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Occupational pesticide poisoning, 2000-2009, Brazil

ABSTRACT

OBJECTIVE: To estimate the mortality rate due to occupational pesticide poisoning in Brazil.

METHODS: Data on diagnoses of death from pesticide poisoning between 2000 and 2009 were obtained from the Mortality Information System. ICD-10 codes T60.0-T60.4, T60.8 and T60.9, Y18, X487 and Z578 as the main or secondary cause of death; data on work-related deaths were obtained from the death certificate, from the fields <work related accident>, <circumstances of death> and whether cases were agricultural workers. Homicides and suicides were excluded. To calculate mortality, the number of agricultural workers was obtained from the Brazilian Institute of Geography and Statistics, National System of Accounts estimates.

RESULTS: There were 2,052 deaths recorded as caused by pesticide poisoning in Brazil, between 2000 and 2009, of which 36.2% (n = 743) had no occupation data. Of the remaining 1,309, 679 (51.9%) were agricultural workers. Mortality from occupational pesticide poisoning declined from 0.56/100.000 (2000-2001) to 0.39/100.000 (2008-2009) workers during the study period, and there was a larger decrease among men compared with women. Males had a higher mortality from this type of poisoning than women in all study years. Most deaths were caused by organophosphates and carbamate pesticides poisoning. During the study period the number of cases declined in all regions, except for the Northeast.

CONCLUSIONS: Improvement in the quality of Death Certificate records is needed, particularly for occupation and the assessment of causes of death as work related, crucial for work injuries control and prevention programs. Special attention is required in the Northeast region.

DESCRIPTORS: Pesticides, poisoning. Occupational Mortality. Accidents, Occupational. Occupational Exposure. Working Conditions. Occupational Health.

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INTRODUCTION

Brazil is one of the world's principal agricultural producers. According to the 2006 Agricultural Census, there were 5.17 million agricultural companies, a total of 329.94 million hectares. This is reflected in the large demand for and consumption of chemical products or compounds named pesticides. In 2008, the country became the world's largest consumer of pesticides and was responsible for 86% of Latin America consumption. The term "agrotóxico" (pesticide) was adopted in Brazil through Federal Law nº 7,802/1989, regulated by Decree nº 4,074/2002, and refers to any chemical compounds aimed to control, destruct or prevent, directly or indirectly, substances pathogenic to plants and animals useful to humans. Pesticides may take the form of herbicides, fungicides, rodenticides, nematicides, acaricides, molluscicides, termiticides, growth regulators and inhibitors, fumigants, fertilizers, wood preservatives and certain veterinary products. The most commonly used substances are organophosphates, carbamates and halogens.[13]

Pesticides affect the health of those who consume agricultural or contaminated products, live in areas close to agricultural or pesticide production or are affected by crop spraying, and exposed workers. Occupational exposure to pesticides is related to trades as diverse as public health, the timber industry or related to the production of such substances. Agricultural workers may have contact with these products by working in: tilling, sowing, irrigation, plant care, harvest, storing and packaging products, soil fertilization, pest control, animal care, animal healthcare when veterinary substances are used, and others.[4] Pesticide poisoning may occur in the workplace, while travelling to work, or during work-related journeys, due to ingestion, inhalation or skin absorption, and can be classified as intentional or non-intentional. The majority of pesticide poisoning cases occur among agricultural workers.[18,11] Work-related pesticide exposure is a public health problem,[9] therefore subject to health surveillance and monitoring.

