Predominance of alcohol and illicit drugs among traffic accidents fatalities in an urban area of Brazil

Fabrício Souza Pelicão, a,b Mariana Dadalto Peres, a,b Jauber Fornaciari Pissinate, a Daniela Mendes Louzada de Paula, a Maria das Graças Corrêa de Faria, a Ester Miyuki Nakamura-Palacios, c and Bruno Spino De Martinis d

aDepartamento Médico Legal, Serviço de Laboratório Médico Legal, Polícia Civil do Espírito Santo, Vitória, Brazil; bDepartamento de Ciências Fisiológicas, Centro de Ciências da Saúde, Universidade Federal do Espírito Santo, Vitória, Brazil; cDepartamento de Ciências Farmacêuticas de Ribeirão Preto, Universidade de São Paulo, Ribeirão Preto, Brazil; dDepartamento de Química, Faculdade de Filosofia, Ciências e Letras de Ribeirão Preto, Universidade de São Paulo, Ribeirão Preto, Brazil

Objective: The objective of this study was to determine the prevalence of alcohol and illicit drug use among victims of fatal traffic accidents in the Metropolitan Region of Vitória, Brazil, during the period 2011–2012.

Methods: Blood samples were collected and analyzed for the presence of drugs from 391 deceased victims of traffic crashes that occurred in the Metropolitan Region of Vitória, Brazil. The victims included drivers, passengers, and pedestrians. Sociodemographic variables such as age, gender, day of the week, and period of the year in which the accidents occurred were recorded. The analyses were performed by a gas chromatography–flame ionization method for alcohol and by a gas chromatography–mass spectrometry for amphetamines, cocaine, and cannabis.

Results: The results showed that 44.8% (n = 175) of all cases were positive for alcohol and/or illicit drugs. The detection of alcohol and/or drugs was more frequent in young males, aged 17 to 34, whose samples were positive in 46.8% of cases. Small differences among drivers, passengers, and pedestrians were observed (drivers = 45.9%, passengers = 46.4%, and pedestrians = 45.6%). In general, the most prevalent drug was alcohol, with 141 positive cases (36.1%), followed by cocaine, with 47 positive cases (12%). Amphetamines and cannabis had positivity rates of 4.1 and 4.3%, with 16 and 17 positive cases, respectively. The combined use of alcohol and other drugs was found in 36 cases (9.2%). Crack cocaine use was observed in 27.7% of the positive cases for cocaine.

Conclusions: For the effective reduction of traffic accidents related to driving under influence of drugs (DUID), we suggest the intensification of enforcement actions against the use of alcohol by drivers, the definition of which illicit drugs should be surveyed, as well the cutoff values, the promotion of changing legislation to oblige drivers to provide samples for toxicological testing, and the establishment of public information programs and specific actions aimed at young drivers to promote behavioral changes.

Introduction

Traffic accidents remain a major health problem around the world but especially in developing countries where 91% of the 1.2 million annual deaths due to traffic accidents are concentrated. Brazil is one of the 10 countries with the highest rates of deaths related to traffic accidents in the world. Brazil, China, India, Nigeria, the United States, Pakistan, Indonesia, Russia, Egypt, and Ethiopia are responsible for 62% of all traffic-related deaths occurring annually (World Health Organization 2009).

In recent years, Brazil has systematically tried to reduce these rates by improving the security devices on cars, by electronic traffic monitoring, and by changing traffic laws, such as reducing the blood alcohol concentration (BAC) to a zero limit for drivers. However, such changes have not reduced death rates (Bachieri et al. 2011). Among the reasons for this failure are the poor conditions of roads in many locations, the heavy interstate traffic on single-lane highways, the low utilization of railroads and other alternative means of transportation, and the low chance of criminal penalties being applied to drivers suspected of driving under the influence.

Driving under influence of alcohol is a well-known risk factor for traffic accidents. Alcohol impairment includes slowed reaction time, reduced ability to concentrate, and impaired judgment leading to risky behavior, such as speeding and violating traffic rules (Das et al. 2012; Jones et al. 2008; McIntosh et al. 2006). In contrast to ethanol, the effect of other drugs on drivers is still little studied and monitored, especially in developing countries (Jones et al. 2009; NHTSA 2010; Yonamine et al. 2013).

