Forensic Science International 200 (2010) 136–140

Contents lists available at ScienceDirect

Forensic Science International

journal homepage: www.elsevier.com/locate/forsciint

Postmortem data related to drug and toxic substance use in the Federal District, Brazil, from 2006 to 2008

Emanuele Lazzaretti Cordova Campelo, Eloisa Dutra Caldas *

Department of Pharmaceutical Sciences, Laboratory of Toxicology, University of Brasilia, 70910-900 Brasilia, DF, Brazil

ARTICLE INFO

Article history:
Received 15 January 2010
Received in revised form 19 March 2010
Accepted 2 April 2010

Keywords:
Alcohol
Drugs of abuse
Pesticides
Postmortem samples
Brazil

ABSTRACT

This study describes the substances involved in fatal events that were investigated by the Forensic Medicine Institute of the Federal District, Brazil, from 2006 to 2008. The presence of pesticides was investigated in liver or stomach content samples by thin-layer chromatography; amphetamines, benzodiazepines, barbiturates, tetra-hydro-cannabinol (THC), cocaine and opioids were analyzed in urine samples by immunoassay. A total of 8736 exams were performed, of which 21.7% tested positive for at least one compound investigated. Men were involved in over 90% of positive cases; most individuals were between the ages of 18 and 30. Alcohol was detected in 47.4% of the blood samples, with over 30% presenting BAC levels higher than 1 g/L. Cocaine was present in 21.6%, and THC in 17.5% of the urine samples analyzed. Pesticides were found in 13.3% of the 188 cases investigated, mostly aldicarb, which is the main component of *chumbinho*, an illegal rodenticide available in the country. Among pharmaceutical drugs, benzodiazepines were the most detected, with 29 samples testing positive (4.6% of the samples analyzed). Most of the individuals who died from traumatism or hypovolemia tested positive for alcohol. Death from intoxication/poisoning corresponded to 1.8% of all positive cases, mainly from the ingestion of pesticides. This is the first Brazilian study reporting data on toxic chemicals from postmortem material. The results confirm other epidemiological data that indicate pesticide as the major cause of fatal poisonings in Brazil.

1. Introduction

Drug abuse has been increasingly involved in violence and the number of deaths around the world [1–4]. Although this abuse is not always the direct cause of death, it can influence the final outcome of a violent event. Fatalities involving alcohol are normally associated with traffic accidents [5,6]. In Washington State, USA, alcohol was detected in 41% of fatally injured drivers in 2001–2002 [7]. In Brazil, about half of traffic accidents with fatalities are associated with the use of alcohol [8]. In many countries, fatal overdoses involve mostly illegal drugs, such as heroin/morphine, alone or in combination with other drugs [9–11].

Aldicarb, a carbamate insecticide, is the main pesticide involved in fatal poisoning cases in Brazil, mainly as a component of *chumbinho*. This product is sold illegally as a rodenticide on the streets and free markets of the country. Most of the poisoning events involving *chumbinho* are related to suicide attempts and accidental poisonings of children [12]. This product was involved in over 55% of fatal pesticide poisoning events that occurred in the Federal District from 2004 to 2007 [12]. In addition to aldicarb, organophosphorous pesticides have also been reported as components of *chumbinho* [13].

Currently, there is no published study regarding the presence of toxic compounds in forensic samples in Brazil. The objective of this study is to describe the substances involved in fatal events that were investigated by the Forensic Medicine Institute of the Federal District (FMI/FD) from 2006 to 2008. The Federal District is located in the Midwestern region of Brazil and includes the nation's capital, Brasilia; the population in 2007 was about 2.5 million inhabitants [14].

2. Material and methods

This is a retrospective registry-based descriptive study covering data collected in the 2006–2008 records of the Forensic Medicine Institute of the Federal District (FMI/FD). These data include information on cause of death, gender, city of residence, age, and laboratory results for toxic substances. All data refer to postmortem cases. The circumstances of death were not investigated in this study.

Blood samples were collected in the hollow heart or aorta and kept in a sealed plastic vial at −20 °C for up to 15 days until analyzed for alcohol content by head space gas chromatography with a flame ionization detector. Results were considered positive when blood alcohol concentration (BAC) was ≥0.2 g/L, which is the method limit of quantification (LOQ). Samples of liver or stomach contents were extracted with ether:chloroform (2:1) and analyzed for the presence of carbamate and organophosphorous pesticides by thin-layer chromatography against analytical standards after spraying the silica gel plate with iodine or

* Corresponding author. Tel./fax: +55 61 3307 3671.
E-mail address: eloisa@unb.br (E.D. Caldas).