Little epidemiological data is available on mortality or morbidity due to occupational pesticide poisoning. In some reviews,[3,9] this lack of data has been found in emerging countries, where the control of the commercialization and use of these products are poorly implemented or less effective. Studies on mortality are even rarer and very distinct patterns may be seen across different countries. In Costa Rica, using data from 1980 to 1986, Wesseling et al[18] (1993) estimated the annual mortality related to occupational pesticide poisoning (probable cause) as 9.2/100,000, which fell to 1.8/100,000 when only autopsy-confirmed diagnoses were considered. In England, deaths from acute pesticide poisoning were identified using data for 1989-1992 from various health information systems. Almost one quarter of cases (24.3%) was classified as occupational and 79 deaths were recognized as caused by acute work-related pesticide poisoning. However, records from the Health and Safety Executive, responsible for legal notifications, revealed only one case.16 Large underreporting of cases has also been reported in other countries. In the USA, a specific notification system – Sentinel Event Notification System for Occupational Risks-Pesticides (SENSOR-Pesticides) was set up in 1998 to monitor pesticide poisoning. Between 1998 and 2005, from all 3,271 registered cases only one fatality was recorded.2 Using data from the California Pesticide Illness Surveillance Program (PISP) between 1994 and 1996, the mortality rate from occupational pesticide poisoning was estimated at 0.024/100,000 person-years.[11]

With few records, reports on the factors associated with occupational poisoning are rare. However, there is evidence that male workers,[11,16,18] aged between 15-19, have a higher mortality rate from occupational pesticide poisoning than other workers. Crop spraying and the use of paraquat were more common among registered cases[18]

No mortality estimates due to occupational pesticide poisoning have been found for Brazil. Bochner1 (2007) analyzed data for 1986-2003 from the Pharmacological Toxic National Information System (SINITOX) for the entire country. She found 3,012 deaths caused by pesticide poisoning in general, and estimated[a] 1.58/1,000,000 mortality, higher in the Midwest (3.1), Northeast (2.7) and South (2.2) regions respectively. There were only 25 cases recognized and recorded as work related.1 Another useful data source is the death certificate, which, since 1997, has incorporated a specific field for recording whether each external cause death is work-related, although this is not commonly analyzed.

The aim of this study is to estimate occupational pesticide poisoning mortality in Brazil.

METHODS

The study was carried out using data from death certificates from 2000 through 2009 using the Mortality Information System (SIM), available at Datasus,[b] which enables the extraction of anonymous individual data.

[a] Instituto Brasileiro de Geografia e Estatística, Sala de Imprensa. Notícias: IDS 2010: país evolui em indicadores de sustentabilidade. Rio de Janeiro; 2010. [cited 2013 May 14]. Available from: http://saladeimprensa.ibge.gov.br/noticias?view=noticia&id=1&busca=1&idnoticia=1703
[b] Ministério da Saúde, Datasus. Informações de saúde: mortalidade: download de arquivos – CID 10. Brasília (DF); 2011 [cited 2013 May 14]. Available from: http://tabnet.datasus.gov.br/cgi/sim/dados/cid10_indice.htm

The study population comprises all active workers from the trade group known as the Agricultural Sector of the National Classification of Economic Trades (CNAE): 0101 – Agriculture, forestry and logging; and 0102 – Livestock and fishing. The population data comes from the Brazilian Institute of Geography and Statistics (IBGE), National Accounts System (SCN),[c] which provides estimates of the number of active workers according to trades and calendar year. Adjustments were made to account for inconsistencies between these estimates and data from the 2006 Agricultural Census.

Poisoning due to non-intentional exposure to pesticides is coded in the International Classification of Diseases (ICD-10[a] Rev.) as: T60.0 organophosphate and carbamate insecticides, T60.1 halogenated insecticides, T60.2 other insecticides, T60.3 herbicides and fungicides, T60.4 rodenticides, T60.8 other pesticides and T60.9 unspecified pesticides (Chapter XIX). From Chapter XX, we used: all codes of the X48 group, that correspond to accidental poisoning [intoxication] from exposure to pesticides, Y18 poisoning/intoxication due to exposure to pesticide poisoning of undetermined intent, and the Z57.8 code for occupational exposure to toxic agents in agriculture.

