

Economic sanctions, military activity, and road traffic crashes in Vojvodina, Serbia

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ABSTRACT

Background: Political violence has not been examined as a risk factor for traumatic injuries from road traffic crashes.

Objective: To identify trends in road traffic crashes related to war-related military activity and international economic sanctions in the Autonomous Province of Vojvodina, Serbia.

Methods: Overall road traffic crashes and crashes leading to hospitalization and fatality in Vojvodina, Serbia were examined from 1996 through 2005. Rates were calculated per 100 000 population and per 10 000 registered vehicles. Three time periods were examined: years with international sanctions and military activity (1996–1999); years with international sanctions but no military activity (2000–2001); years with neither sanctions nor military activity (2002–2005).

Results: Compared with the period with neither sanctions nor military activity, severe injury crashes were 1.23 times more common (95% CI 1.19 to 1.27) during the period with sanctions and military activity and 1.21 times more common (95% CI 1.16 to 1.27) during the period with sanctions but no military activity.

Conclusions: The data suggest that vehicle travel became safer after the end of military action and economic sanctions. Road traffic safety needs to be a priority during both periods of political unrest and its recovery phase.

Road traffic crashes are the 11th leading cause of death globally and are predicted to become the third leading cause of disability-adjusted life years lost by the year 2020.^{1–5} Low-income and middle-income countries have much higher road traffic fatality rates than high-income countries, with poor populations bearing a disproportionate burden.^{1–6} High-income regions of Europe have the world's lowest motor vehicle fatality rates, whereas lower-income regions of Europe have much higher rates.⁷

Political instability, which is concentrated in low-income and middle-income areas, has not been widely examined as a contributing cause of road traffic crashes.⁸ Political instability focuses power and wealth disproportionately and leads to erosion of infrastructure. Road infrastructure may be particularly vulnerable during wartime, when fighting can directly destroy roadways, economic stress can decrease road development and maintenance, and lack of law and order can alter traffic patterns and decimate efforts at traffic safety enforcement.

We examine trends in road traffic crashes, injuries, and fatalities in the Autonomous Province (AP) of Vojvodina, which is the most

developed part of the Republic of Serbia. It is the most northerly province of Serbia covering 21 506 km² west of Romania, east of Croatia, south of Hungary, and north of Bosnia and Herzegovina and Serbia proper (Serbia outside of Vojvodina). It has just over 2 million inhabitants from various ethnic backgrounds and is an important thoroughfare through Central Europe for transportation by both water and road.

Although it was one of most prosperous regions in the former Yugoslavia, war and international economic sanctions have greatly influenced AP Vojvodina. The civil war that led to the break up of former Yugoslavia began in 1991 and ended in 1995, with ongoing military operations by NATO lasting through 1999. In 1999, a NATO bombardment damaged most of the bridges in the region. Economic sanctions affected the Federal Republic of Yugoslavia (including AP Vojvodina) from 1992 until 2001. This period was associated with an ongoing influx of refugees, out-migration of residents, active internal and external war, and country-wide economic sanctions.

During this period, investment in roads plummeted. Total investments in road infrastructure fell from 100.7 million German marks (US\$31.9 million) in 1985 to just 8.7 million (US\$5.4 million) in 1993.⁹ In 1985, the region rehabilitated 81.0 km of road and built 22.4 km of new roadways, compared with just 1.0 km rehabilitated and 2.3 km newly built in 1993.⁹ AP Vojvodina's roadways have international significance. For example, the shortest route by road from Central Europe to the Middle East and from Eastern Europe to the Adriatic Sea passes through this region.¹⁰

Beginning in 2002, AP Vojvodina started to gain increasing autonomy and to focus on safety and infrastructure. Also, new legislation to penalize drivers not wearing seat belts was introduced in 2002,¹¹ and the number of registered motor vehicles increased by 89% from 1980 to 2001.¹² The aim of this study was to explore the epidemiology of road traffic crashes in AP Vojvodina from 1996 through 2005, focusing on the severity of motor vehicle crashes.

METHODS

Study population and data

Road traffic crashes, injuries, and fatalities were examined ecologically from 1996 through 2005. Three major periods were examined: 1996 through 1999 were years with both economic sanctions and military activity; 2000–2001 were years under international economic sanctions but with no military activity; 2002–2005 was a period with neither military activity nor economic sanctions.

Data are from the Ministry of Internal Affairs of the Republic of Serbia, which maintains reports of road traffic crashes. Reports are filed for all crashes reported to the police, and reports are filled out by police at the scene of the crash. Police are required by law to respond to crashes that result in injury, heavy vehicle damage, or when a driver requests a response. Police must file a mandatory report. As with most crash reporting systems, many minor crashes may not be reported to the police.

