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Poisoning and associated factors to death from pesticides: case-control study, Brazil, 2017

Intoxicações e fatores associados ao óbito por agrotóxicos: estudo caso controle, Brasil, 2017

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ABSTRACT: ***Background:*** Pesticide poisoning causes high morbidity and mortality. Surveillance is required for post-marketing monitoring of these products. ***Aim:*** To assess poisonings and associated factors with lethality by pesticides. ***Method:*** This is a case-control study based on the cases of pesticide poisoning assisted in 2017 by Brazilian Poison Control Centers. Patients who died were the cases and the survivors, the control. The odds ratio (OR) of death and 95% confidence interval (CI) were calculated. From the regression model, a predictive model of death was developed, stratified by age, gender and occupational context to investigate the risk of agricultural workers poisoned by extremely hazardous agents. ***Results:*** 3,826 patients poisoned by pesticides were identified, of which 146 died. Older people (OR = 4.94; 95%CI 2.49 – 9.80), males (OR = 1.68; 95%CI 1.15 – 2.46), agricultural workers (OR = 2.20; 95%CI 1.15 – 4.24), suicide attempts (OR = 13.27; 95%CI 6.48 – 27.19) and exposure to extremely hazardous products (OR = 2.77; 95%CI 1.84 – 4.16) odds of death from pesticide poisoning. ***Conclusion:*** Out of 100 pesticides poisoning, four died. Elderly, males, working in the agricultural sector, suicide attempts and extremely hazardous products had a higher risk of death.

Keywords: Pesticides. Agrochemicals. Poisoning. Mortality. Poison control centers. Case-control studies.

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RESUMO: ***Introdução:*** As intoxicações por agrotóxicos causam elevada morbimortalidade. A vigilância é necessária da produção até o uso desses produtos. ***Objetivo:*** Analisar as intoxicações e os fatores associados à letalidade por agrotóxicos. ***Método:*** Trata-se de estudo caso controle baseado nos atendimentos de intoxicação por agrotóxicos realizados em 2017 por centros de informação e assistência toxicológica do Brasil. Pacientes que evoluíram a óbito compuseram o grupo caso, e os sobreviventes, o grupo controle. Calculou-se *odds ratio* (OR) dos fatores de risco para óbito, com intervalo de confiança (IC) de 95%. Com base no modelo de regressão, desenvolveu-se um modelo preditivo de morte, estratificado por faixa etária, sexo e contexto ocupacional, para investigação do risco dos trabalhadores agropecuários intoxicados por agentes extremamente tóxicos. ***Resultados:*** Identificaram-se 3.826 pacientes intoxicados por agrotóxicos, dos quais 146 evoluíram para óbito. Idosos (OR = 4,94; IC95% 2,49 – 9,80), homens (OR = 1,68; IC95% 1,15 – 2,46), trabalhadores do setor agropecuário (OR = 2,20; IC95% 1,15 – 4,24), tentativas de suicídio (OR = 13,27; IC95% 6,48 – 27,19) e exposição a produtos extremamente tóxicos (OR = 2,77; IC95% 1,84 – 4,16) apresentaram mais chances de óbito nas intoxicações por agrotóxicos. ***Conclusão:*** Em cada 100 intoxicações por agrotóxicos, quatro evoluíram para óbito. Idosos, homens, trabalho no setor agropecuário, tentativas de suicídio e produtos extremamente tóxicos apresentaram mais chances de óbito.

Palavras-chave: Praguicidas. Agroquímicos. Intoxicação. Mortalidade. Centros de controle de intoxicações. Estudos de casos e controles.

INTRODUCTION

Pesticide poisoning is an important cause of morbidity and mortality that goes beyond occupational and environmental contexts. These agents are estimated to be involved in 10 to 20% of suicides worldwide, with a high burden of disease on mental health[1]. Restricting access to highly hazardous products through regulatory enforcement reduces poisonings, suicide attempts and related mortality[2,3].

Surveillance of the use of pesticides is necessary to monitor the activities involving these compounds, from production, transportation, storage, marketing to their use. The report of poisonings assisted by poison control centers (*centros de informação e assistência toxicológica* – CIATox) is a significant source for monitoring in the post-marketing phase of products and is routinely employed in developed countries[4,5].

Despite the high consumption of pesticides[6], Brazil lacks analyses to support public policies that mitigate the damage caused by these products. National research on pesticide poisoning is restricted to one location or is of an ecological nature, with less causal power[7,8]. Investigations with individual and nationwide data have the potential to contribute with better quality evidence on the topic.

This research aimed to analyze pesticide poisoning attended by Brazilian CIATox in 2017 and the factors associated with death from these products.