0379-0738/$ – see front matter © 2010 Elsevier Ireland Ltd. All rights reserved.
doi:10.1016/j.forsciint.2010.04.002

p-nitroaniline [15]. No further confirmation of positive samples was performed. Amphetamines, benzodiazepines, barbiturates, THC (tetra-hydro-cannabinol, the most active substance of cannabis), cocaine and opioids in urine were analyzed by immunoassay (Dimension® system and Flex® reagent cartridge).

Alcohol dosage was carried out in all cases in which there was evidence of unnatural death. Tests for other drugs or pesticides were carried out on a case-by-case basis, according to the event history.

3. Results

From 2006 to 2008, 8736 exams were performed on postmortem material at the FMI/FD, of which 2354 exams were performed for alcohol (26.9% of all exams), 1836 for cocaine, and 1813 for THC; 1895 exams (or 21.7%) were positive for at least one substance investigated (Table 1).

3.1. Alcohol

Alcohol was detected (BAC $\geq$ 0.2 g/L) in almost half of the samples analyzed for this substance during the period of the study (Table 1), at levels ranging from 0.2 to 14.3 g/L. The percentage of samples that tested positive for alcohol decreased during the period (from 55.3% in 2006 to 43.8% in 2008) (Table 1). Men were involved in 92% of the positive cases half of individuals were between 18 and 30 years of age (Fig. 1). Seven hundred and thirty-six cases had BAC above 1 g/L (65.9% of the positive cases), 86 above 3.0 g/L and 39 above 3.5 g/L (Fig. 2).

3.2. Illegal drugs

About 22% of the postmortem material (urine) analyzed tested positive for cocaine; the number of exams performed doubled during the period of the study, as well as the percentage of positive results (from 14.2 to 26.7%) (Table 1). Men were involved in 90–97% of the cases. Over 60% of the individuals were between 18 and 30 years old; about 8% were under the age of 18 (Fig. 1), with a 9-year-old boy being the youngest. The percentage of individuals between ages 31 and 50 years increased by 50% in 2008 compared with other years (data not shown).

THC was detected in 17.5% of the urine samples analyzed, with both the number of samples tested and the percentage of positive samples also increasing during the period of the study.

Table 1
Frequency of drugs detected in postmortem material at the FMI/FD from 2006 to 2008.

	Exams performed (% of positive exams)			
	2006–2008	2006	2007	2008
Alcohol	2354 (47.4)	505 (55.3)	880 (47.0)	969 (43.8)
Cocaine	1836 (21.6)	381 (14.2)	691 (20.2)	764 (26.7)
THC	1813 (17.5)	375 (13.0)	681 (17.2)	757 (20.0)
Opioids	661 (0.06)	115 (0.0)	294 (0.0)	252 (0.4)
Benzodiazepines	630 (4.6)	98 (1.0)	282 (5.3)	250 (5.2)
Barbiturics	628 (1.1)	97 (0.0)	284 (1.8)	247 (0.8)
Amphetamines	626 (0.3)	101 (0.0)	282 (0.4)	243 (0.4)
Chumbinho/pesticide[a]	188 (13.3)	50 (24)	85 (4.7)	53 (15.1)
Total	8736 (21.7)	1716 (19.7)	3478 (39.8)	3535 (40.5)

[a] Tested for aldicarb or any other pesticide.

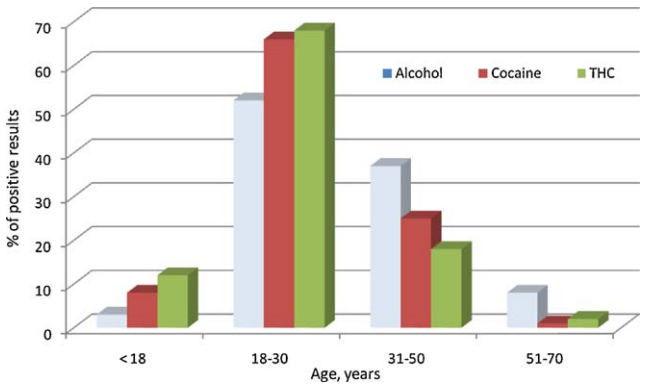

Fig. 1. Percentage of positive results for alcohol, cocaine and THC according to the age of the individual. Age was not reported in 39 cases (1.7% of total) for alcohol, and in 11 cases (0.6% of total) for cocaine.

