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Fatality Risk Factors for Bicyclists in Croatia

Eduard Missoni, Josipa Kern[1]

Department of Traffic Medicine, Zagreb University Faculty of Transport and Traffic Engineering, and [1]Department of Medical Statistics, Epidemiology, and Medical Informatics, Andrija Štampar School of Public Health, Zagreb University School of Medicine, Zagreb, Croatia

Aim. To present the epidemiology of fatal bicyclist injuries in traffic accidents in Croatia.

Methods. Between January 1, 1997 and December 31, 2000, there were 253 bicyclist fatalities in Croatia. The data were collected from the police reports of the Department of Traffic Police, Ministry of the Interior, written at the place of the accident. The data were processed by descriptive epidemiology and compared by tests of significance.

Results. The percentage of bicyclist fatalities among total road fatalities showed a decreasing trend over the years, from 11.6% in 1998 to 8.2% in 2000. The most frequent type of accident involving bicyclist fatalities were accidents in car-bicycle collisions (lowest: 74.7% in 1998; and highest: 81.3% in 1997). Most accidents occurred at the beginning and at the end of the bicycle season – months of April and October. Elderly people were involved in accidents occurring mainly in the morning hours – from 6 to 12 a.m., whereas the youngest and the middle-aged got injured or killed mainly in the evening – 6 to 9 p.m. This association between the age and the part of day when the accident happened was statistically significant (chi square = 36.51, $p < 0.0001$).

Conclusion. Bicycle-related fatal injuries as a part of total road fatalities showed a gradual decrease. Regulation of bicycle traffic, more stringent protection measures and their implementation, as well as preventive measures regarding the time of day are needed to further decrease bicyclist fatalities in traffic.

Key words: *accidents, traffic; bicycling; Croatia; head traumas; wounds and injuries*

Bicycling has been emphasized as a factor contributing to better health and physical condition, as well as to environmental protection (1).

In Sweden, the number of bicyclists between 25 and 64 years of age doubled in the period between 1980 and 1993 (2,3). Every third Swede older than 65 uses the bicycle at least once a year. In the period between 1967 and 1996, 47% of all bicyclist fatalities were accounted for by those older than 65 in Sweden. However, most reports and preventive programs have focused solely on child safety with regard to bicycling (4-7).

Although a number of international studies have described the injury surveys of bicyclists and opportunities for prevention, discussion of the injury control is generally confined to helmet campaigns, and possibly the mandatory wearing of helmets forced through legislation (8-10). Bicyclists have been not obliged to wear helmets in Croatia. It implies that bicyclists mostly do not wear them.

The concern due to the great number of fatalities and heavy injuries related to bicyclists has brought about extensive efforts and programs for their prevention in many countries of the world. However, the concerns vary around the world. In a 1995/1996 study, only 2.2% of bicyclists in Paris, France, wore a helmet, compared with 31.5% in Boston, Mass, USA (11). In contrast, 46.8 % of Parisian bicyclists had their front or rear light on during night-ride, compared with only 14.8% in Boston. These large and seemingly contradictory findings are the result of different laws and public health priorities, types of bicycle riding, and perceived risks.

The available literature has little formal analysis of the fatal risk patterns of bicyclists, because there has been scarce information available on riding exposure (12). The aim of this study was to explore the problem of current traffic accidents in Croatia, accidents with injuries, especially of bicyclists, and to study the conditions in which accidents with the bicyclist fatalities occur.

Methods

We collected data on traffic characteristics (number of drivers and vehicles), number of traffic accidents (with and without injured participant), and data about the bicyclist fatalities in the Republic of Croatia over a period of four years, from January 1,

1997 to December 31, 2000. The data were collected from the police reports of the Department of Traffic Police of the Ministry of Interior in Croatia, taken on the place of the accident.

The data were processed by using descriptive statistics, and the associations between the observed variables were tested by chi-square test of significance.

Results

The number of registered drivers of motor vehicles increased during the study period. In 1997 it amounted to 1.628,919, whereas in 2000 this number was 1.801,817. The number of registered motor vehicles also increased from 1.142,201 vehicles in 1997 to 1.401,010 in 2000 (Fig. 1). Consequently, the number of traffic accidents increased from 61,685 in 1997 to 73,387 in 2000. Traffic accidents with injured persons showed the same trend. In 1997 there were 16,234 injured persons, and in 2000 as many as 20,501 (Fig. 2).

The total number of persons killed in road traffic accidents was lowest in 1998 and highest in 1997 (Fig. 3). The number of fatal bicyclist accidents varied from 54 in 2000 to 75 in 1998, but the overall trend was decreasing (Fig. 3). The average incidence rate of fatal bicyclist accidents in the four year period was 1.51 per 100,000 inhabitants.

