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# The quality of the injury severity classification by the police: An important step for a reliable assessment

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ABSTRACT

This study aims to assess the under-reporting and misclassification of the traffic injury severity reported by the police for the first time in Portugal. The non-fatality traffic injuries classified by the police are compared with the information recorded by the hospitals using linked data. The underreporting in the police data was found to be of 29%. Therefore, a significant number of road traffic casualties admitted in the hospitals were not known by the police. Taking advantage of the linked information on accident injuries, the misclassification in the police reports is assessed considering two criteria: the length of hospital stay (LS) and the maximum abbreviated injury scale (MAIS). The latter criterion corresponds to the common definition recently established by the European Commission, which has the advantage of representing the medical conditions of the casualty. The comparison between police classification and LS indicates that a discrepancy between the police reports and the established police definition exists. On the other hand, the police classification shows a tendency to overclassify the injury severity regarding the MAIS. A remarkable proportion of severe injuries reported by the police are, in fact, slight injuries. Additionally, using univariate and multivariate analyses, factors contributing to the misclassification of casualties by the police are identified. Finally, similarly to the fatality adjustment coefficient used in Portugal and in other countries in the past, non-fatality adjustment coefficients were computed to estimate the total casualties taking into account the under-reporting and misclassification phenomena. These adjustment factors are compared with other countries.



## 1. Introduction

Due to the high number of people killed or seriously injured in road accidents, several studies conducted in different regions have been developed in order to better understand the causes of injury severity. Police reports are often the main source of data for crash investigation and road safety analysis (Tsui et al., 2009). Police officers typically write their report soon after a crash has occurred. These reports contain information about victims, drivers and vehicles characteristics, as well as the crash location and conditions. Also, every crash with victims and sometimes without victims but with a high value of property damage is required to be reported by the police. However, previous research has shown that the incompleteness of police crash reports exists in several countries, which may invalidate the conclusions of some studies or, at least, distort the road safety reality (Alsop and Langley, 2001; Farmer, 2003; Amoros et al., 2006; Guo et al., 2007; Yamamoto et al., 2008; McDonald et al., 2009; Tsui et al., 2009; Broughton et al., 2010). The analysis on the reliability of the police reports is supported by two different data sources, one from the police records and another from the hospitals. To perform such analysis a linkage methodology must be applied in order to correctly connect both police and hospital's databases (Clark, 2004). Such methodology is been studied along the years and the reader is pointed to the one by Amorim et al. (2014) which falls within the same database as the one of this paper. By linking both data records and comparing the final results, the degree of under-reporting and mis-classification of the injury severity of the victims can be obtained. In fact, the degree of underreporting found in previous studies is quite significant (Alsop and Langley, 2001; Amoros et al., 2006; Dandona et al., 2008; Tsui et al., 2009). Police definitions about the injury severity level of casualties differ from one country to another. It can be based on the hospital admission, length of hospital stay, injury type, and medical treatment required. Regardless the police injury definition,

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several differences were found between the injury severity reported by the police and the hospitals. Some studies have focused on the analysis of special groups such as a road user group (Tarko and Azam, 2011). Besides the discrepancies in injury severity classification, contributory factors to these discrepancies have been identified (Tsui et al., 2009).

In Portugal, as in most countries, accident victims are classified into three categories of injury severity: Slight Injury (SLI); Serious Injury (SEI); Fatality (F). In the Portuguese system, the following definition of victim severity is considered: SLI if the person stays in the hospital for no more than 24 h; SEI if the person stays in the hospital for more than 24 h; F if the person dies within the 30 days following the accident as a result of the suffered injuries. The official classification is provided by the police, which do not have the proper skills to assess about the severity of the injuries in a road accident neither do know, a priori, how long the injured will remain in the hospital. However, the classification by the police is rarely checked with the medical records, except when the injured person dies in the hospital (ANSR, 2012).

Additionally, in the discussion about what the injury classification may report, the severity of the casualties have led the European Commission (EC) to seek an agreement on a new definition based on the maximum abbreviated injury scale (MAIS). The MAIS derived from the Abbreviated Injury Scale (AIS), which is a severity score of a casualty with several injuries (Gennarelli and Wodzin, 2006). MAIS simply captures the highest severity among the various AIS codes of the victim's injuries. The AIS is the only dictionary specifically designed as a system to define the severity of injuries throughout the body and its first appearance dates back to 1971 (Baker et al., 1974; Gennarelli and Wodzin, 2006). The scale is an anatomically based, consensus derived, global severity scoring system that classifies each injury by body region according to its relative importance on a 6-point ordinal scale (1 = minor and 6 = maximal) (Association for the Advancement of Automotive Medicine). In contrast, the injury classification based on the length of hospital stay (LS) presents some issues that may lead to biased injury severity interpretation, e.g., if a patient stays longer in the hospital due to other reasons besides the accident injuries, or if administrative reasons lead to a delay on the discharge. In fact, a common agreement seems to exist around the benefits of using the MAIS instead of other common injury severity definitions. For instance, the LS is a classification that is not directly related to the severity of the victims, also depending on the hospital administrative rules and management decisions. In contrast, the MAIS is associated to the medical diagnosis and the probability of dying as a consequence of the injuries suffered.