Men were involved in 95–99% of the cases that tested positive. Most individuals were between 18 and 30 years old, approximately 10% of whom were under 18 years (Fig. 1). Only one urine sample tested positive for opioids, that of a 40-year-old woman in 2008.

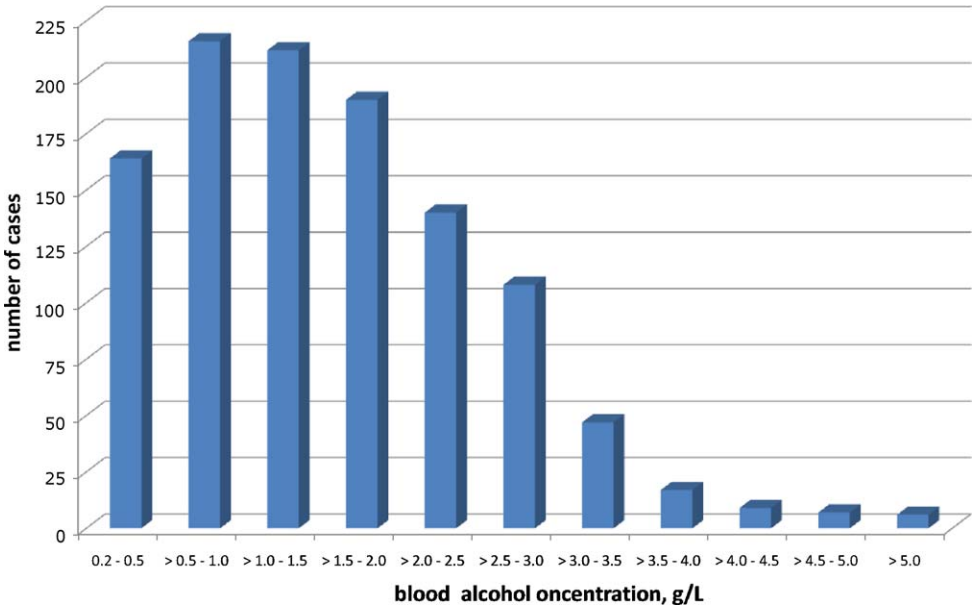

Fig. 2. Distribution of blood alcohol concentrations (BAC) found in the 1116 positive cases investigated in the Federal District from 2006 to 2008.

3.3. Pharmaceutical drugs

Thirty-nine postmortem urine samples analyzed tested positive for pharmaceutical drugs (2%). Individuals were 17–63 years old, including a 1-year-old boy; five cases involved women. Benzodiazepine was the class of substances most found, with 29 samples testing positive, only one in 2006. Barbiturics were found in 8 samples of individuals 22–54 years old; two were women, and two also tested positive for benzodiazepines. Only 2 samples tested positive for amphetamines, both men (aged 18 and 36).

3.4. Pesticides

During the period of the study, 25 postmortem samples tested positive for pesticides, 22 for aldicarb, the main component of *chumbinho*. Individuals were between 19 and 89 years of age, and 6 cases involved women.

3.5. Reported cause of death

Table 2 shows the distribution of the reported cause of death and the relation with cases investigated in the study that tested positive for alcohol, cocaine and THC. The percentage of deaths due to undetermined causes ranged from 3.5 to 5.7%. Individuals who died from traumatisms tested positive for alcohol in almost half of the cases, mainly as a consequence of traffic accidents. The majority of the deaths from hypovolemia also tested positive for alcohol. In nine alcohol positive cases, the reported cause of death was intoxication/poisoning; 4 cases had BAC $>$ 3.5 g/L. In six poisoning cases (BAC of 0.2–4.7 g/L), cocaine or aldicarb were also detected in postmortem material; in one case (6.6 g/L), THC was also detected. In only one poisoning case, alcohol was the only compound detected, with a BAC of 10.7 g/L.

About 25% of the individuals who died from trauma or hypovolemia, and about 17% of those from asphyxia (mainly by carbon monoxide, gagging or mechanically) and drowning, tested positive for cocaine (Table 2). In 21.5% of the deaths from trauma and hypovolemia, the individuals tested positive for THC.

