

THE IMPACT OF DOMINANT CENTRAL NERVOUS SYSTEM INJURIES ON THE SURVIVAL OF TRAFFIC ACCIDENT VICTIMS IN MONTENEGRO

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UTICAJ DOMINANTNIH POVREDA CENTRALNOG NERVOG SISTEMA NA PREŽIVLJAVANJE POVREĐENIH U SAOBRAĆAJU U CRNOJ GORI

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ABSTRACT

Objective. Road traffic accidents are one of ten leading causes of death worldwide. Every 23 seconds, one person is injured on the roads worldwide, which leads to significant consequences in terms of permanent disability for the injured and the burden on a country's healthcare system. The mortality rate in traffic accidents is the highest among people aged 14 to 19, where central nervous system (CNS) injuries are predominant. The aim of this study was to examine the trend of mortality and injury frequency in traffic accidents in Montenegro as a result of CNS injuries.

Methods. The research was designed as an observational case-control study. Participants in traffic accidents in Montenegro who sustained severe bodily injuries or fatal outcomes between 2011 and 2020 due to CNS injuries were selected. The "control" group consisted of individuals who survived the immediate period following their injuries.

Results. In our study, there were 90 male participants (75.4%) with an average age of 39.97 ± 17.72 years, and 30 female participants (24.6%) with an average age of 41.60 ± 21.09 years (Independent samples T test, $p=0.677$). The most common immediate cause of death was brain tissue injury, isolated brain contusions – *Laesio traumatica cerebri focalis* (*Contusio cerebri*). There was a statistically significant impact of the presence of combined injuries on the outcome of traffic accidents, with a fatal outcome being most common in cases of polytrauma.

Conclusion. Mortality in traffic accidents due to head injuries was most common in cases of polytrauma. To preventably address the mortality rate in traffic accidents in Montenegro, it is necessary to form an accessible network of trauma centers, especially those capable of treating CNS injuries.

Key words: public health; primary prevention; accidents, traffic; wounds and injuries; central nervous system.

SAŽETAK

Uvod. Saobraćajne nesreće su jedan od 10 uzroka smrti u svetu, a na putevima svake 23 sekunde strada jedna osoba, što ostavlja značajne posledice u smislu trajnog invaliditeta povređenih i posledica na račun opterećenja zdravstvenog sistema jedne zemlje. Smrtnost u saobraćaju je na prvom mestu kod populacije starosti od 14 do 19. godina gde na prvom mestu prednjače povrede CNS-a. Cilj ove studije bio je da se ispita trend učestalosti smrtno stradalih i povređenih u saobraćajnim nezgodama u Crnoj Gori od posledica povreda CNS-a.

Metode. Istraživanje je dizajnirano kao opservaciona studija slučaja. Uzorkovani su učesnici saobraćajnih nezgoda u Crnoj Gori kod kojih je došlo do teškog telesnog povređivanja ili smrtnog ishoda u periodu 2011–2020. godine od povreda CNS-a. Kontrolnu grupu činili su slučajevi koji su preživeli neposredni period nakon povređivanja.

Rezultati. U našem radu, kada je reč o polnoj distribuciji, bilo je 90 osoba muškog pola (75,4%) prosečne starosti $39,97 \pm 17,72$ godine i 30 osoba ženskog pola (24,6%) prosečne starosti $41,60 \pm 21,09$ godina (Independent samples T test, $p = 0,677$). Neposredni uzrok smrti najčešće su bile povrede moždanog tkiva, nagnječine mozga izolovano – *Laesio traumatica cerebri focalis* (*Contusio cerebri*). Postoji statistički značajan uticaj prisustva združenih povreda na ishod saobraćajnih nesreća u ispitivanoj populaciji – smrtni ishod bio je najčešći u slučaju politraume.

Zaključak. U saobraćajnim nezgodama u kategoriji povreda glave smrtnost je bila najčešća u slučaju politraume. Kako bi se preventabilno delovalo na stopu smrtnosti u saobraćajnim nezgodama u Crnoj Gori potrebno je formiranje dostupne mreže traumatoloških centara, a posebno onih u kojima se može zbrinuti povreda CNS-a.

Ključne reči: javno zdravlje; primarna prevencija; nesreće, saobraćaj; rane i povrede; centralni nervni sistem

INTRODUCTION

Road traffic accidents are one of ten leading causes of death worldwide. According to the World Health Organization (WHO) report for 2021, around 1.19 million people die in traffic accidents, with 15 deaths per 100,000 people globally (1, 2). Every 23 seconds, one person is injured on the roads, which leaves significant consequences in terms of permanent disability and places a burden on a country's healthcare system. Mortality due to traffic accidents is the highest in the 14-19 age group, with central nervous system (CNS) injuries being the most common (1, 2). Traffic mortality is the highest in adolescent populations and it is particularly high in countries with medium and low income (1-3). Alcohol consumption while driving is associated with speeding (3), not wearing helmets, and failing to wear seat belts, all of which significantly impair drivers' attention and cognitive functions (1, 2, 4, 5). Literature suggests that the leading cause of mortality due to traffic trauma worldwide is head and spinal cord injuries. Head injuries are more common among those who died within 1 to 6 days of hospitalization (6-8). Due to the mortality from head injuries and permanent disability, priority is given to reducing traffic-related mortality by addressing all potential preventable risk factors to decrease the mortality of individuals fatally injured in traffic accidents, particularly those with CNS injuries (9, 10).