METHOD

STUDY DESIGN

This is a case-control study carried out based on pesticide poisoning assisted by CIATox that were registered in the Brazilian Poison Data System (Datatox) in 2017.

SETTING

CIATox are units of the Unified Health System (*Sistema Único de Saúde* – SUS), members of the Trauma Care Line, of the SUS Urgency and Emergency Care Network[9]. They work 24 hours a day, seven days a week, to guide the management of poisonings, and follow up until the case is resolved, in person or remotely.

For real-time recording of cases attended to, the Brazilian Association of Toxicological Information Centers developed Datatox, through a research project in partnership with the Telemedicine Laboratory of the Federal University of Santa Catarina[10,11]. The system was structured as a database of agents down to the substance level (active agent principle), which enables the correct classification of the products involved and avoids standardization problems previously mentioned in the literature[12]. The registration of images, symptoms, details of exposures, guidance given to the applicant and clinical evolution is privileged in the system.

PARTICIPANTS

All patients assisted by Brazilian CIATox due to poisoning by pesticides in 2017 and registered with Datatox were included. The group of cases was made up by patients who evolved to death, and the control group, by those who survived poisoning, since they were originally from the same population. There were no exclusion criteria, and incomplete data were treated separately as "not informed".

VARIABLES

The following independent variables were included: age group (0–19; 20–39; 40–59, ≥ 60 years of age), sex (male, female), occupational context (agricultural sector/other), suicide attempt (yes, no), toxicity of the pesticide (highly; highly/moderately/slightly toxic), signs/symptoms and oral route (yes, no). The occupational context was grouped into workers in the agricultural area (multipurpose family farmer, agronomist, agropecuarista, agricultural applicator, insecticide applicator, agricultural assistant, rancher, orange picker, pest

control, agriculture day laborer, farmer, vegetable horticulturist, plowman, agricultural machine operator, agricultural pilot, rural producer, rural worker and agricultural tractor) and other workers/those who do not work.

The toxicity of the pesticide was classified as recommended by the National Health Surveillance Agency (*Agência Nacional de Vigilância Sanitária* – Anvisa) at the time of care[13]: class I (extremely hazardous), class II (highly hazardous), class III (moderately hazardous), and class IV (slightly hazardous). Pesticides were also classified according to the most relevant chemical and/or action group (cholinesterase inhibitors, herbicides, pyrethroids, other insecticides, etc.), according to the frequency of the group.

STATISTICAL METHODS

The cases and controls were described in terms of age, sex, occupational context, motivation, toxicity, route of exposure, pesticides, and symptoms. To investigate the factors associated with death, the odds ratio (OR) was used as a measure of association, with a 95% confidence interval (CI). A direct acyclic graph was built to guide statistical analysis. The unadjusted OR of deaths were calculated by the following independent variables, obtained by logistic regression: age group, sex, agricultural sector, suicide attempt, and toxicity of the pesticide.

In each regression, the Akaike information criterion (AIC) and the Schwarz Bayesian information criterion (BIC) were also obtained, both based on the likelihood ratio test[14]. Multicollinearity was attributed if the variables had values of variance inflation factors (VIF) greater than 10[15]. The variables without multicollinearity were included in a logistic regression model (adjusted analysis), in which the previously obtained AIC and BIC values were compared.

Through the regression model, a predictive model of death was developed, stratified by age group, sex and suicide attempt, to investigate the risk of workers in the agricultural sector and the toxicity of the pesticide. All analyses were performed using the Stata 14.2 program (Stata Corporation, College Station, TX, United States).

ETHICAL ASPECTS

The research project was approved by the Research Ethics Committee of the State University of Campinas (Opinion No. 3.395.121, of June 17, 2019; Certificate of Presentation for Ethical Appreciation — CAAE 12896719.2.0000.5404).

RESULTS

3,826 patients poisoned by pesticides were included, of whom 146 (3.8%; 95%CI 3.2 – 4.4%) died (case group). Most of the poisonings occurred in adults (20–59 years), men,

in an occupational context unrelated to the agricultural sector, and due to suicide attempt (Table 1). In comparison to the control group, the group of cases had a higher proportion of men and individuals aged 40 years old or older.

