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Safety and Security in Traffic
Preliminary Communication
Accepted: Feb. 11, 2012
Approved: Mar. 13, 2013

ASSESSMENT OF TRAFFIC SAFETY AMONG YOUNG PEOPLE AGED 15 TO 24 IN SLOVENIA

ABSTRACT

The probability that an individual will be involved in a car accident is relatively high. Traffic safety is a global problem, and Slovenia is no exception. Despite the large improvement in traffic safety records, Slovenia still ranks very low on the European level with 63 fatalities per million inhabitants. The paper analyses the official data on traffic accidents in Slovenia in the period from 1999 to 2011. The paper presents an overview of road safety in Slovenia with emphasis on the participation of young people in severe accidents. It has been examined whether young people in Slovenia are the most dangerous and at the same time the most vulnerable category of road users and the causes of road accidents involving young people have been compared with the causes of accidents involving overall population.

KEY WORDS

road traffic safety, traffic accident, young people, fatality, traffic accident data analysis, data mining

1. INTRODUCTION

Road traffic accident is an accident on a public road or on non-classified road that is used as public transport infrastructure, in which at least one moving vehicle has been involved and material damage or injury or death has occurred [1]. The consequences of traffic accidents can be property damage, personal injury, or death, resulting in undesirable consequences for individuals, society, and the economy.

Road traffic accidents are the major cause of death of young people; in fact, road traffic injuries cause an estimated 700 [2] to 1,000 young people [3] to die every day. The World Health Organization (WHO) has predicted that road traffic injuries will have risen to become the fifth leading cause of death of the entire population by 2030, being responsible for 3.6% of losses yearly [4]. Nowadays, over 1.2 million people die each year on the roads across the world, and between 20 and 50 million suffer non-fatal injuries [4]. Traffic safety improvement is a global problem; none of the worldwide countries is immune to traffic accidents, although majority of road deaths occur in low-income and middle-income countries.

More than 30,000 accidents, among which around 7,200 are injury accidents, occur in Slovenia every year. These accidents take around 130 lives (around 63 per million inhabitants) per year and leave more than 800 people seriously injured (around 390 per million inhabitants), thus causing significant external costs. The strategic goals are the reduction of the number of fatalities to 35 per million inhabitants and the reduction of seriously injured to 210 per million inhabitants by the year 2021 [5].

Traffic accidents occur due to many factors such as human behaviour, drivers' skills, weather, vehicle or road condition, etc. It is necessary to determine the prevalence of factors or combination of factors in order to assess the adopted measures and to suggest new countermeasures that would eventually improve the safety records.

The paper has two objectives; first, to provide an overview of road accidents in Slovenia and then to focus on the involvement of the youth and young adults, that is young people aged from 15 to 24 years, in severe road accidents in Slovenia. We will establish patterns of traffic accidents and look for differences in this segment of the population with regard to the total population. Consequently, three hypotheses can be set:

- *H1: Young people aged 15 to 24 are the most dangerous category of road users in Slovenia.*
- *H2: The causes of traffic accidents of young people aged 15 to 24 differ from the causes of traffic accidents of adults.*
- *H3: Young people aged 15 to 24 represent the most vulnerable category of road users in Slovenia.*

To achieve the objectives and to test the hypotheses almost one million safety data records provided by the Slovenian police have been analysed.

2. LITERATURE REVIEW

Road safety is an important aspect of transportation system; therefore, the analysis of traffic accidents must be included in transport planning. The methods of traffic safety analysis have evolved over time, and the methods used for the analysis depend mostly on data availability.

One of the commonly used approaches is data mining. Applying data mining techniques can help in understanding the characteristics of drivers' behaviour, roadway conditions, and weather conditions that were causally connected with different injury severity [6].

In addition, logistic regression models are often used to identify statistically significant factors that predict the probabilities of diversely severe crashes [e.g. 7, 8].

A multivariate logistic regression can also be applied in traffic safety analysis in order to determine a formula that can describe how elements in a vector of variables respond simultaneously to changes in others [e.g. 9].

Geographic Information System (GIS) is commonly used for spatial analysis and visualization of traffic accidents. As such, it is an important tool for traffic safety assessment, management and accident prevention, and it is particularly useful to trace the black spots on road networks; however, this is not the subject of our survey.

Young drivers: The road to safety [10], *Youth and road safety* [3] and *Youth and road safety in Europe* [11] are three very comprehensive studies that address the problem of children and youth in transport. Several studies concerning traffic safety on the national level have so far been done in Slovenia, but none of them has focused solely on young people in transport. The Slovenian National Institute of Public Health is participating in the on-going multi-year initiative called *Tools to Address Childhood Trauma, Injury and Children's Safety* [12]. The traffic injuries form just one segment of this research, which focuses on children aged from 0 to 19 years. A study on *External costs of transport* [13] provides good guidance for our work and gives the basis for data comparison for the year 2002. A broad descriptive statistics for the period from 2003 to 2007 can be found in a study entitled *The quantitative analysis of road safety* [14]. A step forward has been provided in the study entitled *Factors of road safety in Slovenia* [15] in which the descriptive statistics is accompanied by linear and logistic regression forecasting. Many other studies deal with traffic safety on the micro level.