No studies have evaluated the completeness, validity, or accuracy of crash reports. However, all variables used for this study had fewer than 3% missing responses. This reporting system is the most comprehensive source of information about road crashes and injuries. The Republican Institute for Statistics collects medical information on all hospitalizations and deaths, including external cause-of-injury codes. However, these reports are collected in aggregate form and only reported for fatalities. In 2004, the crash reporting system included a total of 266 road traffic deaths, whereas the medical data included only 218 deaths. As the medical data were provided in aggregate form, it was impossible to determine the proportion of cases that were in only one or both of the databases. This analysis included reports from the crash data because these data were more complete, included variables about the crash and its outcomes, and could be analyzed at the individual level.

Variables

Information about the crash included urban or rural location, time, whether or not alcohol was involved, and whether or not speeding was involved. Alcohol use was determined at the scene through a breath test conducted by the police. Permission to administer this test is not required. If this result is positive, health institutions are required to draw blood to determine alcohol level. Blood alcohol $\geq 0.05\%$ was considered positive. Speed was estimated by police officers at the scene using crash reconstruction formulas. The reporting officers determined if the estimated speed was a contributing factor to the crash.

Driver information included age, gender, and party (driver, passenger, pedestrian, or bicyclist). Severity of the crash was identified using the police variable that categorizes injuries as none, minor, major, or fatal. Fatal injuries included those resulting in death at the scene or at the hospital before discharge. An injury was reported as major if at least one of the following applied: it was life-threatening; a major organ was damaged or destroyed; a major organ was permanently or badly

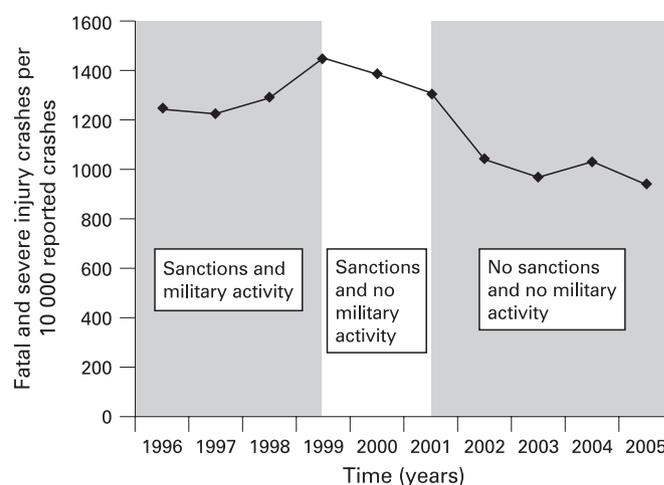


Figure 1 Fatal and severe crashes per 10 000 reported crashes, by year, Autonomous Province of Vojvodina, Republic of Serbia, 1996–2005.

damaged; emergency transport was required to a hospital. If an injury was present but did not meet these criteria, it was coded as minor.

Analysis

Rates were calculated for each study period using two separate denominators. Population-based rates were estimated using census counts from the 1991 and 2002 census estimates. The 1991 estimates were applied to the years 1996 through 2000, and 2002 estimates were applied from 2001 through 2005. No inter-year census estimates were available. Rates were also calculated using registered vehicles as a denominator, and annual estimates of registered vehicles were provided by the Ministry of the Interior.

Average annual rates for overall crashes, severe injury crashes, and fatal crashes were calculated for each of the study periods. Rate ratios and 95% confidence intervals were used to compare study periods, with the period from 2002 through 2005 (when there were neither sanctions nor military activity) used as the reference. Crash severity ratios were compared by year using the ratio of severe and fatal crashes to the number of overall crashes. Crash rates for severe and fatally injured victims were compared by year using population-based denominators. Crash characteristics were compared by period using χ^2 tests, with $p < 0.05$ considered significant.

