Transportation Research Part F 41 (2016) 261–276

Contents lists available at ScienceDirect

Transportation Research Part F

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

How cyclist behavior affects bicycle accident configurations?

Alice Billot-Grasset *, Emmanuelle Amoros, Martine Hours

Université de Lyon, F-69622 Lyon, France
IFSTTAR – TS2 – UMRESTTE: The French Institute of Science and Technology for Transport, Development and Networks – Transport, Health, Safety Department – Epidemiological Research and Surveillance Unit in Transport, Occupation and Environment, UMRT 9405, Avenue François Mitterrand, Case 24, F-69675 Bron Cedex, France
Université Lyon 1, F-69373 Lyon, France

ARTICLE INFO

Article history:
Received 27 June 2014
Received in revised form 25 September 2015
Accepted 7 October 2015
Available online 24 November 2015

Keywords:
Cycling accident typology
Medical register
Survey
MCA

ABSTRACT

In many major cities, bicycle usage is on the increase and cycling safety is becoming a critical issue. Most of the existing studies are based on police data which understate both single-bicycle accidents as well as cyclist victims. In France, an estimation based on a road trauma database reveals that cyclists are 8 times more likely to be injured per hour spent on the road compared to motorists. To give a full picture of cycling accidents, as well as to understand how cyclist behavior interacts with other factors in causing accidents, we surveyed all injured cyclists in the period 2009–2011, as identified in a medical database of road trauma victims in a French territorial "département" (the Rhône, capital city Lyon).

Using classification methods we build a typology of 17 recurring configurations of cycling collisions and single-bicycle accidents: 7 concern utilitarian riding (commuting...), 3 concern recreational riding and 7 concern cycling as a sporting activity. A Multiple Correspondence Analysis (MCA) is then used to check the consistency of this typology, and to gain additional insight on road user behavior by projection of supplementary variables.

External factors contributing to cycling accidents, such as "bad weather" (13%) or "riding at night" (14%), roadway configuration such as "cycling infrastructure" (16%) or "intersections" (25%), and cyclist behavior such as "alcohol consumption" (5%) or "speed" (25%) are discriminatory variables that interact in many accident configurations. This study shows how road user behavior-influences each step in the chain of events leading to an accident. In the discussion of study results, some recommendations are made to public authorities aimed at improving cyclist safety.

1. Introduction

For some years now in France, cycling as means of transport represents a stable or increasing share of traffic in many large cities (Papon & De Solère, 2010). Its popularity in town stems from its efficiency in journey-time and cost terms (Oja et al., 2011; Praznoczy, 2012). Cyclists accounted for 3.4% of road deaths in France in the 2007–2008 period (CERTU, 2012). For non-fatal injuries, official figures based on police statistics are severely biased in France as elsewhere in the world, and so are not well suited to the study of cycling accidents (Elvik & Mysen, 1999; Juhra et al., 2012 ;Laumon & Martin, 2002). Indeed

* Corresponding author at: IFSTTAR – TS2 – UMRESTTE: The French Institute of Science and Technology for Transport, Development and Networks – Transport, Health, Safety Department – Epidemiological Research and Surveillance Unit in Transport, Occupation and Environment, UMRT 9405, Avenue François Mitterrand, Case 24, F-69675 Bron Cedex, France. Tel.: +33 472142309 (office), +33 670439911 (mobile).
E-mail addresses: alice.grasset@ifsttar.fr, alice.grasset@gmail.com (A. Billot-Grasset), martine.hours@ifsttar.fr (M. Hours).

http://dx.doi.org/10.1016/j.trf.2015.10.007
1369-8478/

cycling accidents are estimated to be ten times less likely to be recorded by the police compared to accidents involving motorists (Amoros, Martin, & Laumon, 2006). Moreover, as only the most serious cycling accidents are well recorded, this creates the false impression that 90% of cycling accidents result in serious injury and involve collision with another vehicle. Estimates based on hospital admissions, however, show that some 70% of injured cyclists had lost control and collided with an obstacle, or otherwise fallen, perhaps whilst attempting to avoid an obstacle (Amoros, Chiron, Thélot, & Laumon, 2011; Niska, Gustafsson, Nyberg, & Eriksson, 2013; Thulin & Niska, 2009). Such single-bicycle accidents involving the cyclist alone are poorly studied, accounting for only a smaller part of literature despite being the most prevalent. They still represent however a cost to society public health cost terms (Aertsens et al., 2010; Veisten et al., 2007).