Our study aimed to examine the trend in mortality and incidence of road traffic injuries in Montenegro due to CNS injuries, for the follow-up period from 2011 to 2020.

PATIENTS AND METHODS

The study was designed as an observational case-control study. The population for sampling consisted of all participants in traffic accidents in Montenegro who sustained severe bodily injuries or fatal outcomes due to brain injuries or related complications between 2011 and 2020. The "case" group consisted of individuals who died from injuries, and the "control" group consisted of those who survived the immediate post-injury period (who were transported alive to the hospital, treated, healed, or died from causes unrelated to the injury). The data source for this research was the medical records of the Clinical Center of Montenegro.

Inclusion Criteria: a) the subject sustained severe bodily injury (characterized according to forensic medical standards) with a possibility of survival (intracranial hematomas and hemorrhages – epidural/subdural hematoma, brain contusion, subarachnoid/intraventricular bleeding); b) the subject was treated in the hospital and discharged, or treated with a fatal outcome and subsequently autopsied. Exclusion Criteria: cases in which death was declared upon the arrival of medical assistance

at the scene (patients found at the scene without vital signs, and patients who did not regain spontaneous circulation after resuscitation at the scene).

Statistical Analysis. Chi-square (χ^2) tests were used to compare the differences in the frequency of categorical variables. Statistical significance was considered for results with probability less than 5% ($p < 0.05$). We examined the trend in the number of traffic accidents and deaths in Montenegro and t-test for independent samples. All statistical calculations were performed using the commercial software package SPSS, version 21.0.

The study was approved by the Ethical Committee of the Clinical Center of Montenegro, No. 03/02-12723/1, dated 04/06/2020. Data were used for research purposes and the preparation of a doctoral dissertation at the Faculty of Medical Sciences, University of Kragujevac, whose part is presented in this paper.

RESULTS

From 2011 to 2020, a total of 60,500 traffic accidents were registered in Montenegro, with 22,887 individuals injured, of which 578 (0.95%) died as a result of injuries. In the observed period, a downward trend in the number of traffic accidents was noted ($y = -241.25x + 7376.9$, $R^2 = 0.3405$). Compared to the starting year of observation, the absolute number of traffic accidents in 2020 decreased by 3,369. The highest number of traffic accidents occurred in the initial year of observation, 2011 (8,519 accidents), and the lowest in 2016 (4,944 accidents) (Figure 1). When considering fatalities in traffic accidents, a downward trend was also observed in the number of deaths ($y = 0.5333x + 60.73$, $R^2 = 0.0293$). The highest number of fatalities occurred in 2013 (74 deaths), and the lowest in 2012 (46 deaths) (Figure 2). Of the 122 participants with diagnosed head injuries, 91 (74.6%) died, and the remaining 31 (25.4%) survived.

The average age of participants in traffic accidents with head injuries was 40.37 ± 18.53 years (min 13, max 78 years). The average age of those who died was 41.71 ± 18.59 years, while the survivors averaged 36.42 ± 18.04 years (Independent samples T test, $p = 0.167$). There were 90 male participants (75.4%) with an average age of 39.97 ± 17.72 years, and 30 female participants (24.6%) with an average age of 41.60 ± 21.09 years (Independent samples T test, $p = 0.677$). The most common immediate cause of death was brain tissue injury, isolated brain contusions – Laesio traumatica cerebri focalis (Contusio cerebri) in 20 cases (13.3%) and in combination with hemorrhage under the brain's arachnoid membrane – Haemorrhagia subarachnoidalis traumatica in 23 (18.7%) cases, and with hemorrhage under the dura mater caused by injury – Haemorrhagia subduralis traumatica in 16 (13%) cases. S06.4 – Haemorrhagia epiduralis (12 (9.8%)) and S06.5 – Haemorrhagia subduralis traumatica (7 (5.7%)) (Figure 3).

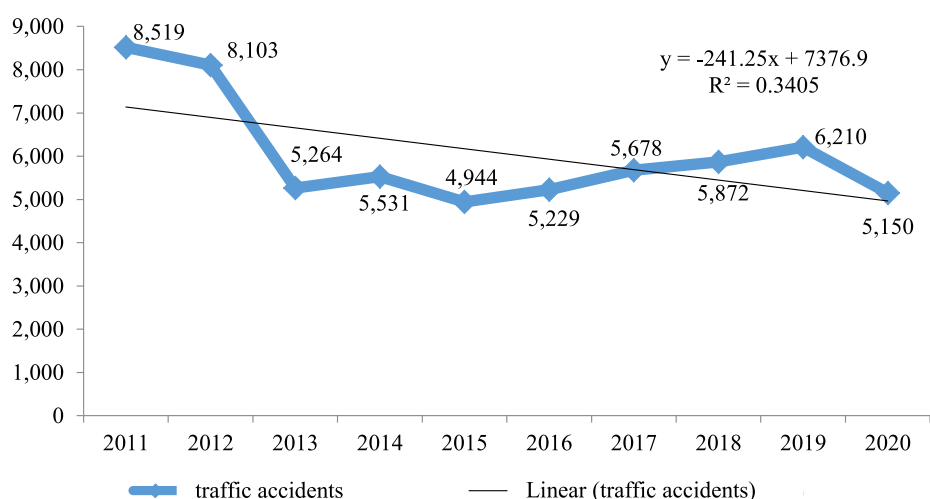


Figure 1. Trend in the number of traffic accidents by observation year, Montenegro, 2011-2020.

