

## Risk for Motorcyclists in a Busy Metropolitan City: The Example of Tel Aviv

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**Key words:** traffic accidents, motorcycles, metropolitan city

### Abstract

**Background:** The proportion of motorcyclists injured in road accidents in Israel is larger than their proportion among road users.

**Objectives:** To identify factors contributing to the risk of injury for motorcyclists as compared to drivers of other motor vehicles.

**Methods:** We retrieved and analyzed National Trauma Registry data on drivers, aged 16 and above, who were involved in traffic accidents and hospitalized between 1 January 1997 and 30 June 2003.

**Results:** The study group comprised 10,967 patients: 3,055 (28%) were motorcyclists and 7,912 (72%) were drivers of other motor vehicles. A multiple logistic regression revealed that Tel Aviv, the busiest metropolitan city in Israel, is a risk for motorcycle injury as compared to other regions; males have an increased risk compared to females; and age is a protecting factor since the risk of injury as a motorcyclist decreases as age increases. Nevertheless, the population of injured motorcyclists in Tel Aviv was significantly older (mean age 32.5 years vs. 28.6 elsewhere; *t*-test  $P < 0.0001$ ). Twenty percent ( $n=156$ ) of the injured motorcyclists in Tel Aviv were injured while working, compared to 9.5% ( $n=217$ ) in other regions (chi-square  $P < 0.0001$ ). Motorcycle injuries in Tel Aviv were of lower severity (7.7% vs. 16.4% according to the Injury Severity Scale 16+,  $\chi^2 P < 0.0001$ ), and had lower inpatient death rates (1.2% vs. 2.5%,  $\chi^2 P = 0.001$ ).

**Conclusions:** Tel Aviv is a risk for motorcycle injury compared to other regions, males have an increased risk compared to females, and age is a protecting factor. The proportion of motorcyclists in Tel Aviv injured while working is double that in other regions

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### Patients and Methods

The study population comprised all patients included in the Israel National Trauma Registry from 1 January 1997 through 30 June 2003, aged 16 or above, who had an ICD-9-CM external cause of injury code indicating their involvement as a driver in a road traffic accident.

The ITR records all casualty admissions to hospital, inpatient deaths and transfers from other hospitals at all six level I trauma centers and three regional trauma centers in Israel. The registry is estimated to cover approximately 70% of the severe trauma cases in the country. Data retrieved from the ITR database include injury diagnoses, demographic variables, severity measures such as the Abbreviated Injury Scale [3] and the Injury Severity Scale [4], indicators of hospital resource utilization such as length of stay and intensive care unit treatment, and patient's survival. The framework for injury diagnoses analysis was based on the Barell [5] body region by nature of Injury Diagnostic Matrix [6].

SAS statistical software was used for data analysis. Chi-square tests and *t*-tests were used to compare between groups. The initial analysis described motorcyclist injuries and sought factors that increase risk of injury. A logistic regression model was created to predict which factors increase the risk of injury for motorcyclists in Israel when compared to drivers of other motor vehicles. Being a motorcyclist was the dependent variable, with gender, age, day of week, and various metropolitan areas as the independent variables. Odds ratios for confounding variables were calculated with 95% confidence intervals. Tel Aviv, the busiest city in Israel, emerged as a risk factor for motorcyclists. Two further analyses were then conducted: a) a comparison of motorcyclists injured in Tel Aviv and motorcyclists injured in other regions of the country, and b) between motorcyclists and four-wheel motor vehicle drivers within Tel Aviv.

### Results

During the study period, 10,967 patients aged 16 or above were hospitalized following an injury sustained as a driver in a road

ITR = Israel National Trauma Registry

Nearly 80,000 motorcycles were registered in Israel at the end of 2001 [1]. From January 1997 through December 2002, a total of 19,348 injuries to motorcyclists, with 217 fatalities, were recorded [1]. Motorcycles comprise 4% of all registered vehicles in Israel but are involved in about 8% of all road traffic accidents in the country [2]. This study set out to characterize injured motorcyclists in Israel, compare them with injured drivers of other motor vehicles, and identify factors contributing to their risk of injury. Ultimately, this analysis can suggest informed recommendations that may aid in decreasing injury, disability and death among motorcyclists.