Cases of intentional poisoning, such as homicides or suicides, were not considered, although cases of self-inflicted poisoning are recognized as potentially related to occupational pesticide poisoning.[9] The main cause of death and the five associated causes recorded on SIM were all checked, either in isolation or linked with other diagnoses. In addition to ICD-10[a] codes, to select study cases we used data recorded in the "work-related" (yes/no), and "circumstances of death" fields (1 = accidental, 2 = suicide, 3 = homicide, 4 = other, 9 = ignored). We defined cases of occupational pesticide deaths as those who had the main or associated cause of death classified within the selected ICD-10[a] codes, were identified as work-related, or where the circumstance of death recorded as "accidental", and worked in the Agriculture (Group 6), according to the Brazilian Occupation Classification 2002. They correspond to occupations related to agriculture, silviculture, aquaculture, forestry, hunting, livestock and fisheries. Descriptive variables were: sex, age group (< 15; 15 to 24; 25 to 44; 45 to 59; > 60 years old), state, region, year of death and specific ICD-10[a] code.

Mortality was calculated yearly and in two-year periods to better visualize trends. The number of fatal cases was divided by the total number of agricultural workers in the corresponding year or period and multiplied by 100,000. Statistical tests were not applicable because census data was used, and the study purpose was descriptive. Missing data was imputed using other records from the same individual. For instance, missing data of the state was identified using the municipality code where the death occurred. Data were analyzed with SAS 9.2 and Excel spreadsheets

RESULTS

There were 2,052 deaths by pesticide poisoning in the SIM database between 2000 and 2009, of which 36.2% contained no information on occupation. When this information was available, 51.9% were identified as agricultural workers. Of these, 5.6% were recorded on the death certificate as work-related injuries, and all of them were coded as "accidental" in the <circumstances of death> field. However, 7.2% of those considered "accidental" were not registered as work-related injury. Valid records (yes; no) for the <work-related injury> field were identified in only 15.5% of the cases selected for this study.

The majority (47.8%) of main cause diagnoses were coded within the pesticide poisoning of undetermined intention (Y18) or undetermined location (Y18.9) (34.3%). The group of accidental pesticide poisoning (X48.0) (27.5%) was the second most common, with the highest proportion of diagnoses recorded "in a non-specified location" (X48.9) (14.3%). Only 30% of the cases had a diagnosis of pesticide poisoning as the associated cause in line "a", 9.6% identified chemical substances, especially organophosphates and carbamates (T60.0) (56.9% of the cases classified in group T60). For the other associated causes, the pattern of diagnosis was similar to the one found for the main cause, with a large proportion of cases coded as of undetermined intention and in an unspecified location. The other associated cause data did not reveal any relevant patterns. There were no missing data for the underlying cause of death diagnosis (Table 1).

In all of the two-year periods considered, most cases occurred in men aged 25 to 44, in the Northeast region of the country. Between 2000-2001 and 2008-2009, the absolute number of deaths by occupational pesticide poisoning in Brazil decreased from 162 to 112, a 30% fall (Table 2). This decline was found in all categories of the variables analyzed, except for an increase (19.2%) amongst those aged 60 and over, and the disappearance, from 2006-2007 onwards, of cases amongst the under 15s. The reduction in the number of deaths from occupational pesticide poisoning occurred in all regions except for the Northeast, where there was no change during the study time.

The occupational pesticide poisoning mortality fell from 0.56/100,000 workers in 2000-2001 to 0.39/100,000 in 2008-2009. Amongst males,

[c] Instituto Brasileiro de Geografia e Estatística. Pesquisas: Sistemas de Contas Nacionais. Rio de Janeiro; 2009 [cited 2013 May 14]. Available from: http://www.ibge.gov.br/home/estatistica/economia/contasnacionais/2009/defaulttab.shtm

Table 1. Distribution of diagnoses of underlying and associated causes of death by occupational pesticide poisoning among agricultural workers. Brazil, 2000 to 2009.

