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# Qualifying information on deaths and serious injuries caused by road traffic in five Brazilian capitals using record linkage

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## A R T I C L E  I N F O

## A B S T R A C T

*Introduction:* Road traffic crashes (RTC) are an important public health problem, accounting for 1.2 million deaths per year worldwide. In Brazil, approximately 40,000 deaths caused by RTC occur every year, with different trends in the Federal Units. However, these figures may be even greater if health databases are linked to police records. In addition, the linkage procedure would make it possible to qualify information from the health and police databases, improving the quality of the data regarding underlying cause of death, cause of injury in hospital records, and injury severity.
*Objective:* This study linked different data sources to measure the numbers of deaths and serious injuries and to estimate the percentage of corrections regarding the underlying cause of death, cause of injury, and the severity injury in victims in matched pairs from record linkage in five representative state capitals of the five macro-regions of Brazil.
*Methods:* This cross-sectional, population-based study used data from the Hospital Information System (HIS), Mortality Information System (MIS), and Police Road Traffic database of Belo Horizonte, Campo Grande, Curitiba, Palmas, and Teresina, for the year 2013 for Teresina, and 2012 for the other capitals. RecLink III was used to perform probabilistic record linkage by identifying matched pairs to calculate the global correction percentage of the underlying cause of death, the circumstance that caused the road traffic injury, and the injury severity of the victims in the police database.
*Results:* There was a change in the cause of injury in the HIS, with an overall percentage of correction estimated at 24.4% for Belo Horizonte, 96.9% for Campo Grande, 100.0% for Palmas, and 33.2% for Teresina. The overall percentages of correction of the underlying cause of death in the MIS were 29.9%, 11.9%, 4.2%, and 33.5% for Belo Horizonte, Campo Grande, Curitiba, and Teresina, respectively. The correction of the classification of injury severity in police database were 100.0% for Belo Horizonte and Teresina, 48.0% for Campo Grande, and 51.4% for Palmas after linkage with hospital database. The linkage between mortality and police database found a percentage of correction of 29.5%, 52.3%, 4.4%, 74.3 and 72.9% for Belo Horizonte, Campo Grande, Palmas, Curitiba and Teresina, respectively in the police records.
*Conclusions:* The results showed the importance of linking records of the health and police databases for estimating the quality of data on road traffic injuries and the victims in the five capital cities studied. The true causes of death and degrees of severity of the injuries caused by RTC are underestimated in the absence of integration of

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health and police databases. Thus, it is necessary to define national rules and standards of integration between health and traffic databases in national and state levels in Brazil.

## 1. Introduction

Currently, low- and middle-income countries report a total of 90% deaths caused by road traffic injury and contain 54% of the vehicle fleet worldwide; high-income countries, on the other hand, report 46% of the fleet and only 10% of deaths (WHO, 2015). In addition, high-income countries have trended towards reduced mortality rates, while rates in low- and middle-income countries have tended to increase (WHO, 2015). This led the United Nations General Assembly to adopt two initiatives to address injuries caused by traffic: The Decade of Action for Road Safety (2011–2020) and the insertion into the sustainable development goals (2015) the additional goal of halving traffic deaths (Lozano et al., 2012; United Nations, 2010; WHO, 2009).

In Brazil, the National Accord for the Reduction of Traffic Accidents was established as a form of the country's adherence to the Decade of Action for Road Safety. The Project Life in Traffic (PLT) was implemented as one of the intervention strategies (Brasil, 2010a,b, 2002). The PLT initially was implemented in five Brazilian capitals. This project is part of the international initiative called *"Road Safety in Ten Countries,"* congregate countries of which account for nearly half of all deaths from road accidents worldwide (Bloomberg Philantropies, 2012; Brasil, 2010a,b, 2002; Silva et al., 2013; WHO, 2004).