Over the years almost all indicators of intensity of bicyclist fatalities – the number of bicyclist fatalities per 100 thousand newly registered motor vehicles, per million drivers, per thousand fatalities, or per million of registered motor vehicles – showed a decreasing trend (Table 1). This was especially true for the number of bicyclist fatalities per thousand fatalities, or per million of registered motor vehicles, which significantly decreased during the study period (Table 1).

Car-bicyclist collision was by far the most frequent type of accident (Table 2). This type of accident accounted for 74.7% to 81.3% of the total number of fatal bicycling accidents, followed by crashes and sliding. Among other types of accidents, only a few accidents were described as a fall from a bicycle or collision in bumper-to-bumper driving.

The most frequent bicyclist fatalities were in the age group between 35 and 64 (46.2%), followed by the eldest bicyclists (34.4%), and the youngest bicyclists (19.4%) (Table 3). The latter group was a heterogenous group of pre-school and school children, students, and other young people. There was a statistically significant association between the age groups and the time of day in which the accident occurred (Table 3). The elderly usually got hurt in the morning hours, from 6 to12 a.m., whereas the middle-aged and the youngest age group got injured in the evening, from 6 to 9 p.m. (Table 3).

The most frequent cases of fatalities were at the beginning of the bicycling season (Fig. 4), in April, with 38 bicyclists involved in the four-year observation period, and at the end of the season, in October, with 28 fatalities. Less frequent fatalities were in summer months, at the end of spring (May), and the begin-

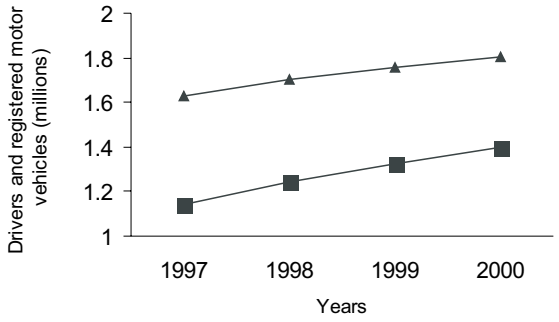

Figure 1. Number of drivers (triangles) compared to the number of registered motor vehicles (squares) in Croatia.

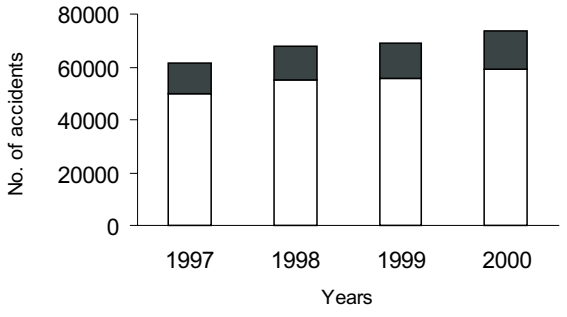

Figure 2. Number of traffic accidents in Croatia. Closed bars – traffic accidents with injured persons; open bars – traffic accidents without injured persons.

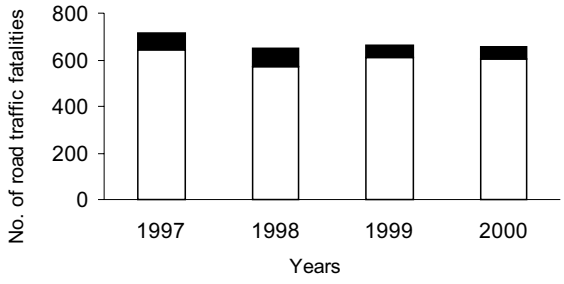

Figure 3. Bicyclist fatalities in total road traffic fatalities. Closed bars – bicyclist fatalities; open bars – other road traffic fatalities.

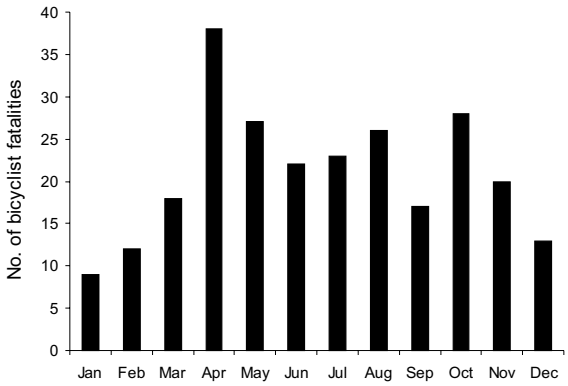

Figure 4. Cumulative number of bicyclist fatalities in Croatia per month for the 1997-2000 period.

