (SINAN), May 29 2015.

*Mann-Whitney test; **Kruskal-Wallis test.

On the other hand, the hegemonic agrarian model in Brazil, based on monocultures and the intensive use of agrochemicals, has leveraged the growing consumption of these compounds in the last decades¹². Nasrala Neto et al.⁴ state that “this fact would imply in the existence of a direct relationship between growth curves of cases of poisoning by pesticides and the sales revenues of these products”, which would lead to the hypothesis of the increase in the number of poisoning cases in the country.

In addition, it is possible that the mandatory reporting of exogenous intoxications by pesticides in the work environment and associated activities in the country, regulated by Ordinance MS/GM no. 777/2004¹³, and the transfer of specific federal resources to all states for health surveillance actions aimed at notifiable conditions — among which is poisoning by pesticide —, regulated by Ordinance MS/GM no. 1.378/2013, may have boosted the number of recorded cases of poisoning by pesticides in Brazil.

The highest increases in pesticide poisoning recorded during the historical series in the South region could be explained by the fact that this region presented the highest incidences of pesticide poisoning in all regions of Brazil between 2007 and 2011¹⁵. Still according to national data¹⁵, between 2007 and 2013, the sales of agrochemicals in the South Region was 1,539,130 tons, corresponding to 22.46% of the amount traded in Brazil. Thus, the highest rates of pesticide poisoning in the South region may be associated with the high consumption of these products in the region.

Nevertheless, the Health Surveillance network of the State of Paraná, located in the South region, is among the most active in Brazil regarding Health Surveillance of Populations Exposed to Agrochemicals¹⁵. Therefore, the greater capacity of Health Surveillance of Populations Exposed to Agrochemicals would be associated to the higher rates of poisoning cases reported, as occurred in 2013, when Paraná stood out as the Brazilian state that registered the most pesticide poisoning cases in SINAN, thus increasing the poisoning rates of the Southern Region.

With regard to the highest increases in pesticide poisoning cases recorded during the historical series in the Midwest Region, it should be noted that, in the period from 2007 to 2013, this region used 1.7 billion kilograms of agrochemicals, corresponding to 24.98% of the sales of these compounds in Brazil, a fact that placed it in second place in the classification of sales in the country¹⁵.

Still according to national data¹⁵, the Midwest Region showed a marked increase in the incidence of poisonings since 2007, from 3.14 to 10.23 cases per 100,000 inhabitants in 2013, which shows a considerable increase in population exposure, as well as the good work of the health services in the region with regard to the actions of the Health Surveillance of Populations Exposed to Agrochemicals. Therefore, it is hypothesized that the high consumption of pesticides and the best practices of the Health Surveillance of Populations Exposed to Agrochemicals increase the number of records of poisoning.

Although no significant differences were found between the sexes in the present study, according to Bochner¹⁶, the predominance of poisoning in males was expected.

On the circumstances of poisoning, Bochner¹⁶ reports similar data in studies conducted in Brazil.

With regard to the circumstance of poisoning by customary use, according to Santana⁸, the use of pesticides has diversified. In addition to the countryside, where they affect workers, their families and those who live nearby, such products are used in public health campaigns, in vector control, in gardening products to combat pests and weeds, as well as being present in the active principles of commercially available insecticides. As consumers are often unaware of their real effects on the human health, they end up using them routinely, exposing the elderly, children and pregnant women and exacerbating the risk of exposure. Thus, increasing the routine contact of humans with pesticides could facilitate the occurrence of poisoning by customary use and be one of the causes of poisoning by this circumstance in the present study.

The circumstance of accidental poisoning is another side of this problem. Contributing factors to its occurrence are the reuse of pesticide containers, the storage of these compounds in places easily accessible to children, improper handling and non-use of personal protective equipment¹.

Poisoning due to environmental circumstances is another major problem due to the massive use of pesticides. Spraying by air, tractors or backpack sprayer, even when following the laws and regulations, leads to pollution in all environmental compartments and, consequently, to humans involuntarily inhaling polluted air and ingesting contaminated water and food in the process^{17,18}.