3. DATA AND METHODS

Slovenia has a long tradition of traffic accident data collection; the first records on traffic accidents date back to early 1950s. The original, modest, data set was later on expanded to give a better picture on the incidence. Today, the Slovenian statistical yearbook provides only superficial data on traffic accidents; however, detailed data on traffic accidents since 1995 can be acquired from the Slovenian police website [16].

The Slovenian police provides two separate yearly databases, one on traffic accidents, and one on people involved in these accidents. The case number links these two databases together. In the course of time some of the descriptive variables were left out (e.g. age of the participants was originally presented in years and months and later only in years; time of accident initially included minutes, etc.) and more variables were introduced and announced; however, not all of them have yet been incorporated into the databases.

After the data unification, the preliminary data analysis was performed, which showed irremediable inconsistency in reporting road category in data covering the period from 1995 to 1998, thus preventing reliable conduct of analysis for the entire period, that is, from 1995 to 2011. For this reason, the analysis was narrowed to the period from 1999 to 2011. Although the inconsistency remained present in 139 records, this did not affect the results.

As the research deals with traffic safety on the national level, certain variables were left out, for example, code of road sections and locations or dwelling place code of the participants. Certain variables were computed in order to carry out the analysis (e.g. day code, month and year were extracted from the date; many dummy variables were created and then aggregated, etc.) and some variables were changed from scale to category values (e.g. age of the participants).

The description of the basic variables used in this research is presented in *Table 1*.

Table 1 - Description of basic variables in datasets for the period from 1999 to 2011

Traffic accidents		Participants in traffic accidents	
Variable	Missing data	Variable	Missing data
Injury type	0	Accident inducer	1,129
Date	0	Age	1,490
Administrative unit	19	Sex	1,142
Road category	0	Citizenship	4,930
Cause	0	Injury	10,548
Type of accident	0	Role	0
Description of accident	0	Driving experience	207,572**
Weather condition	0	Alco test	240,756**
Traffic density	0	Additional test	478,023**
Roadway condition	0		
Roadway surface*	0		

Note:
** - due to data harmonization asphalt is treated uniformly and not in three different states as described in certain ciphers, namely coarse, rough and smoothed*
*** - this is expected, as these variables do not apply to all participants*
Source: Authors, based on [16]

SPSS 17 was used to perform the analysis and discover the dependences in the Slovenian traffic safety data. This was done through clustering and dependency modelling. As Slovenian datasets on traffic accidents and participants consist of very limited number of variables, namely 19 and 12 variables respectively, there was no particular need to apply any variable ranking technique. Just for the sake of curiosity, the Critical Analysis Reporting Environment (CARE) database in Alabama contains 228 categorical variables and each variable contains attribute values varying from two to more than 600 [17].

The available datasets impose some survey limitations, as there is no distinction between different categories of freight vehicles, and there is no information in which vehicle the passengers involved in the accident were travelling.

The Slovenian police manages an upgraded database on traffic accidents that includes the coordinates of the site of accident and is as such more adequate for GIS analysis. In fact, the database is in shapefile SHP format (geospatial vector data format for geographic information systems software), which is standard file format of ESRI (a company founded in 1969) nowadays, the world leading GIS tools developer. However, this database is less accurate than the datasets that were used in the research since the data must be filled in within 15 days of the occurrence while the law imposes to register all the losses that occurred in the period of 30 days after the incidence and are direct consequence of the traffic accident.

The present analysis is based on the official police statistics. These data do not include losses that occurred due to driver or passenger's sudden cardiac arrest or cease in cerebral functions that caused the traffic accident or occurred during the accident. In 2010 seventeen such cases were left out of the official statistics [18].

4. ANALYSIS

As can be seen from *Figure 1*, the Slovenian traffic safety records have improved in recent decades; however, on the European level Slovenia is still achieving relatively poor results with around 63 fatalities per million inhabitants. Between 1970 and 2010, the number of fatalities decreased by almost 80% while distances travelled were multiplied nearly fivefold [19].

4.1. Basic findings

During the analysed period, that is, from 1999 to 2011 the number of fatalities decreased by approximately 60%, while the number of injury accidents remained almost unchanged, but with a significant increase recorded at the beginning of new millennium and reaching the peak in 2004. It is impossible to explain the extent of increase in the number of injury accidents solely by the changes in traffic flows. Actually, the correlation coefficients between these variables are rather small and statistically insignificant, at least at the given data accuracy. A decline in the number of accidents visible in 2005 is probably due to the introduction of harsher penalties for offenders of road transport regulations. However, the history proved such measures have only a short-term impact (similar measure was implemented in 1974 and 1998).