**Table 1.** Risk factors for injury in motorcyclists in Israel

	All injured No.	Injured motorcyclists		OR	95% CI
		No.	%		
Total	10,967	3,055	27.9	8.40	7.241–9.758
Tel Aviv, weekdays	1,026	710	69.2	3.45	2.367–5.043
Tel Aviv, Saturdays	122	61	50.0	1.0	–
Other regions*	9,819	2,284	23.3	3.75	3.26–4.33
Males	8,609	2,781	32.3	1.0	–
Females	2,351	272	11.6		
Age, mean (yrs)	34.46 ± 14.79**	29.61 ± 12.16			
Increase per year				0.970	0.966–0.973

\* Since the number on weekdays and Saturdays were similar in other regions, they are combined.

\*\* Excluding injured motorcyclists.

accident throughout Israel. Of these, 3,055 (28%) were motorcyclists and 7,912 (72%) were drivers of other motor vehicles.

Table 1 presents the factors that contribute to the risk of injury among motorcyclists as compared to drivers of other motor vehicles. Males have an increased risk compared to females (OR 3.75, 95% CI 3.26–4.33). Tel Aviv on weekdays, compared to other regions, increased the risk of injury to motorcyclists eight-fold, while Tel Aviv on weekends presented a threefold chance of injury compared to other regions. Age was a protecting factor: for each year increase in age the risk of injury for a motorcyclist decreased by 3%.

A quarter of all motorcycle injuries in Israel (n=771) occurred in Tel Aviv, compared to less than 5% of all injuries sustained by drivers of other motor vehicles (n=377). The number of motor vehicles registered [1] and the number of injuries among drivers in Tel Aviv, by vehicle type, are presented in Figure 1, showing a reverse trend.

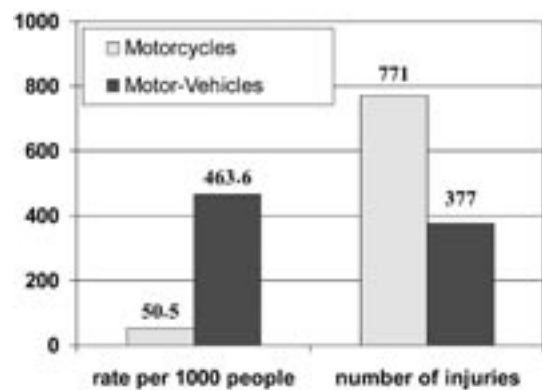
Table 2 compares motorcyclists in Tel Aviv with motorcyclists in other regions. Males comprised 88% of the motorcyclists injured in Tel Aviv and 92% in other regions (P = 0.0007). The Tel Aviv injured population was significantly older, with a mean age of 32.5 years compared to 28.6 elsewhere. Of the injured motorcyclists in Tel Aviv, 156 (20%) were injured while working, compared to 217 in other regions (9.5%) ( $\chi^2$  P < 0.0001). Figure 2 shows the proportion of motorcycle accidents among all accidents by weekday or weekend. The day of accident reinforced data on activity at the time of injury. Of the accidents in Tel Aviv there were more motorcycle injuries during weekdays and more motor vehicle injuries on the weekend, particularly on Saturday (the Jewish Sabbath). In other regions it remained at a similar daily level (ranging from 13% to 16%, with 14% on Saturdays). Nevertheless, weekend work accidents in Tel Aviv were still more frequent (7% of all accidents compared to 3% elsewhere). Figure 2 shows a decrease in the proportion of motorcycle injuries among all injuries between the

ITR = Israel National Trauma Registry

OR = odds ratio

CI = confidence interval

ISS = Injury Severity Scale

**Figure 1.** Tel Aviv: number of vehicles per 1,000 people\* and number of drivers injured.

\* source: [www.cbs.gov.il/publications/cars01/tab12h.shtml](http://www.cbs.gov.il/publications/cars01/tab12h.shtml) accessed on February 24 2004.

**Table 2.** Patient and injury characteristics of motorcyclists in Tel Aviv and other regions

	Tel Aviv		Other	
	No.	%	No.	%
Total	771	100	2,284	100
<b>Gender</b>				
Male	676	87.8	2105	92.2
Female	94	12.2	178	7.8
<b>Age (yrs)*</b>				
16–29	417	54.1	1574	68.9
30–44	210	27.2	451	19.8
45–59	109	14.1	199	8.7
60+	35	4.6	60	2.6
<b>Activity*</b>				
Work	156	20.2	217	9.5
Other/unknown	615	79.8	2067	90.5
<b>Severity*</b>				
ISS 1–8 (minor)	516	66.9	1263	55.8
ISS 9–14 (moderate)	196	25.4	630	27.8
ISS 16+ (severe)	59	7.7	370	16.4
<b>Intensive care*</b>				
Yes	43	5.6	259	11.4
No	728	94.4	2021	88.6
<b>Inpatient death*</b>				
Died in hospital	9	1.2	56	2.5

\* Differences between groups were statistically significant at P < 0.001.

weekday and the weekend in Tel Aviv. This trend is not present in other regions, where a slight increase was observed on the weekend.