In Brazil, police enforcement is mainly focused on inhibiting the use of alcohol by drivers by means of roadside breath tests. However, drivers in Brazil can decline to perform the breath test. This is resulting from an interpretation from an International Treaty, called the Pact of São José da Costa Rica, of which Brazil...
is a signatory. Article 8, Item 2, Line g of this treaty, in short, states that people have the “right to not be compelled to incriminate him/herself or to confess guilt.” Furthermore, unlike alcohol, there are no procedures aimed to detect drug use by drivers.

According to several authors, oral fluid is a good specimen for roadside tests, mainly due the correlation with blood, which is considered the gold standard specimen (Augsburger et al. 2005; DuPont et al. 2012; Logan et al. 2014; Ojanen et al. 2009; Teixeira et al. 2007; Verstraete 2005; Walsh et al. 2004). However, because the purpose of this work was to investigate the presence of drugs in deceased victims, oral fluid sampling was not an option.

Considering the lack of studies aimed to detect the presence of drugs in traffic fatalities in Brazil, the main purpose of this study was to determine the prevalence of drugs in traffic accidents. This would provide evidence to convince Brazilian authorities of the importance of drug testing drivers involved in traffic incidents.

**Methods**

The prevalence of drug use in the context of traffic safety was determined from analysis of 391 blood samples collected from deceased victims of traffic accidents that occurred in the Metropolitan Region of Vitória, Espírito Santo State, Brazil, in the period 2011–2012. The metropolitan area of Vitória consists of 6 municipalities in addition to the state capital. It is a predominantly coastal region, with a population of just over 1.6 million inhabitants and a vehicle fleet of nearly 800,000 vehicles. The victims in this study include drivers, passengers, and pedestrians.

The blood samples were collected from the femoral vein and stored at −20°C in tubes containing sodium fluoride as a preservative until analysis.

This project was approved by the Ethics Committee of the Espírito Santo Federal University, Brazil. The alcohol and illicit drug analyses were performed anonymously for scientific purposes only and had no administrative or legal implications.

The analysis of alcohol was performed by a headspace extraction on a Varian 450 gas chromatography equipped with flame ionization detector (Palo Alto, CA). Drugs were analyzed on a Varian CP-3800 gas chromatograph coupled with a Varian Saturn 2200 ion trap mass spectrometer. Alcohol and illicit drug analyses were performed at the Laboratory of Forensic Toxicology, Police State of Espírito Santo.

The method for alcohol analysis is used routinely in the Forensic Toxicology Laboratory of Vitória and was validated for the following parameters in accordance with Brazilian legislation (Agência Nacional de Vigilância Sanitária 2003): limit of quantification (LOQ), linearity, precision, accuracy, specificity/selectivity, carryover, and stability. The LOQ was 0.1 g/L and the linearity range was 0.1 to 4.0 g/L. Intra- and interday precision, accuracy, specificity/selectivity, carryover, and stability were well within the limits of acceptability. The solid-phase extraction of drugs from whole blood was developed and validated, as described in Pelion et al. (2014). The drugs included in this method are amphetamine, methamphetamine, amphetamine, fenproporex, 3,4-methylenedioxyamphetamine, N-methyl-3,4-methylenedioxyamphetamine, N-ethyl-3,4-methylenedioxyethylampheta mine, cocaine, cocaethylene, anhydroecgonine methyl ester (AEME), ecgonine methyl ester, delta-9-tetrahydrocannabinol (THC), and 11-nor-delta-9-tetrahydrocannabinol-9-carboxylic acid (THCCOOH). The LOQ of all analytes was 10 ng/mL, except for cocaethylene and THCCOOH, which were 25 ng/mL. Opiates were not included in this work because there is no evidence regarding their use related to traffic safety issues in Brazil. Searching for this class of drugs would increase the cost of toxicological analysis with no clear benefits.

Sociodemographic variables examined included age and gender of victims, in addition to the day of week and the period of the year in which the accident occurred. Information about the class of victim (driver, passenger, or pedestrian), type of accident (vehicular, motorcyclist, or on foot), and toxicological results were also considered. The statistical analyses of all toxicological results for alcohol and illicit drugs in blood from all cases were performed using SPSS Ver 17 statistical software (SPSS Inc., Chicago, IL, USA).

**Results**

The fatalities were well distributed throughout the years, without statistical differences between the months or periods of the year. Although the total number of fatal crashes had no statistical differences between the days of week, fatalities with positive results for alcohol and illicit drugs were more frequent on weekends (P < .01).