Pesticides from the cholinesterase inhibitor group were involved in 37.3% of the poisonings (95%CI 35.8 – 38.8%), followed by herbicides (22.7%, 95%CI 21.4 – 24.0%) and pyrethroid insecticides (18.6%, 95%CI 17.5 – 19.8%) (Table 2). *Chumbinho* [anti-cholinesterase agent illegally used as rodenticide in Brazil] (24.8%, 95%CI 23.5 – 26.1%); glyphosate (12.5%, 95%CI 11.6 – 13.6%) and deltamethrin (6.1%, 95%CI 5.4 – 6.9%) were the most frequent

Table 1. Characteristics of patients poisoned by pesticides treated at Toxicological Information and Assistance Centers, Brazil, 2017 (n = 3,826).

Variables	Cases (%)	Controls (%)	Total (%)
Age range (years)*			
0–19	14 (9.6)	979 (26.6)	993 (26.0)
20–39	49 (33.6)	1,398 (38.0)	1,447 (37.8)
40–59	51 (34.9)	1,005 (27.3)	1,056 (27.6)
≥ 60	30 (20.5)	258 (7.0)	288 (7.5)
Sex**			
Female	46 (31.5)	1,510 (41.0)	1,556 (40.7)
Male	100 (68.5)	2,113 (57.4)	2,213 (57.8)
Occupational contexto			
Other/does not work	133 (91.1)	3,349 (91.0)	3,482 (91.0)
Agricultural sector	13 (8.9)	331 (9.0)	344 (9.0)
Suicide attempt***			
No	9 (6.2)	1,761 (47.9)	1,771 (46.3)
Yes	131 (89.7)	1,822 (49.5)	1,953 (51.0)
Toxicity			
High/moderate/low	35 (24.0)	2,183 (59.3)	2,218 (58.0)
Extreme toxicity	111 (76.0)	1,497 (40.7)	1,608 (42.0)
Oral route			
No	7 (4.8)	1,121 (30.5)	1,128 (29.5)
Yes	139 (95.2)	2,559 (69.5)	2,698 (70.5)

*42 records without information for this variable; ** 57 records without information for this variable; ***102 records without information for this variable.

agents. Paraquat had the highest lethality (28.8%, 95%CI 21.8 – 37.0%). Among the cases of death, compared to the control, the extremely hazardous agents, *chumbinho* , paraquat, glyphosate, and 2,4-D presented the highest frequency.

Gastrointestinal disorders (vomiting, nausea, diarrhea, and epigastric pain) were the most common symptoms of poisoning (24.2%, 95%CI 23.3 – 25.2%). More severe symptoms, such as changes in the level of consciousness, hypotension, coma, respiratory failure and cardiorespiratory arrest, occurred in 5.3% (95%CI 4.9 – 5.8%) of poisonings (Table 3). The following signs and symptoms were observed only in deaths: rhabdomyolysis (n = 4), acute respiratory distress syndrome (n = 3), bacterial sepsis (n = 2), muscle concussion (n = 1), aphasia (n = 1), areflexia (n = 1), disseminated intravenous coagulation (n = 1), hydroelectrolytic disorder (n = 1), subcutaneous emphysema (n = 1), ventricular fibrillation (n = 1), and compartment syndrome (n = 1).

Table 2. Main pesticides involved in poisoning treated at Toxicological Information and Assistance Centers, Brazil, 2017 (n = 4,186 *).

Pesticides	Toxicity**	Cases (%)	Controls (%)	Total (%)
Cholinesterase inhibitors				n=1,561
Chumbinho	I	54 (5.2)	982 (94.8)	1,036 (24.7)
Carbofuran	I	5 (6.6)	71 (93.4)	76 (1.8)
Methomyl	III	0 (0.0)	62 (100.0)	62 (1.5)
Aldicarb	I	1 (9.1)	10 (90.9)	11 (0.3)
Acephate	III	0 (0.0)	14 (100.0)	14 (0.3)
Herbicides				n=949
Glyphosate	IV	14 (2.7)	510 (97.3)	524 (12.5)
Paraquat	I	38 (28.8)	94 (71.2)	132 (3.2)
2,4-D	I	10 (11.2)	79 (88.8)	89 (2.1)
Pyrethroids				n=779
Deltamethrin	III	0 (0.0)	256 (100.0)	256 (6.1)
Cypermethrin	II	0 (0.0)	114 (100.0)	114 (2.7)
Other inseticides				n=489
Fipronil	II	1 (1.0)	98 (99.0)	99 (2.4)
Imidacloprid	III	0 (0.0)	44 (100.0)	44 (1.1)
Others				(n=408)

*More than one pesticide may be involved in each case of poisoning; **I: extremely hazardous; II highly hazardous; III moderately hazardous; IV slightly hazardous; 2,4-D: dichlorophenoxyacetic acid.

