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Are car drivers holding a motorcycle licence less responsible for motorcycle—Car crash occurrence? A non-parametric approach

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Abstract

The purpose of this work is to evaluate the effect of a specific motorcycle licence, held by car drivers, in responsibility for motorcycle–car crashes. The data were provided by a multicentric case–control study (MAIDS) regarding the risk of crash and serious injuries of motorcyclists. A non-parametric method, classification and regression tree (CART), was used to accomplish the objective, and then compared to standard unconditional logistic regression. Drivers owning a motorcycle licence turned out to be less responsible for motorcycle–car crashes than drivers who do not have one; both types of analysis are consistent with this result. It is reasonable to assume that car drivers who hold a motorcycle licence have acquired more ability in riding and controlling two wheeled vehicles than drivers without a licence, and this may help them in predicting motorcycles manoeuvres.

Keywords: Motorcycle crashes; Motorcycle licence; Crash causation; Case–control study; CART

1. Introduction

Recent studies have shown that there is a positive association between risk-taking behaviour and the likelihood of being involved in road crashes (Gregersen and Bjurulf, 1996; Stevenson et al., 2003). On the subject of motorcycling, research shows that the willingness of riders to engage in risky riding behaviour could be a more important cause of crashes than a lack of motorcycle handling skills (Reeder et al., 1997). The feeling of danger and increased risk is a part of motorcycling fascination, and sometimes motivate people to turn to two wheeled vehicles (Syner and Vegega, 2001).

In contrast with what one would believe upon these findings, when a motorcycle–car crash occurs drivers are more often responsible than riders, the violation of the motorcyclists' right of way by another vehicle driver being the most common cause of these accidents (Wulf et al., 1989). In some instances this failure to see the motorcycle could be attributed to structural limitations, such as view obstructions (Wulf et al., 1989).

However, most frequently the other vehicle driver failed to detect the approaching motorcycle in time (Wulf et al., 1989).

Horswill and Helman (2003) compared a group of motorcyclists with a matched group of non-motorcycling (NM) car drivers. Using a range of laboratory measures, they ascertained an increased risk-taking behaviour among the former. A second experiment showed that motorcyclists driving a car in a simulation setting, did not differ from the (NM) car drivers on the risk-taking measures. This probably indicates that motorcyclists do not represent a qualitatively different group of people from non-motorcycling (NM) car drivers, and that the widely observed differences in risk-taking attitude are a function of the mode of transport. From this research it also turned out that motorcyclists driving cars were quicker at detecting hazards than NM car drivers and this could have a positive influence on the risk of crash.

Thus, regarding NM car drivers, it would be interesting to know whether gaining some experience in motorcycle riding could realistically reduce their involvement in crashes with motorcycles, due to hazard detection improvement.

The objective of this paper is to investigate whether car drivers are less often responsible for motorcycle–car crash occurrence,

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when owning a specific motorcycle licence. Licence ownership was considered instead of some riding experience measure, because it is an objective way of ascertaining whether drivers have been riding motorcycles. Experience-related variables generally rely on self-reported statement and hence may be biased upward or downward; moreover, they usually contain a considerable amount of missing values.

Analysis was carried out using a non-parametric statistical method, classification and regression tree (CART), and integrating the results with standard unconditional logistic regression.

2. Data and methods

Data for this analysis were obtained from MAIDS study dataset (Motorcycle Accident in Depth Study), a multicentric case–control research conducted in Italy, Spain, Germany, Holland and France from 1999 to 2001, with the specific aim of identifying risk factors of motorcycle crashes and risk factors to discriminate between serious and minor injuries. This study was commissioned by the EU and financed by ACEM (European Association of Motorcycle Constructors), in order to assist decision-making in the context of a renewal of circulation regulations, motorcycle construction and maintenance procedures.

The target population is formed of all two wheeled vehicles circulating through definite areas. Cases consist of motorcycles and their riders that were involved in accidents with injuries; to be enrolled in the study either the rider and/or passenger had to be injured and transported to an emergency ward. Controls consist of riders and vehicles that were not involved in an accident; trained research workers at sampled petrol stations contacted them. The size of the study was: 921 cases and 923 controls.

In the database, almost 1600 variables grouped into three major subjects, mechanical, environmental and human, were collected. They concern the place where accidents happened, crash dynamics, mechanical characteristics of vehicles, damage produced by the crash, the personal, social and behavioural characteristics of riders, drivers and passengers, and a detailed set of information regarding injuries (MAIDS report).

Each accident was jointly reconstructed and analysed by a team of experts, formed of statisticians, engineers, orthopaedic physicians, skilled riders and data managers. The purpose of these workshops was to determine the primary and secondary cause of crashes, using accident information and specific expertise and competences of each member. No previous study known to us is based on such detailed investigation on motorcycle crashes.

Except for variables describing accidents and injuries, the same information was collected for controls.

Researchers made the choice of explanatory variables used in the two approaches. Thus, no automatic (stepwise forward and backward) variable selection procedure was used. Besides the variable of interest, dichotomised in motorcycle licence or just car licence of drivers, five other driver-related predictors were selected; they are: driving experience in the accident vehicle (months), general driving experience in any vehicle (years), age, vehicle travelling speed before accident took place, frequency of transit on the road where the accident happened. They were all used as continuous variables, except the last, which was divided into three categories (once per day, once per week, once per month or less).

The response variable was the primary cause of crash: rider or driver's mistake.

Inclusion criteria were:

- Crashes primarily caused by rider or driver's fault, this classification being made by MAIDS teams of experts who went through a detailed evaluation of each accident.
- Motorcycle–four wheeled vehicle collisions; crashes involving two motorcycles were excluded from the crash sample, since analysis aims at detecting only possible NM car drivers' lack of skills.

Seven hundred and forty two crashes met the inclusion criteria.

2.1. Statistical methods

CART is used in many medical applications as a classification tool. In particular it has been successfully exploited in diagnosis decision processes (Guzick et al., 2001; Thwaites et al., 2002) and prognosis ascertainment (El-Solh et al., 2001; Abu-Hanna and de Keizer, 2003; Rovlias and Kotsou, 2004), among others. Other fields which CART analyses have recently been performed in are epidemiology (Lemon et al., 2003; Dierker et al., 2004; Gerald et al., 2002), microbiology (Ambrose et al., 2001), histology (Smolle and Kahofer, 2001), genetics (Davuluri et al., 2000) and chemistry (Bai et al., 2003). On the contrary, few traffic crashes-related studies have made use of this method.

The methodology, which is outlined extensively in Breiman et al. (1984), consists of building a classification tree for categorical dependent variables or a regression tree for continuous variables. A tree is formed of several *nodes*, and terminal nodes are called *leaves*. Variables cut-off points dividing the units in each node are called *splits*.

Gini is the split criteria adopted for decision trees developed in this paper. Cross-validation was then used to provide estimates of future prediction error. According to this method the whole dataset S is divided into n sub-samples S_n; the classification algorithm is built in the complementary samples $S - S_n$, and its error rate is obtained in the sub-samples S_n.

The resulting CART model is visualised as a tree with intermediate nodes represented by ellipses, and terminal nodes (leaves) represented by rectangles labelled with a corresponding class based on the response variable.

Variables included in the analysis were collected as self-reported statements and contain a high percentage of missing data. CART analysis was thus performed first on a missing listwise deletion-related data and then including the records with missing values, by using the attractive properties of surrogate variables (Breiman et al., 1984).

CART analysis was performed using R 2.0.0 ('rpart' package).