Table 1 Total, severe injury, and fatal crashes by political period, Autonomous Province of Vojvodina, Republic of Serbia, 1996–2005

	1996–1999		2000–2001		2002–2005
	Number/rate	RR (95% CI)	Number/rate	RR (95% CI)	Number/rate
Total crashes					
Average annual number	15471	–	14399	–	16124
Average annual rate per 100 000 population	768.2	0.97 (0.96 to 0.98)	711.3	0.90 (0.87 to 0.93)	793.5
Average annual rate per 10 000 vehicles	295.2	0.94 (0.90 to 0.99)	302.6	0.96 (0.86 to 1.08)	313.6
Severe injury crashes					
Average annual number	1628	–	1603	–	1336
Average annual rate per 100 000 population	80.8	1.23 (1.19 to 1.27)	79.2	1.21 (1.16 to 1.27)	65.7
Average annual rate per 10 000 vehicles	31.1	1.20 (1.12 to 1.28)	33.7	1.30 (1.24 to 1.36)	26.0
Fatal injury crashes					
Average annual number	362	–	331	–	264
Average annual rate per 100 000 population	18.0	1.38 (1.28 to 1.49)	16.3	1.25 (1.13 to 1.38)	13.0
Average annual rate per 10 000 vehicles	6.89	1.34 (1.22 to 1.47)	6.94	1.35 (1.23 to 1.49)	5.15

1996–1999, sanctions and military activity; 2000–2001, sanctions but no military activity; 2002–2005, no sanctions and no military activity (reference period).

RESULTS

Crash rates

Crash rates were highest during the period with no sanctions and no military activity (table 1). From 1996 through 1999, a period in which there were both economic sanctions and military activity, there was an annual average crash rate of 768.2 per 100 000 population and 295.2 per 10 000 registered vehicles (table 1). The crash rate fell to 711.3 per 100 000 population in the next period with sanctions but no military activity, and then increased to 793.5 per 100 000 population in the period that had neither economic sanctions nor military activity. Compared with the period with neither sanctions nor military activity, the population-based rate ratio for the period with sanctions and military activity was 0.97 (95% CI 0.96 to 0.98), indicating that crashes were 3% lower. For the period with sanctions but no military activity, the rate ratio was 0.90 (95% CI 0.87 to 0.93). Trends based on registered vehicles were similar.

In contrast with the trends for overall crashes, severe injury and fatal crash rates were higher in periods with sanctions and military activity. Compared with the period with neither sanctions nor military activity, severe injury crashes were 1.23 times more common (95% CI 1.19 to 1.27) during the period with sanctions and military activity and 1.21 (95% CI 1.16 to 1.27) times more common during the period with sanctions but no military activity.

Fatalities showed a stronger trend, with an increased risk ratio of 1.38 (95% CI 1.28 to 1.49) during the period with sanctions and military activity and 1.25 (95% CI 1.13 to 1.38) during the period with sanctions and no military activity. These trends were similar for rates measured per 10 000 registered vehicles.

Crash severity

Crash severity was measured as fatal and severe injury crashes per 10 000 reported crashes (fig 1). From 1996 through 1998, there were about 1200 severe and fatal injury crashes per 10 000 crashes. Crash severity peaked at over 1400 fatal and severe

injury crashes per 10 000 crashes in 1999, during the NATO bombardment, and remained high until 2001. After the end of sanctions and military action, crash severity decreased to about 1000.

Characteristics of fatal and severe injury victims of road traffic crashes

Fatal and severe injury crash rates were nearly 2.4 times higher for males than females in all time periods (table 2). For both sexes, rates of injury crashes were more than 1.2 times higher in periods of sanction and/or military activity than in the period with no sanctions or military activity.

For all time periods, severe injury crash rates were lowest for those aged 0–14 and highest for the age group 15–24. After the age of 24, rates by age group steadily declined until the age of 64, then increased for those aged 65 and above. The period with sanctions and military activity had the highest rates for all ages.

The highest severe injury crash rates for each period were for vehicle drivers, followed by vehicle passengers, pedestrians, and bicyclists. Severe injury crash rates were significantly higher for all crash victims when comparing the period with both sanctions and military activity with the period with neither. However, severe injury crash rates for motor vehicle drivers were not significantly different, and rate ratios for pedestrians, bicyclists, and pedestrians were significantly higher during both comparison periods.

Crash characteristics

None of the crash characteristics showed significant trends by study period (table 3). For each period, ~20% of crashes occurred on rural roadways. Over 65% of the crashes occurred from 13:00 to 24:00, and only ~10% of crashes occurred between 00:00 and 06:00. Alcohol was involved in 7.4% of crashes during the period with sanctions and military activity, 6.3% during the period with sanctions and no military activity, and 6.7% in the period with neither activity. These differences were not significant. Speeding was involved in over 40% of crashes in all periods.