The elderly, male, workers in the agricultural sector, suicide attempts and extremely hazardous agents increased the odds of death after adjustments (Table 4). Multicollinearity was negligible in the variables included in the adjusted analysis (VIF <10). The values of AIC (997.0) and BIC (1,056.6) were lower in the adjusted analysis in all variables compared to the unadjusted analyzes (AIC = 1,077.9 – 1,244.0; BIC = 1,092.8 – 1,259, 0), which suggests consistency in the model adopted. A higher probability of death was observed among men working in the agricultural sector attempting suicide (Figure 1).

Table 3. Signs and symptoms presented by patients poisoned by pesticides treated at Toxicological Information and Assistance Centers, Brazil, 2017.

Signs and symptoms	Cases (%)	Controls (%)	Total (%)
Vomits	42 (4.2)	963 (95.8)	1,005 (12.3)
Nausea	18 (2.8)	622 (97.2)	640 (7.9)
Sialorrhea	48 (10.1)	425 (89.9)	473 (5.8)
Miosis	45 (10.0)	405 (90.0)	450 (5.5)
Generalized sweating	36 (10.0)	325 (90.0)	361 (4.4)
Somnolence	16 (5.8)	258 (94.2)	274 (3.4)
Dyspnea	15 (7.6)	182 (92.4)	197 (2.4)
Diarrhea	11 (6.0)	171 (94.0)	182 (2.2)
Tachycardia	17 (9.4)	163 (90.6)	180 (2.2)
Epigastric pain	3 (2.0)	145 (98.0)	148 (1.8)
Change in level of consciousness	21 (17.4)	100 (82.6)	121 (1.5)
Bradycardia	23 (19.3)	96 (80.7)	119 (1.5)
Hypertension	8 (7.7)	96 (92.3)	104 (1.3)
Hypotension	34 (37.4)	57 (62.6)	91 (1.1)
Coma	32 (38.6)	51 (61.4)	83 (1.0)
Hyperemia	3 (3.6)	80 (96.4)	83 (1.0)
Mental confusion	9 (11.1)	72 (88.9)	81 (1.0)
Respiratory failure	40 (49.4)	41 (50.6)	81 (1.0)
Cardiorespiratory arrest	35 (61.4)	22 (38.6)	57 (0.7)
Others	291 (8.5)	3,125 (91.5)	3,416 (41.9)

* Each occurrence can have more than one sign/symptom.

DISCUSSION

Pesticides caused death in four out of every 100 people treated by CIATox in 2017 due to poisoning, with a greater odds of death in men, the elderly, workers in the agricultural sector, who attempted suicide, and used extremely hazardous toxic products.

The present analysis is based on cases assisted and recorded by CIATox mainly in an emergency context, in which the priority is to guide the management of the case or to treat the poisoning itself. Failure to record calls can occur and represent information bias. It is possible that the poisonings referred to CIATox are the most severe ones, coming from health services, which indicates selection bias. Under-representation of chronic and occupational

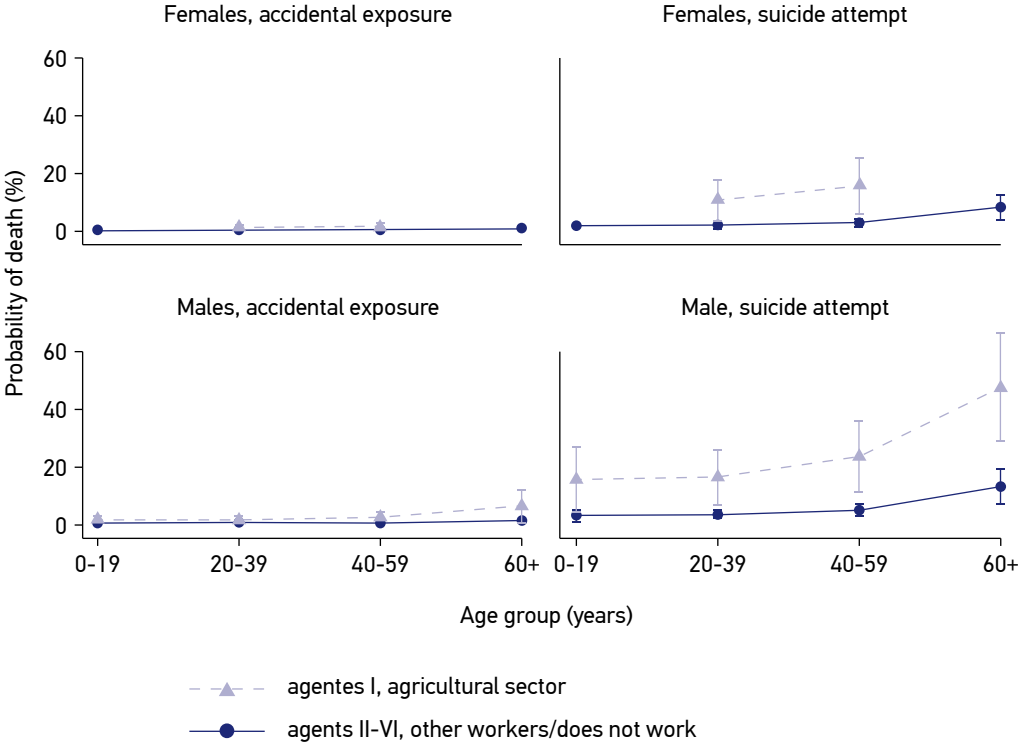
Table 4. Factors associated with mortality from pesticide poisoning attended at Toxicological Information and Assistance Centers, Brazil, 2017 (n = 3,826).