Brazil has a fleet of approximately 89 million vehicles, primarily cars (55%) and motorcycles (22%) (Brasil, 2015). There was a decrease each of 2.3% and 2.7%, in the use of public transport, and two non-motorized transport methods (walking and cycling), respectively, between 2003 and 2013, while modes of private and individual transport (motorcycle and car) increased by 6.6% in the same period (Associação Nacional de Transportes Públicos, 2015; Brasil, 2015). An increasing trend in mortality rates was observed in the last decade, rising from 17.5 deaths per 100 thousand inhabitants in 2001 to 22.5 in 2010. The Central-West region had the highest rate, while the Southeast region had the lowest (Mascarenhas et al., 2012; Reichenheim et al., 2011). A downward trend in mortality rates has been observed for pedestrians, while an increasing trend has been observed in motor vehicle occupants and motorcyclists (Morais Neto et al., 2012). Regarding the risk of death due to road traffic injuries, a five-fold increased risk has been reported among men compared to women, with a higher frequency in the 20–39-year age group (45.7%) (Mascarenhas et al., 2012; Morais Neto et al., 2012; WHO, 2009).

These high rates of traffic-associated mortality may be underestimated due to the underreporting of deaths and hospitalizations. Moreover, the forms regarding the causes of death and hospitalization in the corresponding information systems were not always completed, due to the high percentage of instances of hospitalization cause, and also due to the underlying cause of death being recorded as ill-defined (Chapter XVIII ICD-10) and as garbage codes (ICD-10: V89, V99, Y32) (Gawryszewski et al., 2005; Mello Jorge et al., 2012; Naghavi et al., 2010; Tomimatsu et al., 2009).

Therefore, linking mortality and hospitalization information systems with police records would contribute to improving the completeness and quality of both information systems (Fellegi and Sunter, 1969; Holder et al., 2001; Jaro, 1989; Lima et al., 2009; Mello Jorge et al., 2012).

Linkage of the mortality and hospitalization information systems with the police database aids the former by facilitating the identification of deaths and serious injuries unreported in the systems, as well as the reduction of the number of cases with ill-defined and unspecified causes of deaths and hospitalizations. The linkage also contributes to the police database an improvement in the quality of the information regarding injury severity (Lopez et al., 2000; Paixão et al., 2015).

The aim of this study was to measure the magnitude of the number of deaths and serious injuries by linking different data sources from five representative state capitals of the five macro-regions of Brazil, the most populous country in Latin America. We also estimated the percentage of corrections of the underlying cause of death, the circumstances that caused the injury, and the injury severity of the victims in the traffic records in matched pairs from the linked records.

## 2. Materials and methods

### 2.1. Design and study area

A cross-sectional population-based study was performed in five state capitals in Brazil where the *"Road Safety in Ten Countries"* initiative has been implemented since 2011. Thus, the study area included the municipalities of Belo Horizonte, Campo Grande, Curitiba, Palmas, and Teresina, which also comprise the areas covered by Brazilian PLT. The inclusion criteria of these five capitals were as follows: (i) representative of the five macro-regions of the country, (ii) high mortality rates caused by road traffic injuries, and (iii) traffic agency capable of intervention to reduce deaths and serious injuries caused by traffic (Silva et al., 2013).

### 2.2. Data sources

Three secondary databases were used as data sources: (i) Hospitalizations arising from the Brazilian Ministry of Health Hospital Information System, whose reference document is the authorization for hospital admittance; (ii) the Brazilian Mortality Information System, whose reference document is the death certificate; and (iii) the Police Road Traffic database reported by the police and road traffic agents. All these databases include individual personal data such as name, sex, and age, among others, which facilitated the record linkage procedure.

The police and hospital databases were made available and processed by the health departments of each municipality except for Curitiba, for which it was not possible to link the hospital and police databases. The 2012 databases were used for the record linkage procedure except for the municipality of Teresina, where only the 2013 database was available.

### 2.3. Definitions

For the identification of road traffic crashes (RTC), serious injuries, and deaths, the following case definitions were used, considering only those that occurred in the urban perimeter of the included municipalities:

- RTC: all recorded traffic occurrences named in the bulletin of occurrence of traffic accident (BOAT) issued by a transit agent of the following institutions: municipal traffic agency, state military police, or federal and state highway police. In Brazil, in cases of traffic accidents with victims, it is mandatory to complete a BOAT (Brasil, 1997a).
- Seriously injured person: victim of RTC admitted to a hospital for at least 24 h, as recorded in the hospital database (WHO, 2004).
- Fatal victim: victim of an RTC whose death occurred immediately after the unintentional accident or within 30 days after, as recorded in the mortality database (WHO, 2004).

### 2.4. Record linkage procedures

The linkage procedure was performed in two stages: first between