Altogether, there are more than 526 thousand records on accidents and more than 942 thousand re-

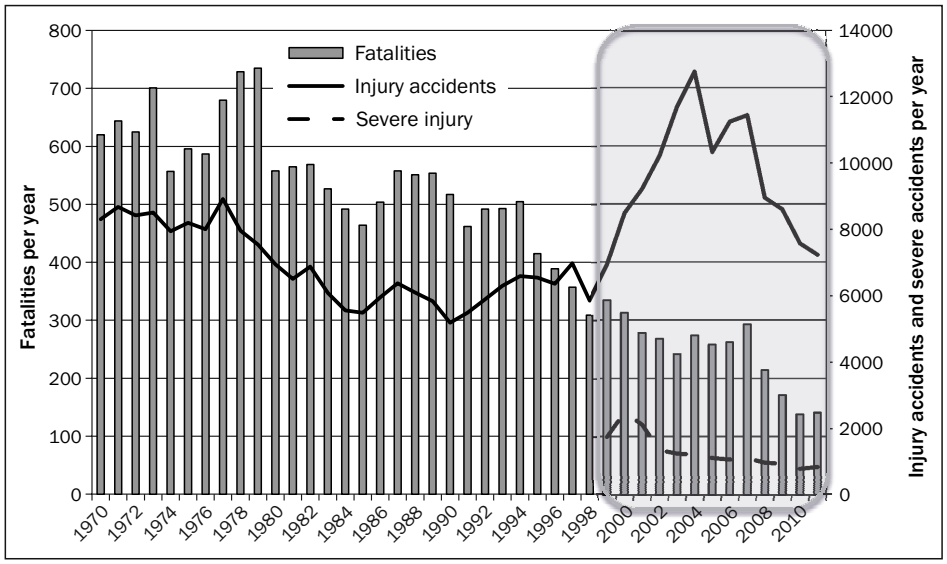


Figure 1 - Traffic safety records in Slovenia

Source: Authors, based on [20] and [16]

cords on participants in those accidents in the analysed period.

A vast majority of accidents occur in the built-up areas with or without street system, 48.5% and 12.1% respectively, and thus somewhat expectedly almost 80% of incidents result only in material damage and another 16.5% end up in minor injuries. Most of these minor accidents occur due to the irregular movement of the vehicle (32.6%), driving in the wrong direction (13.5%), speed (12.1%), and violation of priority rules (9.9%).

We categorized participants into 8 age groups, that is, under 15, 15 to 24, 25 to 34, 35 to 44, 45 to 54, 55 to 64, 65 to 74 and above 75. Similar age grouping is used in various studies; however, we modified the group of youth and young adults to include all legal motorbike riders into our group of interest. The participation of different age groups in accidents follows normal distribution (the risk to reject this statement while it is true is 93.3%). People aged 25 to 34 and 15 to 24 participate most frequently in the traffic accidents, with the share of 26.2% and 22.5%, respectively.

In a 12-year period, 2,888 accidents resulting in death of 3,188 people occurred; 45% of victims were not the inducers of accident. In addition, 16,827 accidents resulted in serious injuries of 19,588 people.

Causes of accidents are given in *Figure 2*. This is accompanied by the connection of accident cause with the severity of accidents and the number of people involved in such accidents. For example, irregular movement is the main cause of accidents in general; however, these accidents are rarely severe or fatal. On the other hand, overspeeding caused around 16% of accidents in total, but 43.5% of fatal accidents and 36.8% of severe accidents were triggered by excessive speed.

Male persons are involved in accidents 3.3 times more frequently than females. The ratio gets even worse in the number of fatalities; it is 3.7. From *Figure 3* it can be seen that this ratio is pretty constant, with certain years not following the symmetric path (e.g. 2002, 2005 or 2011).

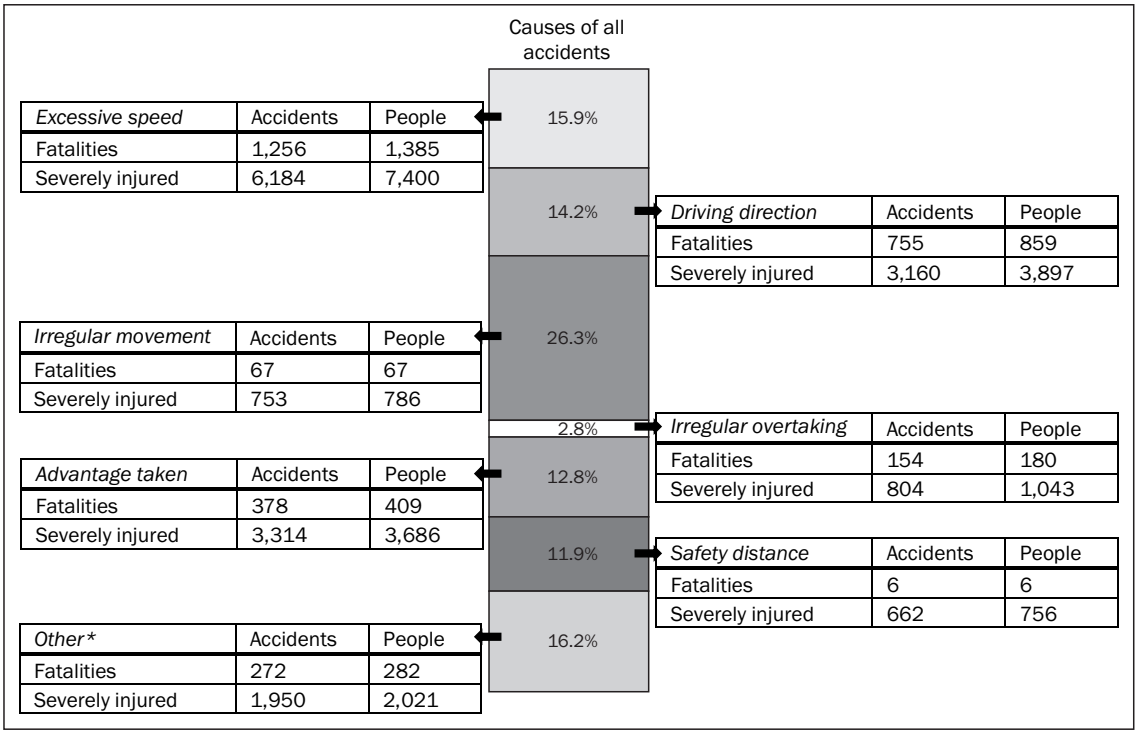
The number of accidents in which the inducer is under the influence of alcohol has been declining. Nevertheless, alcohol is still present in traffic and it is causing many losses; almost 30% of fatalities can be attributed to alcohol as the inducer of accident had blood alcohol content exceeding 0.5‰. However, less than half of the victims were the inducers of accidents themselves. Another 3,684 people were severely injured in accidents involving alcohol.