Table 2 Severe injury and fatal road traffic crash rates by victim characteristics and sanction period, Autonomous Province of Vojvodina, Republic of Serbia, 1996–2005

Characteristic	1996–1999			2000–2001			2002–2005		
	Average annual number	Average annual rate per 100 000 population	RR (95% CI)	Average annual number	Average annual rate per 100 000 population	RR (95% CI)	Average annual number	Average annual rate per 100 000 population	
Gender									
Male	1456	147.8	1.26 (1.18 to 1.34)	1411	143.2	1.22 (1.14 to 1.30)	1156	117.4	
Female	626	59.8	1.25 (1.13 to 1.37)	646	58.7	1.23 (1.11 to 1.35)	500	47.8	
Age									
0–14	148	147.5	1.30 (1.06 to 1.54)	122	121.5	1.07 (0.81 to 1.33)	114	113.7	
15–24	416	415.7	1.15 (1.01 to 1.29)	417	416.5	1.15 (1.01 to 1.29)	326	362.2	
25–34	328	328.2	1.24 (1.08 to 1.40)	307	306.0	1.15 (0.99 to 1.31)	266	265.7	
35–44	348	348.2	1.55 (1.38 to 1.72)	288	288.0	1.26 (1.09 to 1.43)	224	224.0	
45–54	306	306.1	1.08 (0.92 to 1.24)	367	367.0	1.30 (1.15 to 1.45)	283	283.0	
55–64	252	251.7	1.35 (1.16 to 1.54)	223	222.5	1.19 (1.00 to 1.38)	187	187.0	
65+	285	284.5	1.11 (0.94 to 1.28)	304	304.0	1.19 (1.02 to 1.36)	257	256.5	
Crash party									
Driver	742	36.8	1.19 (1.08 to 1.30)	623	30.8	1.00 (0.89 to 1.11)	628	30.9	
Passenger	579	28.8	1.29 (1.17 to 1.41)	532	26.3	1.17 (1.04 to 1.30)	455	22.4	
Bicyclist	351	17.4	1.26 (1.10 to 1.42)	339	16.7	1.21 (1.05 to 1.27)	281	13.8	
Pedestrian	409	20.3	1.19 (1.05 to 1.33)	405	20.0	1.18 (1.04 to 1.32)	345	17.0	

1996–1999, sanctions and military activity; 2000–2001, sanctions but no military activity; 2002–2005, no sanctions and no military activity (reference period).

Table 3 Road traffic crashes with injuries and fatalities, by sanction period, Autonomous Province of Vojvodina, Republic of Serbia, 1996–2005

	1996–1999	2000–2001	2002–2005
Location			
Urban	3110 (76.8)	3356 (79.8)	3149 (79.2)
Rural	939 (23.2)*	847 (20.1)*	827 (20.8)*
Time†			
00:00–06:59	470 (11.9)	527 (12.9)	507 (13.1)
07:00–12:59	853 (21.6)	843 (20.6)	816 (21.1)
13:00–18:59	1350 (34.2)	1385 (33.9)	1326 (34.3)
19:00–23:59	1271 (32.2)	1335 (32.6)	1221 (31.6)
Alcohol involved			
Yes	298 (7.4)	294 (6.3)	268 (6.7)
No	3752 (92.6)	4358 (93.7)	3708 (93.3)
Speeding involved			
Yes	1707 (42.1)	1797 (43.5)	1704 (42.9)
No	2343 (57.9)	2336 (56.5)	2272 (57.1)

Values are number (%). 1996–1999, sanctions and military activity; 2000–2001, sanctions but no military activity; 2002–2005, no sanctions and no military activity.

*Significantly different from urban, $p < 0.05$.

†Only crashes with reported time of crash included.

DISCUSSION

Throughout this study period, the European Union experienced a significant decrease in crashes and crash fatalities that was not found in AP Vojvodina. AP Vojvodina experienced a slight increase in crash rates after 2001, which coincided with the end of military activity and international sanctions.¹³ Increases in overall crashes may be due to increased vehicle miles traveled that resulted from the ending of war activity, lifting of curfews, increases in new registered vehicles after implementation of more liberal import policies for international vehicles in 2000, and an improved standard of living.⁹ Vehicle miles were not available for analysis.

In contrast, crashes that caused fatal and severe injury were significantly higher during periods with sanctions and/or military activity. These trends were found using two different denominators: population and registered vehicles. Information using vehicle miles traveled would probably result in even greater differences by period. For example, the NATO bombardment in 1999 almost completely stopped road traffic for 3 months and led to significant roadway damage, but that year also had the highest ratio of severe and fatal crashes to overall crashes.