The risk of injury is reported to be 8 times higher for a cyclist as for a motorist, for an equivalent time on the road (Blaizot, Papon, Haddak, & Amoros, 2013). It is estimated that for each 100,000 of population, 70 are injured whilst cycling each year on the roads of France (Amoros, Martin, & Laumon, 2008). Cycling has many benefits for the individual cyclist, as well as for society at large, and so it's important that such physical and psychological benefits (Morris & Guerra, 2014; Wipfli, Landers, Nagoshi, & Ringenbach, 2011) not be undermined by too-high accident rates. Safety affects the practice of cycling in two ways: firstly, some victims abandon cycling after an accident; and secondly, some potential cyclists avoid or limit cycling for fear of accidents. For this reason many cycling infrastructures are designed so as to increase the cyclists' sense of safety (Garrard, Rose, & Lo, 2008), thereby promoting cycling in towns. This factor has an indirect yet substantial effect on cyclists' safety: by promoting cycling, which becomes more commonplace, then a "safety in number" effect also appears (Jacobsen, 2003).

Most studies rely on police data, and are heavily focused on fatal accidents. Cycling safety studies conventionally focus on a few aspects such as infrastructure (Reynolds, Harris, Teschke, Cripton, & Winters, 2009), type of cyclist (de Geus et al., 2012), type of accident (Chong, Poulos, Olivier, Watson, & Grzebieta, 2010; Pai, 2011), use of conspicuous clothing (Thornley, Woodward, Langley, Ameratunga, & Rodgers, 2008), and visibility (Schepers & den Brinker, 2011). Another important part of the literature describes the characteristics of injured cyclists and their injuries using medical databases (Amoros, Chiron, Ndiaye, Thélot, & Laumon, 2009; Ekman, Welander, Svanström, Schelp, & Santesson, 2001). Occasionally, a multifaceted approach is used, taking account of host, agent and environment and the chronology of events, to achieve a comprehensive view. A few studies have grouped accidents by similarities so as to construct typologies. Since the first such study (Cross & Fisher, 1977), typologies have paid little attention to cyclist behavior or to the diversity of accidents (collisions with other users, single-user accidents) (Cleven & Blomberg, 2007; Hunter, Pein, & Stutts, 1997; INRETS, 2010) and often focus on just one accident stereotype, such as car versus bike (Herslund & Jørgensen, 2003). The American Pedestrian and Bicycle Crash Analysis Tool for example has only 1 'bicycle-only' accident configuration out of a total of 69 (Harkey, Tsai, Thomas, & Hunter, 2006). The European equivalent has only 2 such configurations out of a total of 120 (Reed & Morris, 2008). In France, two typologies have been developed. The first typology is comprises 10 cycling accident configurations derived from studies of fatal accidents, of which only one is a single-user accident (Got & Got, 1991). The second typology contains 51 accident configurations but groups together single-user and multiple-user accidents (Bue & Propeck, 2010). Moreover, none of the existing typologies were constructed using a medical database, and therefore overlook very many accidents causing minor injury, as is often the case for single-bicycle accidents. The present study seeks to construct a typology which is as representative as possible of cycling accidents, taking account of infrastructure, as well as cyclist behavior and its interaction with the architectural environment and with other road users.

It is also noteworthy that a significant proportion of cyclists injured on the road were practicing cycling as a sport at the time. Obviously mountain-bikers form an easily identifiable group, by riding off-road, and so are frequently studied apart in dedicated literature. To improve knowledge of cycling safety and to address prevention, a tool providing a complete picture of cycling accidents is needed, to better identify the relative importance of the various danger factors for all cyclists, on-road and off-road. A survey was therefore performed to refine the characterization of cycling accidents identified in a road trauma database. Classification methods were used to construct a typology reflecting accident configurations, combining various factors such as the cyclist's characteristics and behavior, the purpose of the journey, cycling infrastructure if applicable and some other accident-related factors already studied in literature. This paper describes: how the typology was built up using classification methods; how its consistency was then tested using Multiple Correspondence Analysis (MCA); the survey method and the questionnaire design; limitations of the study's methodology; and finally makes some suggestions for accident prevention.

2. Material and methods

This section describes population selection, the pilot survey and questionnaire construction, all of which combine towards a satisfying response rate of 43%.

2.1. Data selection

The present study sought to determine how cyclists came to be injured in collisions and single-bicycle accidents. This required data on the cyclist and details about the accident configuration. To collect this information, one option was to conduct a survey or to build a prospective cohort in a group of cyclists, using for example the membership lists of cycling clubs. But this biases the selection, and since accidents are infrequent, a very large population would be needed in order to obtain a usable study sample (de Geus et al., 2012; Heesch, Garrard, & Sahlqvist, 2011; Poulos, Hatfield, Rissel, Grzebieta, & McIntosh,