4.2. Young drivers in traffic

Young drivers and riders are perceived as a risky category in traffic due to driving inexperience, dynamic lifestyle, age and condition of the vehicle, tendency to undergo peer influence, greater propensity to take risks, overestimation of abilities, etc. For these reasons, the following hypotheses were formed:

- *H1: Young people aged 15 to 24 are the most dangerous category of road users in Slovenia.*
- *H2: The causes of traffic accidents of young people aged 15 to 24 differ from the causes of traffic accidents of adults.*
- *H3: Young people aged 15 to 24 are the most vulnerable category of road users in Slovenia.*

Young people aged 15 to 24 are involved in traffic accidents very frequently; in fact only people aged 25 to 34 are more frequent participants in accidents. However, this age group represents 14.5% of the Slovenian population, while the age group 15 to 24 rep-



Excessive speed	Accidents	People
Fatalities	1,256	1,385
Severely injured	6,184	7,400

Driving direction	Accidents	People
Fatalities	755	859
Severely injured	3,160	3,897

Irregular movement	Accidents	People
Fatalities	67	67
Severely injured	753	786

Irregular overtaking	Accidents	People
Fatalities	154	180
Severely injured	804	1,043

Advantage taken	Accidents	People
Fatalities	378	409
Severely injured	3,314	3,686

Safety distance	Accidents	People
Fatalities	6	6
Severely injured	662	756

*Other**	Accidents	People
Fatalities	272	282
Severely injured	1,950	2,021

Figure 2 - Causes of fatal and severe accidents as well as total accidents

*Note: *Other includes irregularities on the road, irregularities in the cargo, and irregularities in the vehicle, mistake of the pedestrian and undefined causes; the chart represents the causes of all accidents while the tables indicate the number of fatal and severe accidents as well as number of fatalities and severely injured people*
Source: Authors, based on [16]

resents barely 10.9% [21]. Considering this, we come to the coefficients of frequency of participation in road accidents of 1.81 and 2.06 meaning that people aged 15 to 24 (here also after young people) are in relative terms the most frequent participants in traffic accidents in Slovenia.

More than 75% of young people involved in accidents are actually young drivers. Additional 9.2% are passengers.

Figure 4 shows the distribution of accidents provoked by certain age group. In addition it shows the number of people involved in these accidents and among them the number of fatalities and severely injured. From *Figure 4* it is thus possible to state that young people are the most dangerous of all road traffic participants, in fact, young drives cause more accidents with fatal consequences and severe injuries than any other age group of participants in traffic.

Young drivers cause fewer accidents in urban areas with street system, and more in settlements with no street system and on regional roads in comparison to total population. Altogether, they caused more than 115 thousand accidents with almost 210 thousand people being involved (see *Figure 3*). This resulted in 811 deaths, among which 547 of young people (but only 332 inducers), and almost 6,000 people seriously injured, among which more than 4,600 young people (but less than 2,600 inducers).

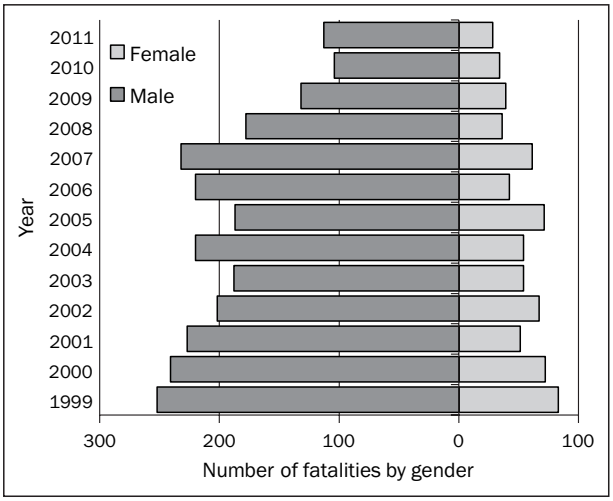


Figure 3 - Number of fatalities by gender

Source: Authors, based on [16]

Figure 5 shows that although young drivers pose threat to all participants in traffic, they are actually most dangerous to themselves, as the vast majority of young fatalities are provoked by young drivers.