Variables	Unadjusted analysis		Adjusted analysis	
	OR (95%CI)	p	OR (95%CI)	p
Age range (years)				
0–19	1.00	< 0.001	1.00	< 0.001
20–39	2.45 (1.35 – 4.46)		1.06 (0.57 – 1.98)	
40–59	3.55 (1.95 – 6.45)		1.67 (0.90 – 3.11)	
≥ 60	8.13 (4.25 – 15.56)		4.94 (2.49 – 9.80)	
Sex				
Female	1.00	0.015	1.00	0.008
Male	1.55 (1.09 – 2.22)		1.68 (1.15 – 2.46)	
Occupational contexto				
Other/does not work	1.00	0.970	1.00	0.018
Agricultural sector	0.99 (0.55 – 1.77)		2.20 (1.15 – 4.24)	
Suicide attempt				
No	1.00	< 0.001	1.00	< 0.001
Yes	14.08 (7.14 – 27.74)		13.27 (6.48 – 27.19)	
Toxicity				
High/moderate/low	1.00	< 0.001	1.00	< 0.001
Extreme toxicity	4.60 (3.13 – 6.75)		2.77 (1.84 – 4.16)	

OR: odds ratio; 95%CI: 95% confidence interval.

poisoning by pesticides, whose clinical association is generally neglected, may have occurred in the present sample[16,17]. In spite of this, the assessment of data from these services is a health surveillance tool widely used in different contexts[18-20]. The present research is the first effort to analyze national data with the clinical details that the CIATox services allow.

Poisonings treated in health services are mandatory to be reported in the Notifiable Diseases Information System (SINAN), according to the Ordinance of the Minister's Office / Ministry of Health (GM / MS) No. 204 / 2016. This notification system has an open field for the substance, and there may be variations or typing errors that make it impossible for the agent to mine data. Through SINAN reports, it is possible to know the national number of poisonings by a given group of agents, without further clinical details or the active principle involved. Datatox's poisonings come from CIATox that adopted this system to record their attendance and also include cases managed outside of health services. Access to CIATox requires that the person in need of assistance — health professional or not — knows the service and contacts it voluntarily. Although CIATox are free and work around the clock, the cases handled by these centers are likely to have limited representativeness.



I: extremely hazardous agents; II-VI: highly, moderately and slightly hazardous agents.

Figure 1. Probability of death related to pesticides, according to gender, occupational context and motivation of exposure.

The toxicity of pesticides was based on the Anvisa classification in force at the time of the poisonings[13]. The modification of criteria by the agency carried out in 2019 considers in the top hazardous class products that lead to death in acute exposure and removes those that cause eye damage, such as blindness, as well as skin irritations, allergies, asthma, and breathing difficulties[21]. This modification reduces the number of products considered extremely hazardous and the respective control and evaluation mechanisms, in addition to artificially indicate higher safety of the products[22]. The weakening of regulation and the growing approval of highly hazardous products increase the risks for the Brazilian population, especially for the most vulnerable ones[23].

There was a high mortality in pesticide poisoning attended by Brazilian CIATox. The severity and difficulty of treating these poisonings reflect greater lethality[24], especially when caused by extremely hazardous agents.

Higher risk of death was observed among men, similarly to the study conducted in India in 2007[25]. Occupations with greater contact with pesticides are carried out largely by men[26,27], which may explain the greater exposure among these individuals. The impact of these deaths on this economically active population must also be taken into account. The odds of death — already adjusted for age and other factors — was also higher in the elderly, which is similar to the research that found more cases of suicide in divorced or widowed people, residents of smaller municipalities, and in areas with intensive use of pesticides[26,27].