During the execution of this work there was a great effort to identify the victim at the time of the accident, whether driver, passenger, or pedestrian. However, a number of victims (n = 46) remained unknown. The average age found in this study was 37 years old (range = 17 to 83 years) and 58% of victims were younger than the mean age (n = 227). In this study, there was a clear predominance of males (n = 337; 86.2%). Males younger than 34 years old represented 46.8% of all victims (n = 183).

Most of the accidents were classified as vehicular (car, truck, or bus), with 178 victims, followed by motorcyclists (n = 149) and pedestrians (n = 59). Most of the victims in this study were drivers (cars, trucks, buses, or motorcycles; n = 230, 80.4%).

Young males also had the highest rates of positive results for alcohol and/or illicit drugs. Males between 17 and 34 years old were responsible for 54.1% of the overall positive findings for alcohol and/or illicit drugs. Indeed, in the specific age group of 25–34 years, more than half of individuals (males and females) had used at least one type of drug just before the accident (Figure 1).

Analyzing the whole population (n = 391), 44.8% of the victims (n = 175) were positive for alcohol and/or illicit drugs; 8.7% (n = 34) were positive only for illicit drugs and 9.2% (n = 36) had positive results for both alcohol and illicit drugs. Thus, 17.9% (n = 70) of all victims were positive for illicit drugs.

Table 1 shows the toxicological findings distributed for the 3 classes of victims: drivers, passengers, and pedestrian.

Compared to the general results, analyses of drivers’ samples showed quite similar results; 47% (n = 108) of drivers were positive for alcohol and/or illicit drugs, 11.3% (n = 26) were positive only for illicit drugs, and 10.4% (n = 24) were simultaneously positive for alcohol and illicit drugs. Thus, 21.7% of drivers...
were positive for illicit drugs, with or without positive results for alcohol \((n = 50; \text{Table 1})\). A detailed view among the results obtained for drivers, passengers, and pedestrians presented some small differences between them. The number of victims with negative results remained similar for all 3 classes of victims, with drivers showing a slightly higher positivity for illicit drugs only (with no presence of alcohol) than passengers and pedestrians. Pedestrian victims showed alcohol positivity slightly higher than other classes, with a lower number of positive cases for illicit drugs (Table 1).

This work revealed a high incidence of victims with positive results for alcohol and at least one other drug at the time of the accident. An overall view shows 9.2% of victims in this condition \((n = 36)\), 68.6% of whom were drivers \((n = 24)\).

In addition, 7 victims (3 drivers and 4 passengers) were positive for more than one class of illicit drugs. One driver had positive results for all 3 classes of illicit drugs studied in this work in addition to a high-level BAC.

The most frequent drug found in this study was alcohol, with 141 positive cases (36.1%). Among illicit drugs, cocaine was the most prevalent drug, positive in 12% of victims (67.1% of positive results for illicit drugs; \(n = 47\)), followed by amphetamines (4.3%; \(n = 17\)) and cannabis (4.1%; \(n = 16\)). The main association of drugs was between alcohol and cocaine \((n = 30)\), representing 73.2% of polydrug use and 17.5% of all positive results, including alcohol.

The inclusion of AEME as one of the analytes in this work allowed the identification of victims who used crack cocaine; 13 victims (7 drivers) used cocaine in its smoked form. Thus, 27.7% of the positive results for cocaine and/or its metabolites showed the presence of AEME (Table A1, see online supplement).

### Table 1. Toxicological results distributed by class of victims.

|                | Negative, \(n \) | Alcohol only, \(n \) | Illicit drugs only, \(n \) | Alcohol and illicit drugs, \(n \) |
|----------------|------------------|----------------------|---------------------------|---------------------------------|
| Drivers        | 122 (53.1)       | 58 (25.2)            | 26 (11.3)                 | 24 (10.4)                       |
| Passengers     | 30 (53.6)        | 16 (28.6)            | 6 (10.7)                  | 4 (7.1)                         |
| Pedestrians    | 31 (52.5)        | 21 (35.6)            | 2 (3.4)                   | 5 (8.5)                         |
| Total          | 183 (53.0)       | 95 (27.5)            | 34 (9.9)                  | 33 (9.6)                        |

**Discussion**

As reported by many other authors, young males were the main victims of traffic fatalities and the reasons remain the same all around the world: lack of driving experience, taking high risks, high speed, and use of alcohol or other drugs (Breitenbach et al. 2011; Drummer et al. 2003; Elliott et al. 2009; Furr-Holden et al. 2006; Gustavsen et al. 2006; Reisfeld 2012; Romano and Pollini 2013; Sweedler et al. 2004; Vaez and Laflamme 2005; Walsh et al. 2005).