Our data suggest that vehicle travel for drivers, passengers, bicyclists, and pedestrians became safer after the end of military activity and economic sanctions. These findings are consistent with research conducted in Israel during the first Gulf War, when decreases in traffic injuries during a period of missile attacks and curfews were offset by an increase in the case fatality rate.⁸ During war operations, severe crashes may be associated directly with political instability because of the loss of general law and order and indirectly with severe crashes because of reduced traffic safety controls and war damage to road infrastructures. Deaths may also have increased because of pressure on emergency medical services from war activity. For example, limited access to fuel because of sanctions and damage to roads made transportation of injured people difficult. After the war, several factors may have contributed to decreases in severe crashes. New legislation introduced in 2002 required seat belt use, and an increased presence of traffic enforcement police probably contributed to enforcement of the new legislation. The increase in newer vehicles with modern safety standards may also have contributed to the reductions in severe injury.

Several trends in these data are similar to those previously reported for other populations. For example, crash rates were higher for males than females, and less experienced drivers were the most common victims of road traffic crashes.^{14–18} Of all road users, crash fatality and injury rates were highest among vehicle occupants, which is similar to trends throughout the European Union.^{15–19} Results for pedestrian fatalities and injuries were similar to those for the European Union, but lower than reported in many low-income and middle-income countries where pedestrians are often the most vulnerable road users.^{14–15–20–21} However, bicyclists represented a far higher proportion of injured road users in AP Vojvodina (14.5%) than in the European Union (4.5%).¹⁵ One explanation is the frequent use of bicycles in AP Vojvodina for transportation between towns, on narrow roadways, and by all ages including the very old. Special bicycle tracks are very rare, existing in only a few of the largest cities, and many of these are in very poor condition. Helmet use by bicyclists, which is not mandatory, is extremely rare.^{22–23} Efforts to improve conditions for traveling by bicycle and to increase helmet use need to be a priority for the region.

Rural roads accounted for nearly a quarter of all crashes. Agriculture is one of the leading economic sectors in AP Vojvodina. Agricultural vehicles are often present on the roads, both local and major, and these large, slow-moving vehicles represent a crash hazard.²⁴

Several limitations are important to note. Our study is ecological in that individual road traffic crashes cannot be tied directly or indirectly to political activity or its resulting damage. Road traffic crashes included only those reported to law enforcement agencies. Although the system for reporting and responding to traffic crashes did not change during the political periods, it is difficult to know to what extent the changing environment affected reporting.

Two denominators were used for rate calculations: population and number of registered vehicles. The population changed dramatically during the political periods, with migration both out of and into the area. Census estimates may not accurately reflect these population shifts. The denominator, number of registered vehicles, excludes an unknown number of unregistered and foreign vehicles, and crashes of these vehicles were in the numerator. During the period of international sanctions, many refugees coming to AP Vojvodina had vehicles registered in Croatia and Bosnia and Herzegovina because legislation for vehicle registration in these countries was less restrictive. Although both denominators have uncertainty, the agreement found between them adds confidence to our findings. Because rate estimates were population based and not sampled, the confidence intervals around the rate ratios are very narrow. These confidence intervals do not incorporate uncertainty in the measurements of the denominators themselves, and thus may not accurately reflect the error in the effect estimates.

These findings suggest that political unrest may be related to increased severity of road traffic crashes. Road traffic safety needs to be a public health priority during both periods of political unrest and its recovery phase. Large social and economic changes occurred and are ongoing in AP Vojvodina after the war, including increases in vehicle ownership and traffic density. These trends may pose a long-term road traffic safety problem if engineering, legislative, and educational prevention approaches are left unaddressed. Serbian public health institutions can play a vital role in recognizing, and educating about, the need to improve road and vehicle design, as well as the role of human factors in crash risk.^{25–26}

Key points

- ▶ Although there is considerable research on the epidemiology of road traffic crashes, most is from high-income countries. Much less is known about road traffic crashes in low-income and middle-income countries, and this is the first study to examine road traffic crash severity in Serbia.
- ▶ Political instability and associated economic sanctions can have damaging effects on road infrastructures. However, political unrest has not previously been examined as an important factor in road safety trends.
- ▶ In Vojvodina, Serbia, road traffic crashes overall increased over time, as war ended, economic sanctions were lifted, and the region experienced increased governmental autonomy. However, crashes leading to severe and fatal injury were highest during periods of war and economic sanctions.
- ▶ This study suggests that periods of political unrest and imposed economic sanctions may increase the severity of road traffic crashes.
- ▶ Future research should further investigate the role of political instability in road traffic safety and identify the best interventions to address these issues.

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