Suicide had the highest measure of association in the present analysis and proved to be a strong predictor of death in pesticide poisoning. Ecological analysis with data from the Brazilian Mortality Information System from 1996 to 2010 observed 4.2 times more suicides with pesticides among men than among women[28]. In developing countries, the use of pesticides in suicide attempts has a high mortality[24], representing one third of the total numbers[29], and is more frequent in underdeveloped countries[30] and by highly hazardous agents[31,32]. In addition to emotional losses, these deaths have an economic impact as they mainly affect the most productive part of society.

Some factors such as failure in productivity, financial problems, emotional problems, domestic arguments, and depression stood out among the triggers for suicide attempts[33]. Exposure to pesticides — many of which are proven to be neurotoxic — causes behavioral changes, emotional and affective disorders, and is sufficient cause to increase suicidal ideation[34]. Easy access to agents is associated with high rates of poisoning and death, and favors suicide attempts[23,24]. The pesticides bans effectively prevents suicide by these products and also occurrences caused by accidental exposures[3,28]. The withdrawal of these products from the market, even in poor countries, reduced deaths due to suicide attempts, without loss of agricultural or economic productivity[32,35,36], and is recommended worldwide as a simple, low-cost and effective measure to prevent suicide, especially in the economically active population[35]. Such robust evidence must be considered in Brazil to modify the present scenario.

Glyphosate, dichlorophenoxyacetic acid (2,4-D) and paraquat are among the most commercialized and used pesticides in Brazil[6,7] and were responsible for a high number of deaths

in this investigation, reflecting the extensive use of herbicides in monocultures. *Chumbinho* — illegal rodenticide based on carbamate and organophosphate anticholinesterase agents — also showed high lethality in this and previous analyzes[37,38]. Despite the prohibition of its commercialization, it is probably of easy access, which requires effective control measures[32,36]. The sale of illegal products may explain the lethality found[37,39]. Comprehensive environmental policies, rigorous evaluation of new pesticides and banning products with greater toxicity would reduce poisoning, preventable deaths and costs with treatments and sequelae without affecting food production[32,35,36].

When analyzing the frequency of the main signs and symptoms, there are more severe signs, such as rhabdomyolysis, acute respiratory distress syndrome, sepsis and ventricular fibrillation, which require greater urgency and emergency care and are associated with the worst outcome[40]. In the elderly population, these effects represent a worse prognosis, due to kinetic and dynamic changes in their physiological functions[41].

CONCLUSION

For every 100 people poisoned by pesticides in 2017, four died. Lethality is higher in suicide attempts, in men, in the agricultural sector, and in extremely toxic hazardous pesticides. Restriction of registration and banning of dangerous pesticides would reduce deaths from these poisonings in the country.

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REFERENCES

1. Mew EJ, Padmanathan P, Konradsen F, Eddleston M, Chang SS, Phillips MR, et al. The global burden of fatal self-poisoning with pesticides 2006-15: Systematic review. J Affect Disord 2017; 219: 93-104. https://doi.org/10.1016/j.jad.2017.05.002
2. Gunnell D, Knipe D, Chang SS, Pearson M, Konradsen F, Lee WJ, et al. Prevention of suicide with regulations aimed at restricting access to highly hazardous pesticides: a systematic review of the international evidence. Lancet Glob Health 2017; 5(10): e1026-e37. https://doi.org/10.1016/S2214-109X(17)30299-1
3. Cha ES, Chang SS, Choi Y, Lee WJ. Trends in pesticide suicide in South Korea, 1983-2014. Epidemiol Psychiatr Sci 2020; 29: 1-9. https://doi.org/10.1017/S2045796019000118