Young people are more often perpetrators than victims in traffic as can be seen from *Figure 6*.

704 young people died and more than 5,500 were severely injured on Slovenian roads in the analysed period, but the situation is improving as can be seen from *Table 2*. The main purpose of *Table 2* is to show

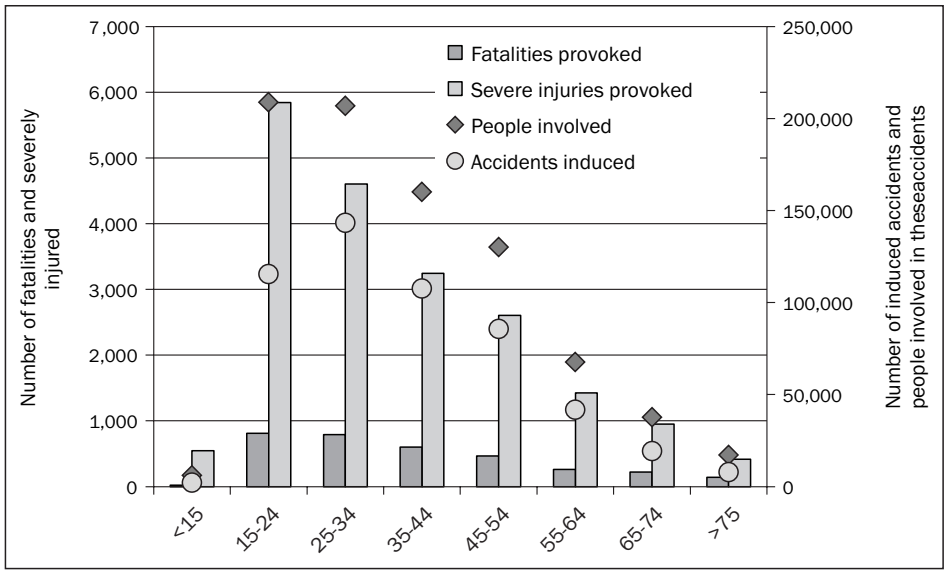


Figure 4 - Distribution of accidents by inducer's age group

Source: Authors, based on [16]

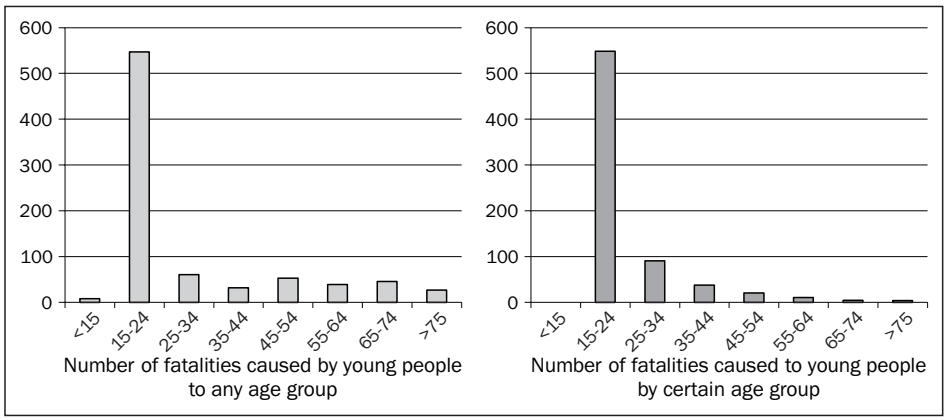


Figure 5 - Number of fatalities caused by young people and to young people
Source: Authors, based on [16]

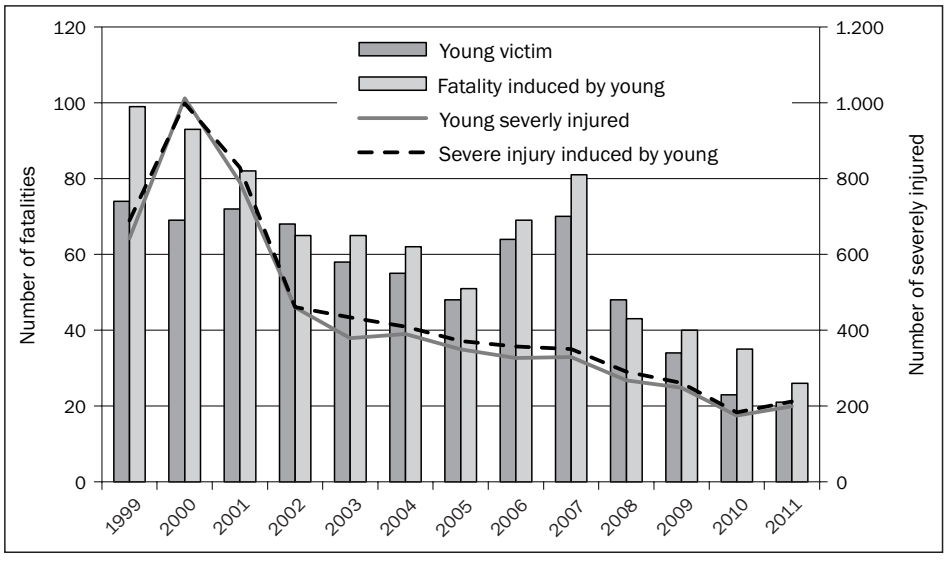


Figure 6 - Number of fatalities and severe injuries caused by young people and to young people