The general positivity rate found by different studies is widely variable, ranging from 5.7 to 89% (Augsburger et al. 2005; Behrens-dorff and Steentoft 2003; Gjerde et al. 2011; Senna et al. 2010). The main reason is the type of population studied, with lower rates being found in random studies and higher rates found in studies where drivers were suspected of driving under the influence of drugs. On the other hand, studies with deceased or seriously injured victims present positivity rates ranging from 33.9 to 54%, nearest to the number found is this work (44.8%; Carmen del Río et al. 2002; Drummer et al. 2003, 2012; Elliott et al. 2009; Jones et al. 2009; Legrand et al. 2012).

In addition to the high number of people driving under the influence, the present work could identify a high incidence of simultaneous use of alcohol and illicit drugs. This was quite different from Breitenbach et al. (2011), which found only 2 cases of simultaneous use of alcohol and illicit drugs \((n = 361)\). According to Gjerde et al. (2011), it is precisely this condition that results in the greatest risk of being involved in a fatal accident.

Cocaine was the most popular illicit drug found in this work. The possibility to identify crack cocaine users by the detection of a pyrolysis product of cocaine (AEME) in victims’ samples was particularly important to demystify the stereotype that the use of crack cocaine is restricted to disadvantaged populations, such as the homeless, but is also present in traffic scenarios. This is seemingly the first study that identifies crack cocaine users in traffic fatalities. Despite the popularity of cocaine use in Brazil, studies conducted in others countries did not reveal similar results. A study conducted by Jones et al. (2008) found a 3% cocaine positivity rate, with no record of crack cocaine use. Studies performed in countries such as Australia, Denmark, France, and Norway showed rates ranging from 0.11 to 3% (Behrens-dorff and Steentoft 2003; Drummer et al. 2003; Gjerde et al. 2011; Mura et al. 2006).

The toxicological analysis of amphetamines was particularly important for traffic safety issues in Brazil until the early 2000s, when the National Agency prohibited the sale of appetite suppressants (Brasil 2011). Drugs like fenproporex and amphetamine were frequently abused by professional drivers due to their stimulant effects, which allowed these drivers to accomplish many working hours with no rest period. With the restriction imposed in 2011 for the purchase of these drugs, many professional drivers may have switched to consumption of cocaine and crack cocaine. However, the number of positive cases for appetite suppressants has not changed in this study, with 4 positive cases in 2011 and 3 positive cases in 2012. Further...
studies must be developed in order to confirm the decrease in amphetamine use by professional drivers, as well the increase in cocaine and crack cocaine use by this class of workers. There was elevated use of cocaine and crack cocaine, whereas positivity rates for amphetamines and cannabis were much lower than in similar studies in developed countries, which reported rates of 1.2 to 5.1% for amphetamines and 1.6 to 28.9% for cannabis in similar studies in developed countries, which reported rates.

Data obtained from this work can help define the profile of the Brazilian driver for the use of psychoactive substances. This allows the implementation of a series of public policies, in addition to intensification of enforcement actions against the use of alcohol. Among these actions, we suggest the formulation of per se laws, with a clear definition of which drugs should be surveyed as well their cutoff values, the promotion of changing legislation to mandate that drivers provide samples for toxicological testing, an increase in specific actions aimed at young drivers, and promoting behavioral changes.

Acknowledgments

The authors thank the Forensic Toxicology Laboratory staff from Vitória-ES for their assistance during this research. The authors also thank Rodger D. Scurlock and Melissa Verhaeghe for revision of the article.