The causes of death reported in cases that tested positive for pesticides were intoxication/poisoning (21 cases), pulmonary edema and acute respiratory failure (3 cases)—both symptoms characteristic of acute exposure to acetylcholinesterase inhibitors and trauma (one case). In two poisoning cases, there was association with alcohol and two with cocaine.

4. Discussion

Alcohol was the main substance found in the postmortem materials, with the profile of the individuals involved in the cases agreeing well with that of alcohol users in Brazil. A survey conducted in the country in 2005/2006 showed that individuals between the ages of 18 and 24 drink more than other age groups; women drink less and less frequently than men [16]. According to the Ministry of Health, about 12% of the Brazilian population between the ages of 12 and 65 years presents signs of alcohol dependence, an incidence that is higher than the worldwide average [8].

Hypovolemia and traumatism, mainly as consequence of traffic accidents, were the main cause of death in the alcohol positive cases. Since 2008, Brazil has a zero-tolerance policy for driving under the influence of alcohol, with penalties being imposed for BAC levels equal to or greater than 0.2 g/L. In the present study, about 7.7% of the individuals who tested positive for alcohol had BAC $\geq$ 3.0 g/L, a level that can lead to lack of coordination, disorientation, muscle weakness and unconsciousness [1]. Thirty-nine cases (3.5%) had BAC $\geq$ 3.5 g/L, levels that can lead to coma and possibly death [1,17]; in four cases, the cause of death was reported as poisoning, but in only two of the cases alcohol was the only acute toxic compound detected in the postmortem material. A non-tolerant individual, however, may die from a lower blood ethanol level. In a study conducted in Jordan, 26.6% of deaths due to alcohol poisoning were observed for BACs between 0.9 and 2 g/L [18].

Cocaine and THC were, respectively, the second and the third most frequently found substances in postmortem material. The estimated 1-year prevalence of cannabis use for the Brazilian population was estimated by Jungerman [19] to be 2.1%, with higher probability for men and individuals between the ages of 18 and 30. Cocaine and crack users appear to be especially vulnerable to deaths from external causes. The annual mortality rate among crack users admitted to a hospital in the city of São Paulo (1992–1994) was 2.5%, seven times higher than the overall mortality rate in the city during the same period; the majority of the fatal cases involved men under 30 [20]. In another study conducted in the city, about 20% of the 124 crack-dependent patients admitted to a public detoxification unit died, mainly from homicide [21]. The observed mortality rate, adjusted for age and sex, was 24.92 per 1000, over nine times the adjusted expected all-cause mortality rate in the state. In Denmark, fatal poisoning involving cocaine represented 15% of fatal poisoning cases in 2002 [2].

Alcohol is also the main substance found in postmortem material in other countries; however, the second most detected substance varied substantially, probably due to different social and cultural aspects, and drug availability. In Sweden (2002–2003), alcohol accounted for 43%, and morphine for 35% of the cases investigated [4]. In Australia (1996–2006), alcohol, cannabis and opioides were the most detected substances in homicide victims [22] and non-overdose suicides [23]. In Jordan, alcohol accounted for 50% of the 60 cases investigated, followed by neuroleptic drugs (26.6%) [18]. In Spain, between 1991 and 2000, at least one psychoactive substance was detected in half of the drivers killed in road accidents, mainly alcohol (43.8%), followed by cocaine (5.2%), opioids (3.2%) and cannabis (2.2%) [24].

In a review published by Macdonald et al. [25], the percentages of fatal injuries testing positive for cocaine and cannabis were shown to vary widely among and within countries. In the USA, the percentage of patients testing positive for cocaine ranged from 0.3 to 9.8% for drivers, and from 8 to 40% for other populations. Drivers testing positive for cocaine in other countries ranged from 0.1% in Australia to 6–7% in Canada and Spain. Data from European countries, USA, Canada, Australia, South African and Tasmania showed the percentage of injury patients testing positive for cannabis to range from 1.4 to 27.5%.

In the present study, only one sample tested positive for opioids, reflecting a low use of these compounds in Brazil. Indeed, the last national household survey on drug abuse conducted in 2001 showed the percentage of lifetime use of opioids as 1.3%, mainly from the use of codeine syrup [26]. Only 4 individuals

Table 2
Leading causes of death and positive exams for alcohol, cocaine and THC.