ICD codes	Underlying cause		Associated cause	
	n = 679	100.0%	n = 679	100.0%
T60.0 Organophosphate and carbamate insecticides (diagnoses alone or in combinations)	0	–	37	5.4
T60.1 Halogenated insecticides	0	–	2	0.3
T60.2 Other insecticides	0	–	4	0.6
T60.3 Herbicides and fungicides	0	–	2	0.3
T60.4 Rodenticides	0	–	6	0.9
T60.8 Other pesticides	0	–	1	0.1
T60.9 Non-identified pesticide	0	–	13	1.9
Total	0	–	65	9.6
X48.0 Accidental poisoning by exposure to pesticides at home	44	6.5	15	2.2
X48.1 Accidental poisoning by exposure to pesticides in collective dwelling	1	0.1	1	0.1
X48.2 Accidental poisoning by exposure to pesticides in schools or public institutions	4	0.6	1	0.1
X48.4 Accidental poisoning by exposure to pesticides in the street or road	5	0.7	3	0.4
X48.5 Accidental poisoning by exposure to pesticides – business and services	0	–	2	0.3
X48.7 Accidental poisoning by exposure to pesticides on a farm	28	4.1	14	1.5
X48.8 Accidental poisoning by exposure to pesticides in specific locations	8	1.8	2	0.3
X48.9 Accidental poisoning by exposure to pesticides in an unspecified location	97	14.3	5	6.4
Total	187	27.5	43	6.3
Y18.0 Pesticide poisoning, undetermined intent, at home	60	8.8	23	3.4
Y18.1 Pesticide poisoning, undetermined intent, in collective dwelling	3	0.5	2	0.3
Y18.2 Pesticide poisoning, undetermined intent, in schools or public institutions	6	0.9	0	–
Y18.4 Pesticide poisoning, undetermined intent, in the street or road	7	1.0	2	0.3
Y18.7 Pesticide poisoning, undetermined intent, on a farm	10	1.5	1	0.1
Y18.8 Pesticide poisoning, undetermined intent other location	5	0.7	3	0.4
Y18.9 Pesticide poisoning, undetermined intent, unspecified location	233	34.3	63	9.2
Total	324	47.8	94	11.0
Other	168	24.7	477	70.3

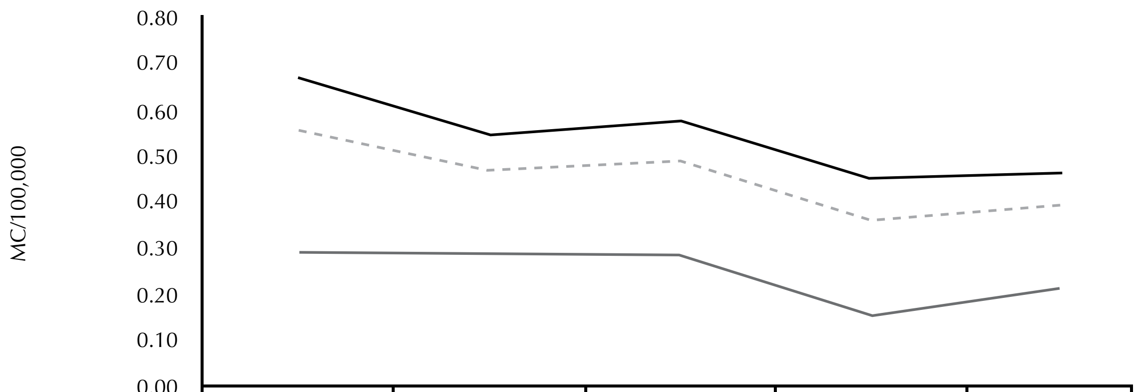
Source: Ministry of Health. Mortality Information System, 2000 to 2009.

this decrease was from 0.67/100,000 workers to 0.47/100,000, whereas the variation for women was from 0.29/100,000 to 0.21/100,000, less (27.6%) than the male estimate (29.9%). Men had a higher risk of dying from occupational pesticide poisoning compared to women throughout the study period, with the smallest difference occurring in the last two-year period (2008 to 2009) (Figure 1).

There was a large variation in the occupational pesticide poisoning mortality in 2009, with Mato Grosso do Sul being the state with the highest mortality (1.42/100,000 agricultural workers), followed by Rio de Janeiro (1.27/100,000), Acre (1.00/100,000), Goiás (0.72/100,000) and Espírito Santo (0.63/100,000), whereas no deaths were recorded in Amapá, Roraima, Rondônia, Sergipe, Rio Grande do Norte, Mato Grosso, Santa Catarina and the Federal District (Figure 2).