4. Wang A, Law R, Lyons R, Choudhary E, Wolkin A, Schier J. Assessing the public health impact of using poison center data for public health surveillance. Clin Toxicol (Phila) 2018; 56(7): 646-52. https://doi.org/10.1080/15563650.2017.1413194
5. Brett J, Wylie CE, Raubenheimer J, Isbister GK, Buckley NA. The relative lethal toxicity of pharmaceutical and illicit substances: A 16-year study of the Greater Newcastle Hunter Area, Australia. Br J Clin Pharmacol 2019; 85(9): 2098-107. https://doi.org/10.1111/bcp.14019
6. Brasil. Ministério do Meio Ambiente. IBAMA. Relatórios de comercialização de agrotóxicos. Brasília: IBAMA; 2019.
7. Pignati WA, Lima F, Lara SS, Correa MLM, Barbosa JR, Leão L, et al. Spatial distribution of pesticide use in Brazil: a strategy for Health Surveillance. Ciênc Saúde Coletiva 2017; 22(10): 3281-93. https://doi.org/10.1590/1413-812320172210.17742017
8. Queiroz PR, Lima KC, Oliveira TC, Santos MMD, Jacob JF, Oliveira A. Notifiable Diseases Information System and human poisoning by pesticides in Brazil. Rev Bras Epidemiol 2019; 22: e190033. https://doi.org/10.1590/1980-549720190033
9. Brasil. Ministério da Saúde. Portaria nº 1.678, de 2 de outubro de 2015. Institui os Centros de Informação e Assistência Toxicológica (CIATox) como estabelecimento de saúde integrantes da Linha de Cuidado ao Trauma, da Rede de Atenção as Urgências e Emergências no âmbito do Sistema Único de Saúde - SUS. Diário Oficial da União 2015: 55-6.
10. Alves JM, Albino DBL, Resener MC, Zannin M, Savaris A, Wangenheim CG, et al., editores. Quality Evaluation of Poison Control Information Systems: A Case Study of the DATATOX System. In: IEEE 29th International Symposium on Computer-Based Medical Systems (CBMS); 2016. 2016.
11. ABRACIT. DATATOX. Sistema Brasileiro de Dados de Intoxicações [Internet]. 2018 [acessed in Feb 4, 2020]. Disponível em: http://datatox.abracit.org.br
12. Galvao TF, Pereira MG. [Standardization of toxicological information in Brazil]. Ciênc Saúde Coletiva 2011; 16(8): 3633-4. http://dx.doi.org/10.1590/S1413-81232011000900030
13. Agência Nacional de Vigilância Sanitária. Regulariação de Produtos. Agrotóxicos [Internet]. Brasil: ANVISA; 2019 [acessado em 27 jul. 2019]. Disponível em: http://portal.anvisa.gov.br/registros-e-autorizacoes/agrotoxicos/produtos/monografia-de-agrotoxicos
14. Long JS, Freese J. Regression Models for Categorical Dependent Variables Using Stata. 3ª ed. College Station: Stata Press; 2014.
15. Belsley DA, Kuh E, Welsch RE. Regression diagnostics: identifying influential data and sources of collinearity. Nova Jersey: Wiley; 1980.
16. 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 Coletiva 2007; 12(1): 25-38. http://dx.doi.org/10.1590/S1413-81232007000100008
17. Oliveira-Silva JJ, Meyer A. O sistema de notificação das intoxicações: o fluxograma da joeira. In: Peres F, Moreira JC, editores. É veneno ou é remédio. Rio de Janeiro: Fiocruz; 2003. p. 317-26.
18. Bentur Y, Lurie Y, Cahana A, Bloom-Krasik A, Kovler N, Neuman G, et al. Poisoning in Israel: Annual Report of the Israel Poison Information Center, 2017. Isr Med Assoc J 2019; 21(3): 175-82.
19. Gummin DD, Mowry JB, Spyker DA, Brooks DE, Osterthaler KM, Banner W. 2017 Annual Report of the American Association of Poison Control Centers' National Poison Data System (NPDS): 35th Annual Report. Clin Toxicol (Phila) 2018: 56(12): 1213-415. https://doi.org/10.1080/15563650.2018.1533727
20. Perry L, Adams RD, Bennett AR, Lupton DJ, Jackson G, Good AM, et al. National toxicovigilance for pesticide exposures resulting in health care contact - An example from the UK's National Poisons Information Service. Clin Toxicol (Phila) 2014; 52(5): 549-55. https://doi.org/10.3109/15563650.2014.908203
21. Agência Nacional de Vigilância Sanitária. RDC nº 294, de 29 de julho de 2019 - Dispõe sobre os critérios para avaliação e classificação toxicológica, priorização da análise e comparação da ação toxicológica de agrotóxicos, componentes, afins e preservativos de madeira, e dá outras providências. Brasil: Agência Nacional de Vigilância Sanitária; 2019.
22. Moraes RF. Agrotóxicos no Brasil: padrões de uso, política da regulação e prevenção da captura regulatória. 2019. https://doi.org/10.13140/RG.2.2.12874.72645
23. Brasil. Instituto de Pesquisa Econômica Aplicada. TD 2506 - Agrotóxicos no Brasil: padrões de uso, política da regulação e prevenção da captura regulatória. Brasil: Instituto de Pesquisa Econômica Aplicada; 2019.
24. Eddleston M, Karalliedde L, Buckley N, Fernando R, Hutchinson G, Isbister G, et al. Pesticide poisoning in the developing world--a minimum pesticides list. Lancet 2002; 360(9340): 1163-7. https://doi.org/10.1016/s0140-6736(02)11204-9
25. Bose A, Sandal Sejbaek C, Suganthy P, Raghava V, Alex R, Muliyil J, et al. Self-harm and self-poisoning in southern India: choice of poisoning agents and treatment. Trop Med Int Health 2009; 14(7): 761-5. https://doi.org/10.1111/j.1365-3156.2009.02293.x