Table 1. Indicators of bicyclist fatalities in Croatia, 1997-2000

Year	No. of bicyclist fatalities per			
	million of registered motor vehicles	100 thousand newly registered motor vehicles	million drivers	thousand fatalities
1997	60.4	48.7	42.4	96.6
1998	60.4	65.3	44.1	116.1
1999	41.6	49.5	31.4	83.1
2000	38.5	47.5	30.0	81.2
chi-sguare (df = 3)	8.341	4.020	4.325	8.250
p	0.039	0.259	0.228	0.041

Table 2. Number (%) of bicyclist fatalities according to type of accident

Years	Number (%) of fatalities according to the type of accident					
	collision	lateral collision	head-on collision	other	sliding	Total
1997	56 (81.3)	5 (7.2)	1 (1.4)	6 (8.7)	1 (1.4)	69 (100.0)
1998	56 (74.7)	3 (4.0)	10 (13.4)	2 (2.6)	4 (5.3)	75 (100.0)
1999	43 (78.2)	6 (10.9)	3 (5.5)	2 (3.6)	1 (1.8)	55 (100.0)
2000	41 (75.8)	3 (5.6)	1 (1.9)	5 (9.3)	4 (7.4)	54 (100.0)
Total	196 (77.5)	17 (6.7)	15 (5.9)	15 (5.9)	10 (4.0)	253 (100.0)

Table 3. Number (%) of accidents according to age and according to time of day

Age groups	Time of accident (hours)*					
	9 p.m.-6 a.m. (night)	6 a.m.-noon (morning)	noon-3 p.m. (early afternoon)	3 p.m.-6 p.m. (late afternoon)	6 p.m.-9 p.m. (evening)	Total
younger than 35	10 (20.4)	4 (8.2)	10 (20.4)	10 (20.4)	15 (30.6)	49 (19.4)
35-64	20 (17.1)	20 (17.1)	9 (7.7)	23 (19.7)	45 (38.5)	117 (46.3)
65 and older	8 (9.2)	37 (42.5)	12 (13.8)	16 (18.4)	14 (16.1)	87 (34.4)
Total	38 (15.0)	61 (24.1)	31 (12.3)	49 (19.4)	74 (29.3)	253 (100.0)

*chi-square = 36.51, df = 8, p < 0.0001

ning of autumn (September), whereas the smallest number of accidents was recorded in winter.

Also, being male presented a greater risk for a bicycle accident fatality than being a female (83% males, 16% females, 1% missing data). Slippery road surface was found in 15% of accidents with bicyclist fatalities and 46% fatalities happened during bad visibility. Most of bicyclist fatalities (53%) happened on local roads.

Discussion

During the observed four-year period, an average of 63 bicyclists got killed annually, which is 1.51 killed per 100,000 inhabitants in the Republic of Croatia. Comparison of this rate with rates reported for other countires is very difficult because they also depend on the number of bicyclists and the general use of bicycles as a vehicle, as well as on the regulation of bicyclist traffic and security measurements. The reported rate for bicycle fatalities in the USA is 0.3 per 100,000 population (13), compared with 0.6 per 100,000 population in Sweden (2) and France (11). This certainly does not mean that it is more dangerous to drive a bicycle in Sweden than in the USA, but rather that a bicycle is a more common mode of transport in Europe than in USA. In China, where bicycles are the most common transportation vehicle, the rate of bicyclist fatalities is 2.2 per 100,000 (14,15).

Traffic regulations regarding bicycle routes are an important deteminator of bicycle accidents. Sweden is an excellent example of the superbly regulated and extensive bicycle route network. The most important are "Sverigeleden" (4,000 km through the entire country) and "Cykelspĺret" (2,800 km along the coastline) (16). In Croatia, bicycling routes are almost non-existent. In the capital of Zagreb, which houses amost a quarter of the whole Croatian population, there are currently only 26 km of bicycle pathways. The City has plans for another 160 km in near future, and the general urban plan predicts a bicycle network of more than 300 km. However, there are no available data on the number of bicycles and their use in traffic in Croatia. Although our study showed a slight decrease in the rate of bicycle fatalities in relation to motor vehicles and total traffic fatalities, the number of bicycle fatalities per new motor vehicles and total number of drivers did not change, indicating that bicycle traffic is not safe in Croatia.

There were several risk-patterns of bicyclist fatalities depending on the age of bicyclists. Most of them were characterized by collisions with motor vehicles, simiar to other studies (17), and by the time of accident. Morning hours were prevailing fatal hours for bicyclists aged over 64, evening hours for bicyclists aged bellow 65. These differences are probably related to different lifestyles of different age groups. Also, most bicyclist were killed on local roads, indicating the need for separating bicycle traffic from that of motor vehicles.

Despite the limitations of our study related to its retrospective design and lack of data on bicycle traffic in Croatia, the results indicate the importance of bicyclist safety in traffic at the time when bicycling is promoted as a part of a healthy lifestyle. What is needed is a proper study of the number and driving habbits of bicycle drivers in Croatia, and consequent implementation of safety regulations and traffic regulation to decrease accident risks among this growing population of traffic participants.

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Correspondence to:
Eduard Missoni
Department of Traffic Medicine
Zagreb University Faculty of Transport and Traffic Engineering
Vukelićeva 4
10000 Zagreb, Croatia
missoni@fpz.hr