DISCUSSION

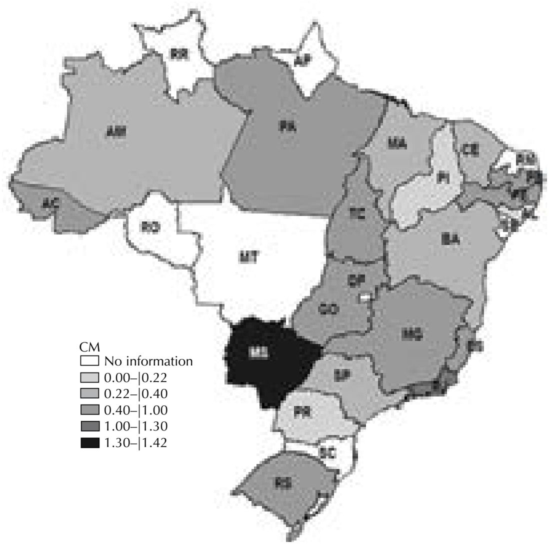
In Brazil, between 2000 and 2009, 679 agricultural workers died from occupational pesticide poisoning. This significant number may be even higher, considering the large number of death certificates lacking information about occupation, work-relatedness or circumstance of death. There was a declining trend in the number of deaths due to occupational pesticide poisoning over the study period, especially amongst men, workers under 24 years old and in the Midwest and Southeast regions of the country. A similar pattern was observed for mortality, which fell during the study time, and was higher amongst men than women. The most common occupational pesticide poisonings were related to organophosphates and carbamates. Men (male to female ratio of 5:1), people aged 25 to 44 and those resident in the Northeast region prevailed amongst the recorded study cases.



	2000/2001	2002/2003	2004/2005	2006/2007	2008/2009
Male	0.67	0.55	0.57	0.45	0.47
Female	0.29	0.29	0.29	0.16	0.21
Total	0.56	0.47	0.49	0.37	0.39

Source: Ministry of Health. Mortality Information, 2000-2009, National Household Survey – *Pesquisa Nacional por Amostra de Domicílio* (PNAD)/ *Instituto Brasileiro de Geografia e Estatística* (IBGE) 2000-2009.

Figure 1. Mortality coefficient for work-related injuries for pesticide poisoning (MC/100,000) in agricultural workers by sex and two-year period. Brazil, 2000-2009.



Mortality coefficients per 100,000 in brackets. PR: Paraná (0.18); SC: Santa Catarina (0.00); RS: Rio Grande do Sul (0.49); MG: Minas Gerais (0.47); SP: São Paulo (0.33); ES: Espírito Santo (0.63); RJ: Rio de Janeiro (1.27); MT: Mato Grosso (0.00); GO: Goiás (0.72); DF: Distrito Federal (0.00); MS: Mato Grosso do Sul (1.42); MA: Maranhão (0.30); PI: Piauí (0.12); CE: Ceará (0.35); RN: Rio Grande do Norte (0.00); PB: Paraíba (0.41); PE: Pernambuco (0.74); AL: Alagoas (0.22); SE: Sergipe (0.00); BA: Bahia (0.26); AC: Acre (1.0); AM: Amazonas (0.37); RO: Rondônia (0.00); TO: Tocantins (0.57); AP: Amapá (0.00); PA: Pará (0.50); RR: Roraima (0.00) Source: Ministry of Health. Mortality Information System, 2009. National Accounting/Instituto Brasileiro de Geografia e Estatística (IBGE), 2008.

Figure 2. Mortality coefficients (MC/100,000) by occupational pesticide poisoning, by state, 2009.

The occupational pesticide poisoning mortality in the agricultural trade (0.39/100,000 in 2008-2009) found here is lower than the 1980s estimate for Costa Rica,[18] from over 30 years ago. However, it is higher than the 1994 to 1996 results for California (0.024/100,000 person-year mortality in the general population),[11] even considering differences in the nature of the population, not limited to workers, the measure of mortality, and the data source. While we use death certificates, the Californian study data came from a specific pesticide monitoring system, with greater potential for case identification. We estimate mortality in contrast with the Californian study, which used mortality rate based on person-time; and the study population was not composed exclusively of agricultural workers. Studies in India,[12] South Korea[10] or for the total population of the United States[2] have found between 1 and 3 cases, which did not justify mortality estimates. Also in the USA, in a prospective cohort study of more than 57,000 workers potentially exposed to pesticides, and their wives, who composed a referent group, the pesticide-related mortality was not estimated due to small numbers.[17]