26. World Health Organization. World Health Statistics 2019: Monitoring health for the SDGs [Internet]. World Health Organization; 2019 [acessed in Feb 4, 2020]. Disponível em: https://www.who.int/gho/publications/world_health_statistics/2019/en/
27. Hendges C, Schiller ADP, Manfrin J, Macedo EK, Jr., Goncalves AC, Jr., Stangarlin JR. Human intoxication by agrochemicals in the region of South Brazil between 1999 and 2014. J Environ Sci Health B 2019; 54(4): 219-25. https://doi.org/10.1080/03601234.2018.1550300
28. Faria NM, Fassa AG, Meucci RD. Association between pesticide exposure and suicide rates in Brazil. Neurotoxicology 2014; 45: 355-62. https://doi.org/10.1016/j.neuro.2014.05.003
29. World Health Organization. Safer Access to pesticides for suicide prevention. Experiences from community interventions. Genebra: World Health Organization; 2016.
30. World Health Organization. The public health impact of chemicals: knowns and unknowns. Genebra: World Health Organization; 2016.
31. Swiderska A, Wisniewski M, Wiergowski M, Krakowiak A, Sein Anand J. Poisonings in Poland reported to the Polish National Health Fund in the years 2009-2011. BMC Pharmacol Toxicol 2018; 19: 62. https://doi.org/10.1186/s40360-018-0254-x
32. Chowdhury FR, Dewan G, Verma VR, Knipe DW, Isha IT, Faiz MA, et al. Bans of WHO Class I Pesticides in Bangladesh-suicide prevention without hampering agricultural output. Int J Epidemiol 2018; 47(1): 175-84. https://doi.org/10.1093/ije/dyx157
33. Eddleston M, Phillips MR. Self poisoning with pesticides. BMJ 2004; 328(7430): 42-4. https://doi.org/10.1136/bmj.328.7430.42
34. Kori RK, Singh MK, Jain AK, Yadav RS. Neurochemical and Behavioral Dysfunctions in Pesticide Exposed Farm Workers: A Clinical Outcome. Indian J Clin Biochem 2018; 33(4): 372-81. https://doi.org/10.1007/s12291-018-0791-5
35. World Health Organization. Preventing suicide: a resource for pesticide registrars and regulators. Genebra: World Health Organization / Food and Agriculture Organization of the United Nations; 2019.
36. Knipe DW, Chang SS, Dawson A, Eddleston M, Konradsen F, Metcalfe C, et al. Suicide prevention through means restriction: Impact of the 2008-2011 pesticide restrictions on suicide in Sri Lanka. PLoS One 2017; 12(3): e0172893. https://doi.org/10.1371/journal.pone.0172893
37. Cruz CC, Carvalho FN, Costa VÍB, Sarcinelli PN, Silva JJO, Martins TS, et al. Epidemiological profile of Aldicab poisoning registered by the Forensic Medical Institute in the State of Rio de Janeiro from 1998 to 2005. Cad Saúde Coletiva 2013; 21(1): 63-70. http://dx.doi.org/10.1590/S1414-462X2013000100010
38. Nelson LS, Perrone J, DeRoos F, Stork C, Hoffman RS. Aldicarb poisoning by an illicit rodenticide imported into the United States: Tres Pasitos. J Toxicol Clin Toxicol 2001; 39(5): 447-52. https://doi.org/10.1081/clt-100105414
39. Medeiros MNC, Medeiros MC, Silva MBA. Acute anticholinesterase pesticide poisoning in Recife, Pernambuco State, Brazil, 2007-2010. Epidemiol Serv Saúde 2014; 23(3): 509-18. http://dx.doi.org/10.5123/S1679-49742014000300013
40. Moon JM, Chun BJ. Predicting acute complicated glyphosate intoxication in the emergency department. Clin Toxicol (Phila) 2010; 48(7): 718-24. https://doi.org/10.3109/15563650.2010.488640
41. Kim YH, Lee JH, Cho KW, Lee DW, Kang MJ, Lee KY, et al. Prognostic Factors in Emergency Department Patients with Glyphosate Surfactant Intoxication: Point-of-Care Lactate Testing. Basic Clin Pharmacol Toxicol 2016; 119(6): 604-10. https://doi.org/10.1111/bcpt.12624

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