Death cause	Cases investigated (% positive)		
	Alcohol	Cocaine	THC
Traumatism/injury	1330 (48.3)	962 (21.4)	956 (18.3)
Hypovolemia	531 (55.0)	450 (28.2)	444 (24.7)
Asphyxia/suffocation	102 (38.2)	87 (18.4)	85 (8.2)
Drowning	65 (44.6)	49 (16.3)	48 (10.4)
Electrocution	24 (25.0)	17 (5.9)	17 (5.9)
Intoxication/poisoning	12 (75.0)	13 (61.5)	10 (10)
Others[a]/undetermined	290 (34.1)	258 (12.0)	253 (7.4)
Total	2354 (47.4)	1836 (21.6)	1813 (17.5)

[a] Includes respiratory failure, edema, heart attack, pneumonia, septicemia and sudden death.

among the 8589 respondents (aged 12–65) had ever used heroin (0.04%), a much lower rate than that found in the USA in the same year (1.2%) [27]. In Europe, the average prevalence of problem opioid use from 2002 to 2007 was estimated to be between 3.6 and 4.6 cases per 1000 of the population aged 15–64 [28].

Although pharmaceutical drugs are the main cause of intoxication in Brazil, accounting for about 30% of all cases reported to the SINITOX, the fatality rate is low (0.26%) compared with that of pesticide (1.8%), the second cause of intoxication in the country [29]. These data support the low percentage of postmortem material testing positive for these substances in the present study (2%). In New South Wales, Australia, 26.5% of non-overdose suicide cases tested positive for antidepressants, antipsychotics and benzodiazepines, mostly women [23]. In Spain, 4.7% of drivers involved in fatal road accidents between 1991 and 2000 tested positive for pharmaceutical drugs [24].

In the present study, poisoning, from exposure to alcohol, cocaine and/or pesticide, was the cause of death reported for 40 cases, representing 0.46% of all cases investigated. This rate is much higher in other countries. In Germany, about 9% of all autopsies performed from 1991 to 2000 were related to poisoning [30]; in Norway, about 10% of the autopsies of violent deaths (1972–1992) were related to poisoning [31].

The majority of the poisoning cases involved pesticides. This trend is completely different from that found in other countries, where alcohol, illegal drugs or CO are involved in most fatal poisoning cases [9–11,30,32]. However, this is typical for the Brazilian case, as reported in other data sources [29,33]. Brazil is one of the world's largest pesticide consumers, where highly acute pesticides are largely available [34]. Poisoning with these compounds, mainly in the form of *chumbinho*, is an ongoing problem in the country [12,35]. According to the Brazilian legislation, pesticide products may only be purchased by agronomic prescription issued by a technical professional [36]. However, this regulation is rarely enforced, and consequently pesticide is the most frequent cause of lethal intoxication in the country [29]. The number of pesticide-related deaths varies according to the data source, mainly due to different inclusion criteria [37]. The results from the present study show that 16 fatal poisonings with pesticides occurred in the Federal District in 2006 and 2007. During this period, 13 cases fatal cases were reported to the Toxicological Information and Assistance Center of the Federal District [12] and the Brazilian Mortality System contains only 7 deaths classified as ICD-10:X48 (accidental poisoning by or exposure to pesticides) in the region [33]. Underreporting of fatal poisonings in the compiled ICD statistics compared with medico-legal statements based on forensic toxicological examinations has also been reported in Finland [32].

This is the first published study in the country that reports data on toxic chemicals in forensic postmortem material. One major limitation found while searching for information in the FMI/FD records was the lack of standardization in the reports, mainly regarding the cause of death. Furthermore, with the exception of alcohol, only qualitative information of the chemicals investigated was provided in the reports, making it difficult in some cases to confirm the actual underlying cause of death. Additionally, no other method, such as mass spectrometry, was used to confirm the presence of the chemicals in the samples, mainly in the case of pesticides.

5. Conclusion

The data described in this study follows the global trend reported in other countries, with alcohol being the primary drug found in postmortem material. A specific trend found in the region, which agrees with the Brazilian scenario, was the important involvement of pesticides in the poisoning cases. Data obtained in this study showed that information obtained from forensic analysis material better reflects the gravity of the pesticide poisoning problem in Brazil in comparison with other data sources available in the country.