Although the statistical tests have indicated significance in this study for several poisoning circumstances, suicide attempt is the one with the highest median in the period, similar to the results found by Bochner¹. Some studies on poisoning point out that pesticides are involved in the majority of suicide cases in the world¹⁹⁻²².

According to a study conducted by Bombardi²³, the psychological pressure of workers indebted due to the economic dependence on the agrochemical package could influence the act of attempting suicide. According to Pires et al.²⁴ and Rebelo et al.²⁵, the availability, ease of access and variety of agrochemicals available on the market are probably related to the involuntary intake of these products as lethal agents and can therefore be pointed out as important factors for the high incidence of poisoning by such compounds^{1,23}.

Regarding the circumstance of poisoning due to causes involving occupational accidents, Carneiro considers that the situations of greater risk are strongly related to the preparation of the compounds, to their application, to the harvesting and even to the act of preparing the field, since workers, due to do not receiving personal protective equipment and adequate training for the preparation and use of the compounds, become victims of this work process, thus increasing the occurrence of accidents.

In 2014, according to data from SINITOX, 7,511 cases of pesticide poisoning were registered in Brazil. Of these, 3,820 correspond to work accidents, which makes them the second most frequent circumstance among the others⁶. Even so, this number may be underestimated, since these events are highly underreported⁷. Even though it may mask even more

critical results, this information reveals that occupational accidents account for a large percentage of the poisoning circumstances and could thus justify the data from this study on this circumstance.

Still on the circumstances of poisoning, attention is drawn to the occurrence, even at very low frequency, of poisonings in circumstances such as therapeutic use, medical prescription and self-medication. As these are cases of poisoning by pesticides, products that are not used in such circumstances, the hypothesis is that these occurrences arise from errors during the registration process.

Regarding the limitations of this study, the possibility of variability in data quality cannot be excluded, since the underreporting of cases is a fragility of the information systems. Because it is a serious public health problem that pervades the country, pesticide poisoning demands more critical data collection, as well as effective notification by professionals, reinforcing the need for collaboration and training.

Still on the limitations, regarding the variable “circumstances of poisoning”, it is necessary to clarify that its arrangement in two blocks (Table 2) arises from the impossibility of grouping its categories in the period from 2001 to 2014. In 2006, the database of SINAN underwent changes in the names of the categories that comprised the list of possibilities of poisoning circumstances. Two categories (work accident and accidental) with divergent denominations were grouped into a single category (accidental). During the data tabulation process, these changes were incompatible with the merging of the “work accident” and “accidental” categories between 2001 and 2006 with data from the “accidental” category from 2007 to 2014, since “work accident” is restricted to a specific situation, and “accidental” is a broader category. This merging is inadequate, because the data would represent contexts of different circumstances.

In spite of these limitations, the present study brings important contributions to the understanding of the human poisoning events caused by pesticides registered in SINAN over the years, the variation of the poisoning rates by regions, the behavior of the poisoning rates according to sex, and the circumstances of poisoning.

In addition, this situation can be aggravated by the intensive use of agrochemicals due to the hegemonic agrarian model practiced in Brazil. In addition to these factors, public policies for prevention demonstrate low efficacy, and research on the effects of poisoning on the human organism in the long term is scarce, which is worrying, as its chronic effects reveal the most serious aspect of this problem^{2,3,8,26}.

In this context, there is a need for population-based research to understand the effects of pesticide poisoning on the population of the different regions of Brazil, knowing the intrinsic characteristics of poisoning cases, especially in the regions with the highest growth of this condition.

CONCLUSIONS

The incidence of pesticide poisoning in Brazil, according to SINAN records, follows an upward trend. Higher poisoning rates were observed in the South and Midwest regions,

although there was a greater increase of notifications during the period in the Midwest and Southeast regions.

No statistically significant differences were found between the sexes. For the circumstances of poisoning, statistically significant differences were identified among the different categories. However, suicide attempt is the one with the highest medians in the period.

ACKNOWLEDGEMENTS

The authors would like to thank the Sectoral Dentistry Library “Prof. Alberto Moreira Campos” of Universidade Federal do Rio Grande do Norte (UFRN).