Source: Authors, based on [16]

Table 2 - Number of fatalities and severely injured by age group

	<15		15-24		25-34		35-44		45-54		55-64		65-74		>75		S	
	F	S	F	S	F	S	F	S	F	S	F	S	F	S	F	S	F	S
1999	12	184	74	642	45	400	52	292	47	216	38	144	32	132	35	64	335	2,074
2000	8	165	69	1012	51	686	39	422	52	327	39	186	34	135	21	62	313	2,995
2001	4	132	72	791	58	579	40	367	35	279	23	160	30	109	16	63	278	2,480
2002	3	98	68	460	47	314	27	212	48	199	29	123	32	100	15	55	269	1,561
2003	3	85	58	379	33	242	32	200	44	210	20	114	32	118	20	63	242	1,411
2004	9	93	55	390	49	248	43	195	45	177	24	130	26	92	23	71	274	1,396
2005	9	49	48	349	65	274	39	172	37	166	17	103	25	99	18	54	258	1,266
2006	9	74	64	327	56	220	46	186	33	166	21	107	19	83	14	57	262	1,220
2007	6	71	70	329	65	247	42	157	39	176	20	123	28	100	23	60	293	1,263
2008	4	54	48	268	36	199	39	143	30	163	23	108	12	98	22	70	214	1,103
2009	2	31	34	248	28	197	20	132	25	132	23	146	14	82	25	67	171	1,035
2010	2	44	23	175	22	158	21	139	20	122	19	99	13	69	18	59	138	865
2011	6	43	21	199	22	154	24	136	25	144	20	112	7	77	16	54	141	919
Sum	77	1,123	704	5,569	577	3,918	464	2,753	480	2,477	316	1,655	304	1,294	266	799	3,188	19,588
Share	2.4%	5.7%	22.1%	28.4%	18.1%	20.0%	14.6%	14.1%	15,1%	12.6%	9.9%	8.4%	9.5%	6.6%	8.3%	4.1%		
Pop. sh.	14.2%		11.0%		14.7%		14.7%		15.1%		13.7%		8.8%		7.8%			
Coef.	0.17	0.40	2.00	2.58	1.24	1.36	0.99	0.96	1.00	0.84	0.73	0.62	1.08	0.75	1.07	0.52		

Note: F – fatality, S – severe injury, Σ - sum; Pop. sh. – population share (2011H2);
Coef. – coefficient of fatality/severe injury frequency in regards to population share
Source: Authors, based on [16]

the coefficient of fatality/severe injury frequency in regards to population share. When averages are computed it is clear that young people are twice as much endangered than other participants in traffic.

Among young people, boys cause almost 80% of accidents, also almost 80% of participants in accidents involving young people are boys, subsequently the majority of losses among young people are boys.

The majority of accidents occur on weekends both in the entire population and in the segment of young people, but in the latter, this is more intensively manifested. Young people generally cause more accidents in the early morning and late evening hours; this is, of course, most visible on Saturdays and Sundays.

Similar to the entire population, young people cause the majority of accidents (including severe accidents) in favourable weather conditions and on dry roads. Consequently, the fewest serious accidents occur during the winter months.

Causes of accidents induced by young drivers differ somewhat from the causes in the entire population. As it can be seen from *Figure 7* excessive speed is the main cause of all kinds of accidents caused by young people, ranging from accidents resulting only in material damage to accidents resulting in severe injuries and fatalities.

Even though media campaigns against speeding are very common (e.g. “Hurry slowly” or “Speed – Thank you for not speeding”), excessive speed is still by far the most frequent reason of accidents caused by young drivers. It took 482 out of 811 lives in twelve years.

The evolution of causes of accidents and fatalities can be seen in *Figure 8*.

Young people caused 224 road deaths under the influence of alcohol. More than thousand people were severely injured in accidents in which the young inducer’s blood alcohol content exceeded 0.5‰. This share is similar to the entire population, that is, around 30%; however, novice drivers, that is, all drivers below the age of 21 and all drivers of motor vehicles during the period of two years from the first acquisition of the driving license, undergo more restrictive limits in terms of blood alcohol content. If these restrictions are taken into account, then the proportion of young drivers causing accident under the influence of alcohol increases significantly. Anyway, the presence of alcohol among young people has been decreasing in recent years; however, it is difficult to confirm the declining trend for the entire period under investigation.