Table 2. Toxicological results distributed by classes of drugs and victims.

| Drug                  | Drivers, n (%) | Passengers, n (%) | Pedestrians, n (%) |
|-----------------------|----------------|-------------------|-------------------|
| Alcohol               | 126 (54.8)     | 30 (53.6)         | 31 (52.5)         |
| Cocaine               | 54 (23.5)      | 16 (28.8)         | 21 (35.6)         |
| Amphetamines          | 7 (3)          | 2 (3.6)           | 1 (1.7)           |
| Cannabis              | 4 (1.7)        | 1 (1.8)           | 1 (1.7)           |
| Cocaine + Alcohol     | 21 (9.1)       | 2 (3.6)           | 5 (8.5)           |
| Amphetamines + Alcohol| 1 (0.4)        | —                 | —                 |
| Cannabis + Alcohol    | 1 (0.4)        | —                 | —                 |
| Amphetamines + Cannabis|              | 2 (3.6)           | —                 |
| + Alcohol             |                | —                 | —                 |
| Amphetamines + Cannabis| 2 (0.9)        | —                 | —                 |
| + Alcohol             |                | —                 | —                 |
| Cocaine + Cannabis    | 1 (0.4)        | 1 (1.8)           | —                 |
| Amphetamines + Cocaine|              | —                 | —                 |
| + Cannabis            |                | —                 | —                 |
| Amphetamines + Cocaine+ Cannabis + Alcohol | 1 (0.4) | — | — |

References

Agência Nacional de Vigilância Sanitária (ANVISA - National Health Surveillance Agency). Resolução nº 899, de 29 de maio de 2003. Available at: http://www.anvisa.org.br. Accessed January 26, 2010.

Augburger M, Donzé N, Ménetrey A, et al. Concentration of drugs in blood of suspected impaired drivers. Forensic Sci Int. 2005;153(1):11–15.

Bacchieri G, Barros AJD. Traffic accidents in Brazil from 1998 to 2010: many changes and few effects. Rev Saude Publica. 2011;45:494–963.

BehrensDorf I, Steentoft A. Medicinal and illegal drugs among Danish car drivers. Accid Anal Prev. 2003;35:851–860.

Brasil. Lei Nº 11.705, de 19 de junho de 2008. Diário Oficial da União. June 20, 2008.

Brasil. Portaria 52, de 06 de outubro de 2011. Diário Oficial da União. October 10, 2011.

Brasil. Lei No 12.760, de 20 de dezembro de 2012. Diário Oficial da União. December 12, 2012.

Breitenbach TC, Pechansky F, Benzano D, De Boni R. High rates of injured motorcycle drivers in emergency rooms and the association with substance use in Porto Alegre, Brazil. Emerg Med J. 2011;29:205–207.

Carmen del Rio M, Gómez J, Sancho M, Alvarez FJ. Alcohol, illicit drugs and medicinal drugs in fatally injured drivers in Spain between 1991 and 2000. Forensic Sci Int. 2002;127(1–2):63–70.

Das A, Gjerde H, Gopalani SS, Normann PT. Alcohol, drugs, and road traffic crashes in India: a systematic review. Traffic Inj Prev. 2012;13:544–553.

Drummer OH, Gerostamoulos J, Batziris H, et al. The incidence of drugs in drivers killed in Australian road traffic crashes. Forensic Sci Int. 2003;134(2–3):154–162.

Drummer OH, Kourtis I, Beyer J, Tayler P, Boorman M, Gerostamoulos D. The prevalence of drugs in injured drivers. Forensic Sci Int. 2012;215(1–3):14–17.

DuPont RL, Voas RB, Walsh JM, Shear C, Talpins SK, Neil MM. The need for drugged driving per se laws: a commentary. Traffic Inj Prev. 2012;13:31–42.

Elliott S, Woolacott H, Braithwaite R. The prevalence of drugs and alcohol found in road traffic fatalities: a comparative study of victims. Sci Justice. 2009;49:19–23.

Furr-Holden D, Voas RB, Kelley-Baker T, Miller B. Drug and alcohol-impaired driving among electronic music dance event attendees. Drug Alcohol Depend. 2006;85:83–86.

Gjerde H, Normann PT, Christophersen AS, Samuels SO, Morland J. Alcohol, psychoactive drugs and fatal road traffic accidents in Norway: a case–control study. Accid Anal Prev. 2011;43:1197–1203.
Gustavsen I, Mørland J, Bramness JG. Impairment related to blood amphetamine and/or methamphetamine concentrations in suspected drugged drivers. *Accid Anal Prev*. 2006;38:490–495.

Hackett AM, Garrison HG, Reeder TJ. National Highway Traffic Safety Administration (NHTSA) notes. *Ann Emerg Med*. 2003;42:811–812.

Holmgren P, Holmgren A, Ahlner J. Alcohol and drugs in drivers fatally injured in traffic accidents in Sweden during the years 2000–2002. *Forensic Sci Int*. 2005;151(1):11–17.