REFERENCES

1. Bochner R. Perfil das intoxicações em adolescentes no Brasil no período de 1999 a 2001. *Cad Saúde Pública* 2006; 22(3): 587-95. <http://dx.doi.org/10.1590/S0102-311X2006000300014>
2. Carneiro FF, Rigotto RM, Augusto LGS, Friedrich K, Búriço AC. Dossiê Abrasco: um alerta sobre os impactos dos agrotóxicos na saúde. Rio de Janeiro: Abrasco; 2012. Parte I.
3. Carneiro FF, Rigotto RM, Augusto LGS, Friedrich K, Búriço AC, Faria NM, et al. Dossiê Abrasco: um alerta sobre impactos dos agrotóxicos no ambiente e na saúde. Rio de Janeiro: Abrasco; 2012. Parte II.
4. Nasralla Neto E, Lacaz FAC, Pignati WA. Health surveillance and agribusiness: the impact of pesticides on health and the environment. *Danger ahead! Ciênc Saúde Coletiva* 2014; 19(12): 4709-18. <http://dx.doi.org/10.1590/1413-812320141912.03172013>
5. Pignati W, Oliveira NP, Silva AMC. Vigilância aos agrotóxicos: quantificação do uso e previsão de impactos na saúde-trabalho-ambiente para os municípios brasileiros. *Ciênc Saúde Coletiva* 2014; 19(12): 4669-78. <http://dx.doi.org/10.1590/1413-812320141912.12762014>
6. Brasil. Ministério da Saúde. Sistema de Nacional de Informações Tóxico-farmacológicas. Dados de intoxicação: dados agentes tóxicos: tabulação de dados: a partir de 2014: intoxicação, óbitos [Internet]. [acessado em 17 nov. 2017]. Disponível em: <https://sinitox.icict.fiocruz.br/dados-de-agentes-toxicos>
7. Scardoelli MGC, Buriola AA, Oliveira MGF, Waidman MAP. Intoxicações por agrotóxicos notificadas na 11ª regional de saúde do estado do Paraná. *Ciênc Cuid Saúde* 2011; 10(3): 549-55. <http://dx.doi.org/10.4025/ciencucuidsaude.v10i3.17381>
8. Soares WL, Porto MF. Pesticide use and economic impacts on health. *Rev Saúde Pública* 2012; 46(2): 209-17. <http://dx.doi.org/10.1590/S0034-89102012005000006>
9. Rigotto RM, Vasconcelos DP, Rocha MM. Pesticide use in Brazil and problems for public health. *Cad Saúde Pública* 2014; 30(7): 1-3. <http://dx.doi.org/10.1590/0102-311XPE020714>
10. Londres A. Agrotóxicos no Brasil: um guia para a ação em defesa da vida. Rio de Janeiro: AS-PTA; 2011.
11. Instituto Brasileiro de Geografia e Estatística. Censo Agropecuário 2006: agricultura familiar. Primeiros resultados. Brasil, Grandes Regiões e Unidades da Federação. Rio de Janeiro: Instituto Brasileiro de Geografia e Estatística; 2009.
12. Portos MF, Soares WL. Modelo de desenvolvimento, agrotóxicos e saúde: um panorama da realidade agrícola brasileira e propostas para uma agenda de pesquisa inovadora. *Rev Bras Saúde Ocup* 2012; 37(125): 17-50. <http://dx.doi.org/10.1590/S0303-76572012000100004>
13. Brasil. Ministério da Saúde. Portaria nº 777, de 28 de abril de 2004 [Internet]. Brasília: Ministério da Saúde; 2004 [acessado em 17 nov. 2017]. Disponível em: http://bvsms.saude.gov.br/bvs/saudelegis/gm/2004/prt0777_28_04_2004.html
14. Brasil. Ministério da Saúde. Portaria nº 1.378, de 9 de julho de 2013 [Internet]. Brasília: Ministério da Saúde; 2013 [acessado em 18 nov. 2017]. Disponível em: http://bvsms.saude.gov.br/bvs/saudelegis/gm/2013/prt1378_09_07_2013.html