Although the occupational pesticide poisoning mortality may be considered low in Brazil, it is higher when compared to the findings from other countries. This is not surprising, given the high level of pesticide use in the country and the poor compliance with norms related to workers' health and safety, especially amongst rural workers.[5,7] However, the decreasing number of cases and mortality especially in the South and Southeast is encouraging, suggesting improvements in the

Table 2. Number and percentage of deaths due to occupational pesticide poisoning among agricultural workers, according to sex, age and region. Brazil, 2000 to 2009. (N = 679)

Variable	2000-2001		2002-2003		2004-2005		2006-2007		2008-2009		Variation (%) in the number over the period
	n	%	n	%	n	%	n	%	n	%	
Brazil	162	100.0	139	100.0	156	100.0	110	100.0	112	100.0	-30.0
Sex											
Male	137	84.6	114	82.0	129	82.7	96	87.3	94	83.9	-31.3
Female	25	15.4	25	18.0	27	17.3	14	12.7	18	16.1	-28.0
Age (years)											
< 15	7	4.3	5	3.6	8	5.1	0	–	0	–	-100.0
15 to 24	33	20.4	29	20.9	35	22.4	12	10.9	17	15.2	-48.5
25 to 44	58	35.8	59	42.4	50	32.0	44	40.0	35	31.2	-39.7
45 to 59	38	23.5	27	19.4	42	26.9	25	22.7	29	25.9	-23.7
> 60	26	16.0	19	13.7	21	13.5	29	26.4	31	27.7	+19.2
Region											
North	12	7.4	12	8.6	7	4.5	1	0.9	3	2.7	-75.0
Northeast	49	30.2	62	44.6	79	50.6	45	40.9	49	43.8	0.0
Southeast	49	30.2	28	20.1	31	19.9	18	16.4	20	17.9	-59.2
South	39	24.1	26	18.7	34	21.8	39	35.4	35	31.2	-10.2
Midwest	13	8.0	11	7.9	5	3.2	7	6.4	5	4.5	-61.5

Source: Ministry of Health. Mortality Information, 2000-2009, National Household Survey – *Pesquisa Nacional por Amostra de Domicílio* (PNAD)/ *Instituto Brasileiro de Geografia e Estatística* (IBGE) 2000-2009.

effectiveness of prevention and control interventions. There has been a significant extension of workers' health care, as part of the SUS implementation, particularly with the growth of the Environmental Health Surveillance and the number of Referral Center for Workers' Health (CEREST). These centers comprise part of the Workers Integral Health Care Network (RENAST),[d] which has been under expansion in every state. In addition, there have been important debates on environmental health and pesticides policies, highlighting food contamination, workers' exposure and its health effects,[5,7] as well as the economic impact.[15] Studies conducted with samples of rural workers reveal high levels of pesticide poisoning, either perceived[5] or measured through biological tests.[7,15]

The situation in the Northeast is worrying and requires urgent attention from the healthcare authorities. In this region, there was a higher proportion of cases recorded on death certificates, and the number of fatal occupational pesticide poisonings did not decline over the study period. It is possible that this is due to improvements in the quality of death certificate recording, but we cannot rule out the opposite, an increasing number of cases resulting from greater exposure and/or unsafe conditions related to pesticides amongst agricultural workers. We know these are more likely to be informal workers, with low levels of education and little access to healthcare and social protection.

The fall in occupational pesticide poisoning mortality was lower amongst women, in contrast to the higher decline of the total work-related injuries mortality in women.[e] The sex difference is smaller for deaths due to occupational pesticide poisoning, when compared with all fatal work-related injuries, usually to the order of 10. Women working in agriculture may be in a more vulnerable condition, which could be a result of low access to protective measures and less knowledge about the pesticide effects on health, amongst other factors, as reported by Faria et al[5] (2004).