Jones AW, Holmgren A, Kugelberg FC. Concentrations of cocaine and its major metabolite benzoylecgonine in blood samples from apprehended drivers in Sweden. *Forensic Sci Int*. 2008;177(2–3):133–139.

Jones AW, Kugelberg FC, Holmgren A, Ahlner J. Five-year update on the occurrence of alcohol and other drugs in blood samples from drivers killed in road-traffic crashes in Sweden. *Forensic Sci Int*. 2009;186(1–3):56–62.

Legrand S-A, Houwing S, Hagenzieker M, Verstraete AG. Prevalence of alcohol and other psychoactive substances in injured drivers: comparison between Belgium and The Netherlands. *Forensic Sci Int*. 2012;220(1–3):224–231.

Logan BK, Mohr ALA, Talpins SK. Detection and prevalence of drug use in arrested drivers using the Dräger Drug Test 5000 and Affiniton Drug-Wipe oral fluid drug screening devices. *J Anal Toxicol*. 2014;38:1–7.

McIntosh J, O’Brien T, McKeganey N. Drug driving and the management of risk: the perspectives and practices of a sample of problem drug users. *Int J Drug Policy*. 2006;19:248–254.

Mura P, Chatelain C, Dumestre V, et al. Use of drugs of abuse in less than 30-year-old drivers killed in a road crash in France: a spectacular increase for cannabis, cocaine and amphetamines. *Forensic Sci Int*. 2006;160(2–3):168–172.

NHTSA. Traffic safety facts. Drug involvement of fatally injured drivers. 2010. Available at: http://www-nrd.nhtsa.dot.gov/Pubs/811415.pdf. Accessed May 27, 2014.

Ojaniemi KK, Lintonen TP, Impinen AO, Lillsunde PM, Ostamo AI. Trends in driving under the influence of drugs: a register-based study of DUID suspects during 1977–2007. *Accid Anal Prev*. 2009;41:191–196.

Pelição FS, Peres MD, Passante JF, De Martinis BS. A one-step extraction procedure for the screening of cocaine, amphetamines and cannabinoids in postmortem blood samples. *J Anal Toxicol*. 2014;6:1–8.

Reisfield GM, Goldberger BA, Gold MS, DuPont RL. The mirage of impairing drug concentration thresholds: a rationale for zero tolerance per se driving under the influence of drugs laws. *J Anal Toxicol*. 2012;36:353–356.

Romano E, Pollini RA. Patterns of drug use in fatal crashes. *Addiction*. 2013;108:1428–1438.

Senna M-C, Augsburger M, Aebi B, et al. First nationwide study on driving under the influence of drugs in Switzerland. *Forensic Sci Int*. 2010;198(1–3):11–16.

Sweedler BM, Biecheler MB, Laurell H, et al. Worldwide trends in alcohol and drug impaired driving. *Traffic Inj Prev*. 2004;5(3):175–184.

Teixeira H, Verstraete A, Proença P, Corte-Real F, Monsanto P, Vieira DN. Validated method for the simultaneous determination of delta9-THC and delta9-THC-COOH in oral fluid, urine and whole blood using solid-phase extraction and liquid chromatography–mass spectrometry with electrospray ionization. *Forensic Sci Int*. 2007;170(2–3):148–155.

Vaez M, Laflamme L. Impaired driving and motor vehicle crashes among Swedish youth: an investigation into drivers’ sociodemographic characteristics. *Accid Anal Prev*. 2005;37:605–611.

Verstraete AG. Oral fluid testing for driving under the influence of drugs: history, recent progress and remaining challenges. *Forensic Sci Int*. 2005;150(2–3):143–150.

Walsh JM, de Gier JJ, Christopherson AS, Verstraete AG. Drugs and driving. *Traffic Inj Prev*. 2004;5:241–253.

Walsh JM, Flegel R, Atkins R, et al. Drug and alcohol use among drivers admitted to a level-1 trauma center. *Accid Anal Prev*. 2005;37:894–901.

World Health Organization. *Global Status Report on Road Safety—Time for Action*. 2009.

Yonamine M, Sanches LR, Paranhos BAPB, de Almeida RM, Andreuccetti G, Leyton V. Detecting alcohol and illicit drugs in oral fluid samples collected from truck drivers in the state of São Paulo, Brazil. *Traffic Inj Prev*. 2013;14(2):127–131.