The proportion of motorists involved in accidents is twice as high among young people in comparison to entire population. There were 85 young people who lost their lives on motorbikes when they caused an accident, and altogether 99 young people lost their lives on motorbikes.

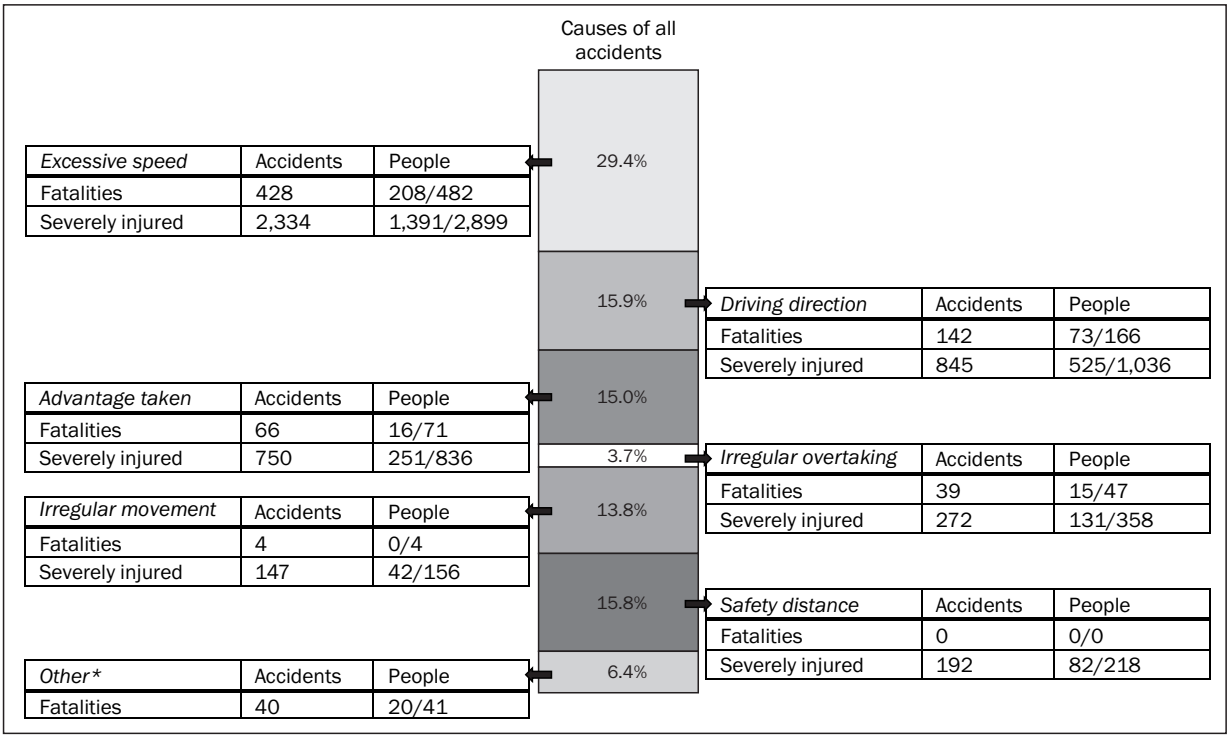


Figure 7 - Causes of accidents and their consequences when a young person caused the accident

*Note: *Other includes irregularities on the road, irregularities in the cargo, and irregularities in the vehicle, mistake of the pedestrian and undefined causes; the chart represents the causes of all accidents while the tables indicate the number of fatal and severe accidents as well as the number of fatalities and severely injured people; in the column People x/y; x – inducer, y – all victims*
Source: Authors, based on [16]