15. Brasil. Ministério da Saúde. Agrotóxicos na ótica do Sistema Único de Saúde [Internet]. Brasília: Ministério da Saúde; 2016 [acessado em 18 nov. 2017]. v. 1. Disponível em: http://bvsmms.saude.gov.br/bvs/publicacoes/agrotoxicos_otica_sistema_unico_saude_v1_t.1.pdf
16. Bochner R. Sistema Nacional de Informações Tóxico-farmacológicas – SINITOX e as intoxicações humanas por agrotóxicos no Brasil. *Ciênc Saúde Coletiva* [Internet] 2007; 12(1): 73-89 [acessado em 14 nov. 2017]. Disponível em: http://www.scielo.br/scielo.php?script=sci_arttext&pid=S1413-81232007000100012 <http://dx.doi.org/10.1590/S1413-81232007000100012>
17. Pignati WA, Machado JMH, Cabral JF. Acidente rural ampliado: o caso das “chuvas” de agrotóxicos sobre a cidade de Lucas do Rio Verde – MT. *Ciênc Saúde Coletiva* 2007; 12(1): 105-14. <http://dx.doi.org/10.1590/S1413-81232007000100014>
18. Belo MSSP, Pignati W, Dores EFGC, Moreira JC, Peres F. Uso de agrotóxicos na produção de soja do Estado do Mato Grosso: um estudo preliminar de riscos ocupacionais e ambientais. *Rev Bras Saúde Ocup* 2012; 37(125): 78-88. <http://dx.doi.org/10.1590/S0303-76572012000100011>
19. Kim J, Shin DH, Lee WJ. Suicidal ideation and occupational pesticide exposure among male farmers. *Environ Res* 2014; 128: 52-6. doi: 10.1016/j.envres.2013.10.007. Epub 2013 Nov 21.
20. Nock MK, Borges G, Bromet EJ, Cha CB, Kessler RC, Lee S. Suicide and suicidal behavior. *Epidemiol Rev* 2008; 30: 133-54. doi: 10.1093/epirev/mxn002. Epub 2008 Jul 24.
21. Jamal GA. Neurological syndromes of organophosphorus compounds. *Adverse Drug React Toxicol Rev* 1997; 16(3): 133-70.
22. Freire C, Koifman S. Pesticides, depression and suicide: a systematic review of the epidemiological evidence. *Int J Hyg Environ Health* 2013; 216(4): 445-60. doi: 10.1016/j.ijheh.2012.12.003. Epub 2013 Feb 17.
23. Bombardi LM. A intoxicação por agrotóxicos no Brasil e a violação dos direitos humanos. In: Merlino T, Mendonça ML, editores. *Direitos humanos no Brasil 2011: relatório da rede social de justiça e direitos humanos*. São Paulo: Rede Social de Justiça e Direitos Humanos; 2011. p. 71-84.
24. Pires DX, Caldas ED, Recena COM. Uso de agrotóxicos e suicídios no Estado do Mato Grosso do Sul, Brasil. *Cad Saúde Pública* 2005; 21(2): 598-605. <http://dx.doi.org/10.1590/S0102-311X2005000200027>
25. Rebelo FM, Caldas ED, Heliodoro VO, Rebelo RM. Intoxicação por agrotóxicos no Distrito Federal, Brasil, de 2004 a 2007: análise da notificação ao Centro de Informação e Assistência Toxicológica. *Ciênc Saúde Coletiva* 2011; 16(8): 3493-502. <http://dx.doi.org/10.1590/S1413-81232011000900017>
26. Faria NMX, Fassa AG, Facchini LA. Intoxicação por agrotóxicos no Brasil: os sistemas oficiais de informação e desafios para realização de estudos epidemiológicos. *Ciênc Saúde Colet* 2007; 12(1): 25-38. <http://dx.doi.org/10.1590/S1413-81232007000100008>

Received on: 11/23/2017

Final vision approved on: 03/07/2018

Accepted on: 03/21/2018

Authors' contributions: Queiroz PR participated in all the stages of the drafting of the article; Lima KC participated in the definition of the study methodology, discussion and revision of the article; Oliveira AMBM participated in the revision of the article; Oliveira TC participated in the data analysis and revision of the article; Santos MM participated in the data analysis; Jacob JF participated in the drafting and revision of the article.