Conclusions based on the findings from this study should be viewed with caution, due to the large number of losses from the lack of occupation data and the possible underreporting of study cases. This is especially worrying, since it concerns agricultural workers who are in the majority in rural areas, where access to healthcare services and the quality of healthcare information are poorer than in urban areas. Since deaths from exogenous poisoning are violent deaths, it is possible that those responsible for completing the

[d] Santana VS, Silva JM. Os 20 anos da saúde do trabalhador no SUS. Brasília (DF): Ministério da Saúde; 2009. (Série Saúde Brasil). Available from: http://bvsms.saude.gov.br/bvs/publicacoes/saude_brasil_2008.pdf

[e] Universidade Federal da Bahia, Instituto de Saúde Coletiva, Centro Colaborador em Vigilância dos Acidentes de Trabalho, Programa Integrado em Saúde Ambiental e do Trabalhador. Acidentes fatais no Brasil 2000-2010. *Bol Epidemiol Acid Trab.* 2011;1(1):1-4. Available from: http://www.2pontos.net/preview/pisat/hp/upload/boletim_1_final_3.pdf

death certificates are reluctant to record data about the cause, because of its legal implications. The recording of occupational causes of death implies the responsibility of employers and may lead to pressure for it to be omitted. Evidence of this is seen in the high proportion of cases classified as of undetermined intention and unspecified location found in this study. However, our definition of occupational pesticide poisoning based on the occupation of the deceased worker, the use of all ICD-10 codes related to pesticides, the main cause of death and all five associated causes available, in isolation or in combination, should have avoided, or at least substantially reduced cases undercounting. The underreporting of the work relatedness of injuries is a problem commonly found in Brazil and other countries.[8] This could have been reduced by the adoption of a presumed occupational causal relation as used in this study, supported by the obvious relationship between working in agriculture and work-related exposure to pesticides.[5,7,14,15] There was a large proportion of lost occupation data, a variable used to identify our study cases. The fatal pesticide poisoning cases with missing occupation data could ultimately be agricultural workers, thus increasing our mortality estimates. In 2006, changes were introduced in the structure of the death certificate form, which may have affected the recording quality of causes of death related to this type of poisonings. Although we did not find estimates of underreporting of deaths from work-related poisoning, for all non-fatal occupational injuries in rural Rio Grande do Sul it was estimated as 91%.[5,6]

This study highlights the importance of SIM data in monitoring workers' health, especially for work-related injuries from 1997 onwards although these data has not been frequently used in epidemiological studies. Death certificate data need to be more commonly analyzed to generate the knowledge required for prevention programs tailored to the local context. Rural workers have been targeted in epidemiological research in Brazil but this is the first national study of occupational pesticide poisoning mortality that covers all workers, both the formal (insured) and the informal (uninsured). In fact, no cases of occupational pesticide poisoning deaths can be found in the Social Security compensation database, because it does not use the Chapter XX codes of ICD-10[a], for external causes. One of the most important, and as yet unanswered, questions on this topic concerns the circumstances in which these poisonings occur, which could be useful in guiding the development of prevention programs and understanding the role gender plays in occupational pesticide poisoning. Studies using data from the National System of Notifiable Diseases (SINAN) may be able to further explore such questions, based on national data.

Documents reviewing successful prevention experiences demonstrate that the most important actions to reduce pesticide poisoning mortality target the banning of pesticides, especially those classified as Class I and II pesticides by the World Health Organization (WHO).[4] These pesticides have been replaced by others, less toxic and polluting, based on biological control or even on the manual removal of pests,[4] measures that impact on the health of workers, consumers and the environment.

In addition to more effective control norms, healthcare professionals could receive better training focusing on the identification and treatment of cases and healthcare surveillance, with an emphasis on prevention and control. It is important to disseminate knowledge and practices for the secure storage and handling of pesticides, since this is the most immediate way of preventing deaths and the other serious effects of pesticide poisoning. The safe use of pesticides has been questioned widely, suggesting that their elimination is viable. Pressure on the manufacturers of these products to use less toxic substances, as well as incentives to adopt economically sustainable development models, are recommended.

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