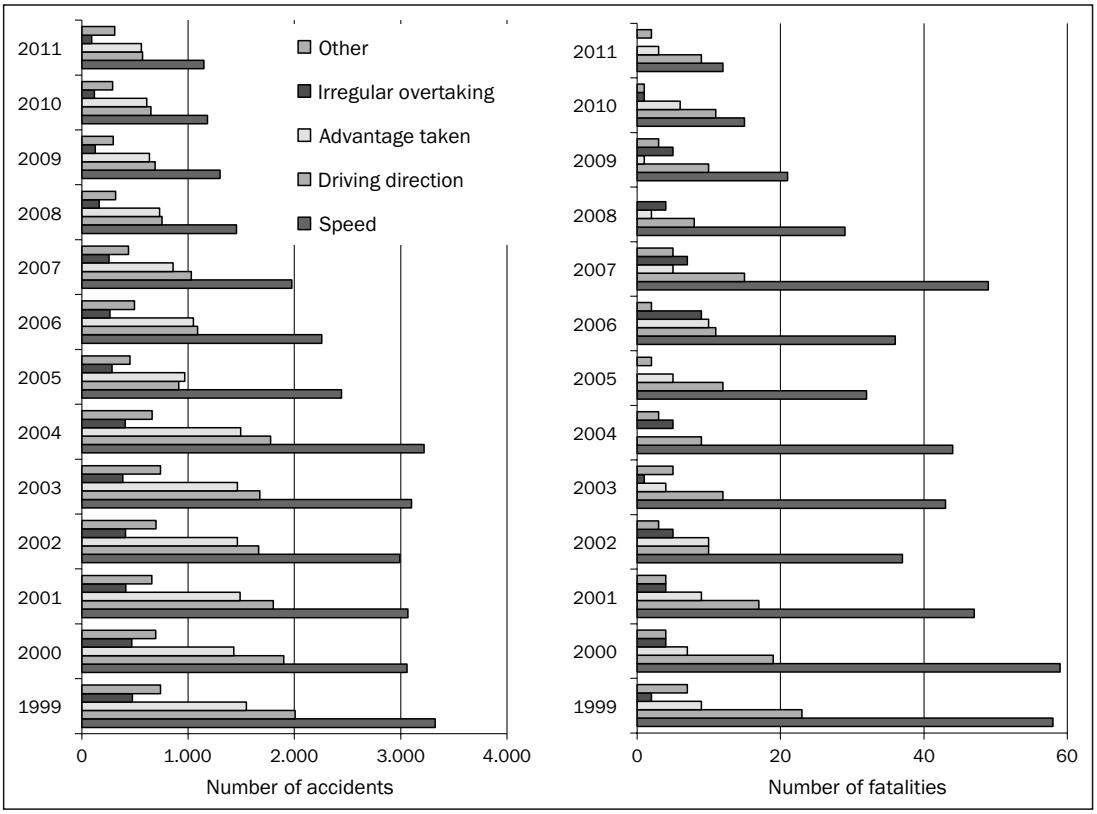


Figure 8 - Number of accidents and number of fatalities caused by young people; by year and cause

Source: Authors, based on [16]

5. DISCUSSION AND CONCLUSION

All set hypotheses have been confirmed; young people are the most dangerous and the most vulnerable segment of road users in Slovenia. The dominating causes of traffic accidents induced by young people are often closely related to their inexperience (on the average, young inducers of road accidents in Slovenia have less than 3 years of driving experience) and showing up with the peers, which is reflected in speeding and drink driving. It is clear that although stricter limitations apply to young and novice drivers in Slovenia with regard to alcohol use, these rules are often disobeyed.

The fact that young drivers induce fewer accidents in urban areas and more accidents in settlements with no street system and on regional roads can point out to the problem of inadequate public transport system which gives poor or even no alternative to personal car usage in suburbanized or rural areas in Slovenia.

Young people drive faster and in general less responsibly than older people do, but road safety among young people in Slovenia is improving as well. In fact, if the number of victims caused by young people is compared to the number of victims caused by others, then it is possible to see that the number of victims caused by young people is declining faster than the number of victims caused by any other age category; namely, 10.5% in comparison to 7%. The most visible progress was recorded in 2011 and maybe it might be attributed to the fact that since the fall 2010, novice drivers have had to pass additional training before obtaining the regular driving licence. This training consists of 12 hours of theoretical education and 6 hours of practical testing.

The fact is that good drivers are made, not born, and learning to drive safely takes time and needs extensive practice [10]. As the analysed data show, young participants on Slovenian roads actually pose the greatest threat to themselves and there is for sure some room left for improvement. The resolution of safety of young people in traffic demands a synchronised action, involving education (impact on transport culture as well as on general social values) and licensing process, strict law enforcement, prominent media campaigns and provision of public transportation.

It is thus impossible to adequately interpret the alternations in traffic safety trends without considering the broader aspect, which includes the revision of implemented transport policy measures and the analysis of traffic flows. Further work will therefore consist of quantifying the so far taken crash protection measures in Slovenia as well as of conducting a survey among the citizens which will help understand what generated the significant improvement of traffic safety. Special attention will be given to young people and survey questions for this segment of population will deeply rely on the study completed by Gharaibeh and Abdo [22]. In this way we expect to learn about their habits in traffic and possibly be able to propose certain combination of transport policy measures that should beneficially contribute to improvement of road safety among youngsters and of road safety in Slovenia in general.

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POVZETEK

OCENA CESTNE PROMETNE VARNOSTI MLADIH MED 15 IN 24 LETI V SLOVENIJI

Verjetnost, da doživimo prometno nesrečo je sorazmerno visoka. Prometna varnost je globalni problem in Slovenija ni izjema. Ne glede na veliko izboljšanje v preteklih letih, Slovenija v pogledu prometne varnosti s 63 smrtnimi žrtvami na milijon prebivalcev v evropskem merilu dosega zelo slabe rezultate.

Avtorji analizirajo podatke slovenske policije o prometnih nesrečah v Sloveniji v obdobju od leta 1999 do leta 2011. Predstavljen je splošen pregled prometne varnosti v Sloveniji, s poudarkom na udeležbi mladih ljudi v težkih prometnih nesrečah. Avtorji so preverili ali so mladi v Sloveniji najbolj nevarna in hkrati najbolj ranljiva kategorija udeležencev v prometu ter primerjali vzroke za prometne nesreče mladih z vzroki celotne populacije.

KLJUČNE BESEDE

cestno-prometna varnost, prometna nesreča, analiza podatkov o prometnih nesrečah, podatkovno rudarjenje

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