Motorcycle injuries in Tel Aviv were of lower severity; with 8% having a severe injury (ISS<sup>4</sup> 16+) compared to 16% in other regions [Table 2]. Six percent in Tel Aviv and 12% in other regions were admitted to an intensive care unit. The inpatient death rate in Tel Aviv was double the rate elsewhere.

The nature of injuries differed between Tel Aviv and other regions. Patients injured in Tel Aviv had significantly more fractures (81% vs. 71%) and fewer internal injuries (13% vs. 31%) when compared with patients injured in other regions of the

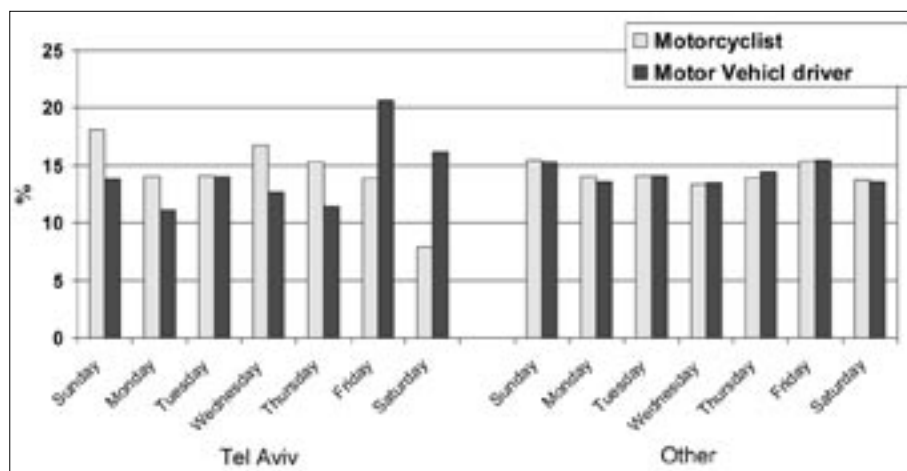


Figure 2. Distribution of day of accident of motorcyclists and drivers of other vehicles

country. Traumatic brain injuries (23 vs. 7%) and injuries to the abdomen (11 vs. 6%) were more frequent in patients injured in other parts of Israel than in patients injured in Tel Aviv. There was no difference in the reporting of the use of helmets in urban and rural areas. Fifty-three percent (412 patients) of the motorcyclists injured in Tel Aviv underwent a surgical procedure. This rate is high, translating into a more costly hospitalization. The median duration of hospitalization for motorcyclists in Tel Aviv was 4 days (interquartile range 2–6 days), accumulating to 4,320 inpatient days for Tel Aviv motorcyclists. The median stay in an ICU for motorcyclists injured in Tel Aviv was 3 days (interquartile range 1–7 days) amounting to 207 ICU days for the study period.

## Discussion

An analysis of motorcycle injuries demonstrated that many of these accidents occurred in urban areas. Tel Aviv, the largest and busiest metropolitan city in Israel, stood out in its affect and was selected for a more detailed enquiry. Tel Aviv is Israel's business center, and as such suffers from high traffic volumes, slow rush hour traffic and severe parking problems, resulting in a high proportion of motorcycles entering the city each morning, probably the highest rate in the country.

The number of registered motorcycles in Tel Aviv is the highest in the country, with nearly 50 motorcycles per 1,000 people [1]. As a result, a high number of motorcycle injuries in Tel Aviv could be expected, yet despite the large number, the injury rate per number of vehicles may not have warranted intervention. However, the proportion of motorcycle accidents among all road accidents in Tel Aviv was found to be much higher than the proportion of motorcycles among all vehicles in Tel Aviv, thus the injury rate is relatively higher. We contend that the fact that two-thirds of all driver injuries are to motorcyclists is a cause for concern. Other studies also found that motorcycles are involved in more accidents than other vehicle types. For example, in a study in Washington State, Rowland et al. [7] reported that

the rate of accidents per 1,000 motorcycles was 62.4, compared to 15.8 for other vehicle types. The high rate of motorcycle accidents in Tel Aviv noted by the police in 1999 [8] was reflected in the number of patients admitted to hospital and recorded in the trauma registry. If pedestrians are included, as they are in the police report, the proportion of motorcyclists in this article would be 33% compared to the 35% found by the police because some accidents that the police record do not result in hospitalization while the trauma registry includes admitted patients only. In their study of the incidence of traffic injuries in Barce-

lona, Plasencia and colleagues [9] note the large proportion of motorcycle injuries, emphasizing the urgent need to implement effective strategies to reduce injury risk associated with motorcycles and mopeds.