Acknowledgements

We thank the help and support of the Forensic Medicine Institute of the Federal District, mainly Dr. Nivaldo Alves, João Batista dos Santos and Silvana de Almeida.

References

[1] W. Jones, F.C. Kugelberg, A. Holmgren, J. Ahlner, Five-year update on occurrence of alcohol and other drugs in blood samples from driver killed in road-traffic crashes in Sweden, Forensic Sci. Int. 186 (2009) 56–62.
[2] A. Steentoft, B. Teige, P. Holmgren, E. Vuori, J. Kristinsson, A.C. Hansen, G. Ceder, G. Wethe, D. Rollmann, Fatal poisoning in Nordic drug addicts in 2002, Forensic Sci. Int. 160 (2006) 148–156.
[3] A.K. Jonsson, P. Holmgren, J. Ahlner, Fatal intoxications in Swedish forensic autopsy material during 1992–2002, Forensic Sci. Int. 143 (2004) 53–59.
[4] A.K. Jonsson, P. Holmgren, H. Druid, J. Ahlner, Cause of death and drug use pattern in deceased drug addicts in Sweden, 2002–2003, Forensic Sci. Int. 169 (2007) 101–107.
[5] I. Nordrum, T.J. Eide, L. Jorgensen, Alcohol in a series of medico-legally autopsied deaths in northern Norway 1973–1992, Forensic Sci. Int. 110 (2000) 127–137.
[6] P. Lunetta, A. Penttilä, S. Sarna, The role of alcohol in accident and violent deaths in Finland, Alcohol. Clin. Exp. Res. 25 (2001) 1654–1661.
[7] E.W. Schwilke, M.I.S. dos Santos, B.K. Logan, Changing patterns of drug and alcohol use in fatally injured drivers in Washington State, J. Forensic Sci. 51 (2006) 1191–1198.
[8] Brazilian Ministry of Healthy, Department of Mental Health, Governo lança campanha de prevenção dos riscos do consumo de bebidas alcoólicas, 2007, http://www.ccs.saude.gov.br/saude_mental/noticias_2007.asp, retrieved March 12, 2010.
[9] L. Webb, A. Oyefeso, F. Schifano, S. Cheeta, M. Pollard, A.H. Ghodse, Cause and manner of death in drug-related fatality: and analysis of drug-related deaths recorded by coroners in England and Wales in 2000, Drug Alcohol Depend. 72 (2003) 67–74.
[10] S. Toprak, I. Cetin, Heroin overdose deaths and heroin purity between 1990 and 2000 in Istanbul, Turkey, J. Forensic Sci. 54 (2009) 1185–1188.
[11] M.S. Hadidi, M.I. Ibrahim, I.M. Abdallat, K.A. Hadidi, Current trends in drug abuse associated fatalities—Jordan, 2000–2004, Forensic Sci. Int. 186 (2009) 44–47.
[12] E.D. Caldas, F.M. Rebelo, V.O. Heliodoro, A.F.A. Magalhães, R.M. Rebelo, Poisonings with pesticides in the Federal District of Brazil, Clin. Toxicol. 46 (2008) 1058–1063.
[13] J.L.F. Vieira, B.A. Silva, E.E.G. Silva, Chemical identification of granulated rodenticides market in Belém-Pará, Rev. Paraense Med. 20 (2006) 19–21.
[14] Brazilian Institute of Geography and Statistics (Instituto Brasileiro de Geografia e Estatística, IBGE), Contagem da População, Ministério de Planejamento, Orçamento e Gestão, 2007.
[15] E. Azevedo, J. Andrade, E. Nascimento, Técnicas Analíticas do Laboratório Central de Polícia Técnica, Secretaria de Segurança Pública, Departamento de Polícia Técnica da Bahia, Laboratório Central de Polícia Técnica, 2001.
[16] R. Laranjeira, I. Pinsky, M. Zaleski, R. Caetano, I Levantamento Nacional sobre os padrões de consumo de álcool na população brasileira, Secretaria Nacional Antidrogas, Brasilia, DF, Brasil, 2007.
[17] D. Zaridze, D. Maximovitch, A. Lazarev, V. Igitov, A. Boroda, J. Boreham, P. Boyle, R. Peto, P. Boffetta, Alcohol poisoning is a main determinant of recent mortality trends in Russia: evidence from a detailed analysis of mortality statistics and autopsies, Int. J. Epidemiol. 38 (2009) 143–153.
[18] S.Y.A. Ragheb, K.A. Hadidi, Fatal poisoning with alcohol and drugs in Greater Amman County, Forensic Sci. Int. 99 (1999) 209I–215I.
[19] F.S. Jungerman, P.R. Menezes, I. Pinsky, M. Zaleski, R. Caetano, R. Laranjeira, Prevalence of cannabis use in Brazil: data from the I Brazilian National Alcohol Survey (BNAS), Addict. Behav. 35 (2010) 190–193.
[20] L.B. Duailibi, M. Ribeiro, R. Laranjeira, Profile of cocaine and crack users in Brazil, Cad. Saúde Públ. 24 (2008) S545–S557.
[21] M. Ribeiro, J. Dunn, R. Laranjeira, R. Sesso, High mortality among young crack cocaine users in Brazil: a 5-year follow-up study, Addiction 9 (2004) 1133–1135.
[22] S. Darke, J. Duflou, Toxicology and circumstances of death of homicide victims in New South Wales, Australia 1996–2005, J. Forensic Sci. 53 (2008) 447–451.
[23] S. Darke, J. Duflou, M. Torok, Toxicology and circumstances of completed suicide by means other than overdose, J. Forensic Sci. 54 (2009) 490–494.
[24] M.C. del Rıo, J. Gomezb, M. Sanchob, F.J. Alvareza, Alcohol, illicit drugs and medicinal drugs in fatally injured drivers in Spain between 1991 and 2000, Forensic Sci. Int. 127 (2002) 63–70.
[25] S. Macdonald, K. Anglin-Bodrug, R.E. Mannb, P. Erickson, A. Hathaway, M. Chipmanc, M. Rylett, Injury risk associated with cannabis and cocaine use, Drug Alcohol Depend. 72 (2003) 99–115.