Although previous studies have been conducted to analyze the level of under and misreporting in several countries, this subject is new in the Portuguese context. The study was developed under the research project LIVE – *Tools to Injury Prevention*, co-funded by the European Commission (EC). Through this project, for the first time in Portugal, police and hospital records were obtained and linked (Amorim et al., 2014). Fatal casualties were excluded from the present study because a different process exists to report fatalities. Further, fatal casualties are currently the subject of a specific analysis in Portugal. Therefore, the study is only focused on the two types of casualties: SLI and SEI.

In this context, the objective of this study is to assess the level of underreporting and misclassification in traffic casualties in the Portuguese context. To analyze the misclassification of the casualties existing in the police records, two different comparisons were assumed. First, considering the police definition for the two levels of injury severity, the LS information was used to check the police records. Thus, the 24-h-threshold was used to classify the victims' injuries according to the LS. Additionally, the EU common definition based on the MAIS was used to classify the victims as SLI and SEI. Thus, a SEI is defined whenever the MAIS is equal to or greater than 3, otherwise is a SLI. Despite the clear advantages of using the MAIS, its full implementation will not be as fast as it would be desirable in some countries like Portugal. Therefore, by comparing the police and the MAIS classifications, adjustment factors may be used as an approximate inference, similarly to the fatality-adjusting coefficient that was used in the past in Portugal; until 2010, the official number of fatalities was set by multiplying the number fatalities declared at the accident scenes by an adjustment factor of 1.14. Therefore, considering these results, adjustment factors are provided to determine the real number of traffic casualties by severity type.

## 2. Data

Under the scope of the project LIVE, data from hospitals and the police were obtained. The datasets correspond to crash victims occurred in the Porto Metropolitan Area, Portugal, covering a 6-year period (2006–2011). The hospital dataset was obtained from three hospitals, two located in the city of Porto, and one in the neighboring city Vila Nova de Gaia. The police dataset contains the crash records collected by the police authorities in the same. The first comparison between the total number of casualties reported by the police and the hospitals denotes a 29% under-reporting level; while 25,985 records were obtained by the three hospitals, just 18,529 were reported by the police. In fact, the International Traffic Safety Data and Analysis Group (IRTAD–OECD/ITF) (International Traffic safety Data and Analysis Group, 2012), supported by studies conducted in different countries, states that many road traffic casualties are admitted to hospital without the police knowledge.

To combine the two datasets, a mixed deterministic and weight-based probabilistic linkage method was used, as described in Amorim et al. (2014). The process included a bias analysis and a linkage validation, ensuring that the present study is supported by a database that is correctly linked within a 5% error. This database has a total number of 7468 observations. The non-linked hospital data comprises 10,902 observations in Porto city and 7615 observations in Gaia city. The non-linked police data contains 8124 casualties occurred in Porto city and 2937 casualties occurred in Gaia city. The injury severity scale used in Portugal is directly related with the length of the victim's hospital stay (LS), i.e., the threshold reference to classify the injuries is 24 h spent in the hospital. However, this information is rarely checked by the police as demonstrated in this study.

As previously mentioned the MAIS will be adopted by the EU and presents a more detailed description of injuries (Gennarelli and Wodzin, 2006). The AIS (and, consequently, the MAIS) is obtained through a mapping with the commonly used codes of the International Classification of Diseases (ICD) (MacKenzie et al., 1986, 1989; Long et al., 1994; Durbin et al., 2001; Haas et al., 2012; Barnard et al., 2013). In Portugal, the ICD codes are applied, but the AIS is not commonly known by the medical community, which leads to a lack in the AIS practice. Therefore, the ICD-9 to MAIS conversion was made through a searching algorithm named ICDMAP. Based on an AIS-ICD-9 dictionary, the ICDMAP finds the maximum of three possible MAIS values given by the dictionary, accordingly to MacKenzie et al. (1989). Because 24 observations did not have the diagnosis information, the MAIS code was not achieved for those observations. Therefore, the MAIS sample reached a total of 7444 observations.

Table 1 shows the description of the variables used in this study. These variables were found relevant to the misclassification analysis among the variables contained in the linked database from Amorim et al. (2014).