Cope and team [10] identified the problem of messengers driving motorcycles in England. In cities many companies and restaurants use messenger services for deliveries. In the United States, it was reported that pizza delivery motorcyclists working against the clock take risks in order to meet their deadline. Additionally, new messengers who do not yet know their routes well often have difficulty estimating the time it would take them to get from one place to another, and rush to the next destination on unfamiliar streets. A possible approach for persuading companies to promote the safety of their workers is to make public any information on messenger companies whose workers are involved in accidents; this would create external pressure on the companies to promote safety among their employees.

Although Tel Aviv motorcyclists were injured more frequently, they sustained less severe injuries. Most injuries were fractures of the extremities. This finding agrees with the study of Rowland et al. [7] who reported that injuries to an extremity are the most common injury in hospitalized motorcyclists. While these injuries are not always life-threatening, they translate into high costs during hospitalization due to an increased rate of operations and extended rehabilitation. Moreover, there is a loss of income during rehabilitation, which may even be permanent if the injury results in disability. These authors [7] also found that head injuries, which were more severe and potentially fatal, occurred during dark hours, in rural areas, on highways, and as a result of collisions. This could, in part, explain the difference in severity between Tel Aviv accidents and accidents occurring elsewhere in Israel. The majority of injuries in Tel Aviv were not severe, which could be attributed to the fact that they occurred before dark, on urban roads, and often involved slipping or a minor collision with a vehicle at a traffic light. In contrast, accidents elsewhere occurred later at night and were more likely to take place on highways [8]. The finding that the inpatient death rate was higher in other areas could also be due to the speed

ICU = intensive care unit

at the moment of collision on out-of-town roads. These results have important implications for planning intervention aimed at prevention.

Nevertheless, two limitations of this study should be kept in mind. Firstly, the data from the trauma registry include only patients who arrived alive to the trauma center and not those who were killed at the scene of the accident. Secondly, since our study was based on data collected at nine trauma centers, including the six level I trauma centers in the country, there is a bias towards the more severe casualties from the rural areas who were transferred to trauma centers; Tel Aviv casualties with minor injuries are likely to be admitted to trauma centers because the nearest hospital is a trauma center. Interpretation of the relative low severity of Tel Aviv injuries should take this factor into account, and it is reasonable to assume that non-urban injuries also include a proportion of minor injuries, but these would have remained at the peripheral hospitals and not transferred to the trauma centers, thus they would not be accounted for in this study. Nonetheless, these limitations do not affect the conclusions of this study – namely, the high proportion of motorcycle injuries in Tel Aviv in relation to injuries sustained by drivers of other motor vehicles.

## Conclusions

The high incidence of motorcycle accidents in Tel Aviv suggests that the municipal authority and the transport department should set policy to reduce injury among motorcyclists in Tel Aviv. Accidents in Tel Aviv were often minor, occurred during work, and resulted in extremity fractures and other non-severe injuries. Nevertheless, these injuries have a cost in terms of healthcare resource utilization and a personal cost due to loss of ability to work, particularly for messengers injured while working.

In order to reduce motorcycle injuries in Tel Aviv it is important to raise awareness to the presence of motorcycles on the road; for example, placing road signs drawing attention to these vehicles at intersections. Alternatively, motorcyclists could be protected by the establishment of special routes for motorcycles. Messengers should be dissuaded from working

against the clock, and the reputation of companies with high injury rates among their motorcyclists should be made public.

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## Capsule

### Giving a self-antigen its natural identity

Natural killer (NK) T cells recognize lipids, rather than protein-derived antigens, that are presented by major histocompatibility class I-like CDI molecules. Although certain artificial lipids and a handful derived from bacteria have been shown to stimulate NKT cells, the identity of naturally occurring endogenous lipid ligands has been elusive. Zhou et al. reveal that a single mammalian lysosomal glycosphingolipid, isoglobotrihexosyl-ceramide, or iGb3, can stimulate large numbers of

human and mouse NKT cells, and found that mice lacking a subunit of an enzyme responsible for generating iGb3 have a profound deficiency in NK T cell development in the thymus. This lipid antigen may thus play a role in directing NK T cell development and function and may contribute to a variety of disease states, from infection to cancer.

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