[26] J.C.F. Galduro, A.R. Noto, S.A. Nappo, E.A. Carlini, Household survey on drug abuse in Brazil: study involving the 107 major cities of the country—2001, Addict. Behav. 30 (2005) 545–556.
[27] USA Substance Abuse Mental Health Services Administration (SAMHSA), Results from the 2001 National Household Survey on Drug Abuse, U.S. Government Printing Office, 2002.
[28] European Monitoring Centre for Drugs and Drug Addiction (EMCDDA), Prevalence estimates of problem opioid use, 2001, http://www.emcdda.europa.eu/situation/opioids/3, retrieved March 12, 2010.
[29] Sistema Nacional de Informação de Informações Tóxico-Farmacológica (SINITOX), Ministry of Health, Brazil, www.fiocruz.br/sinitox, retrieved March 12, 2010.
[30] E. Below, E. Lignitz, Cases of fatal poisoning in post-mortem examinations at the Institute of Forensic Medicine in Greifswald-analysis of five decades of post-mortems, Forensic Sci. Int. 133 (2003) 125–131.
[31] I. Nordrum, T.J. Eide, L. Jorgensen, Medicolegal autopsies of violent deaths in northen Norway 1972–1992, Forensic Sci. Int. 92 (1998) 39–48.
[32] R.A. Lahti, E. Vuori, Fatal alcohol poisoning: medico-legal practices and mortality statistics, Forensic Sci. Int. 126 (2002) 203–209.
[33] Sistema de Informações sobre Mortalidade (SIM), Ministry of Health, http://tabnet.datasus.gov.br/cgi/deftohtm.exe?sim/cnv/extuf.def, retrieved March 12, 2010.
[34] Brazilian Sanitary Surveillance Agency (Agência Nacional de Vigilância Sanitária, ANVISA), Monografias de Produtos Agrotóxicos, http://www.anvisa.gov.br/toxicologia/monografias/index.htm, retrieved March 12, 2010.
[35] J.S. Lima, C.A.G. Reis, Poisoning due to illegal use of carbamates as a rodenticide in Rio de Janeiro, Clin. Toxicol. 33 (1995) 687–690.
[36] Brazilian Pesticide Regulation, Decreto N° 4.074, Diário Oficial da União, Poder Executivo, January 8, 2002, Brazil.
[37] N.M.X. Faria, A.G. Fassa, L.A. Facchini, Pesticides poisoning in Brazil: the official notification system and challenges to conducting epidemiological studies, Ciênc. Saúde Col. 12 (2007) 25–38.