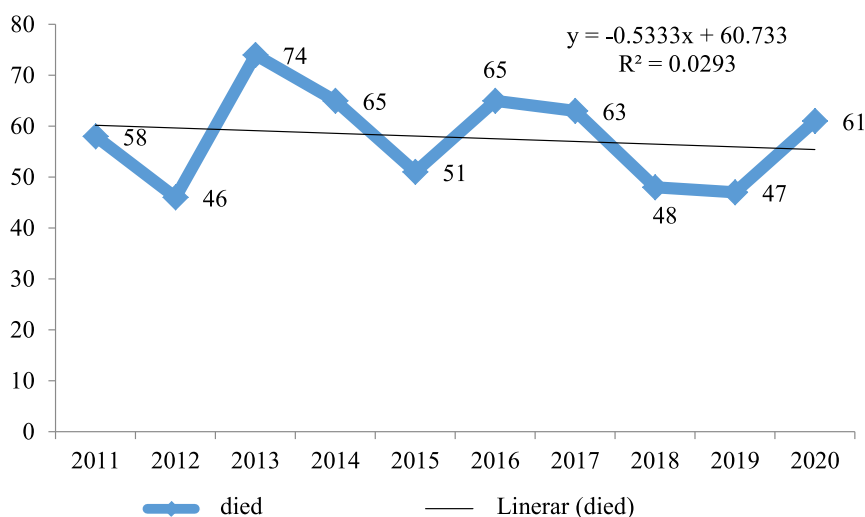


Figure 2. Trend in the number of fatalities by observation year, Montenegro, 2011-2020.

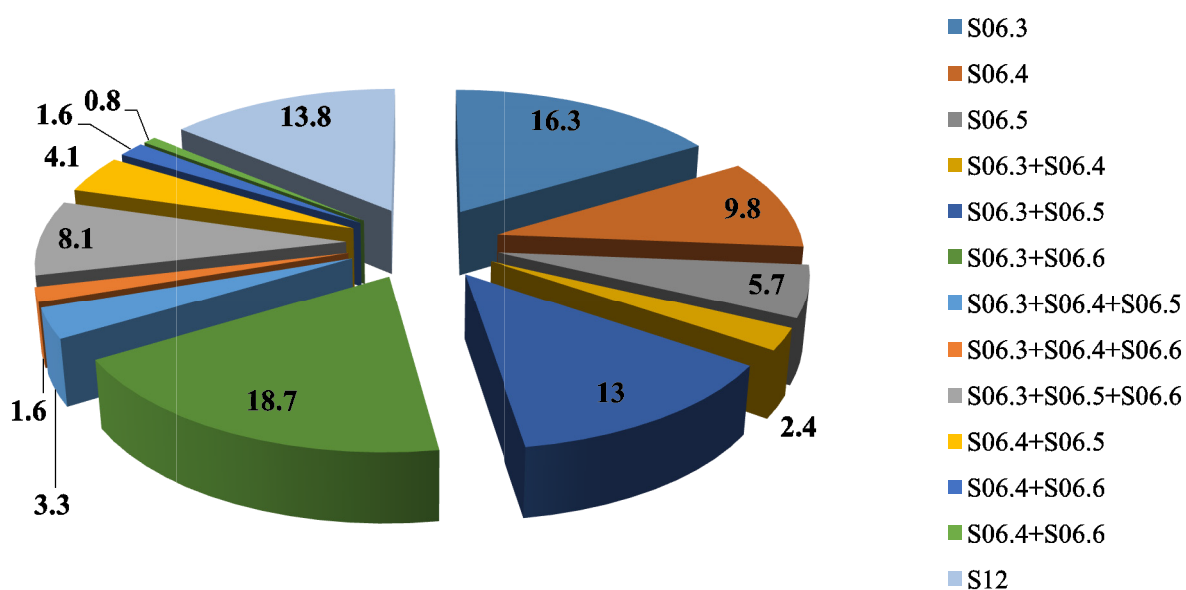


Figure 3. Distribution of dominant injuries in relation to traffic outcomes accident with head injury.

Regarding the outcome, no statistically significant effect of sex on the outcome of traffic accidents with head injuries was found ($\chi^2=0.179$; $p=0.672$). In the male group, there were 70 (76.9%) fatalities and 22 (71.0%) survivors, while in the female group, 21 (23.1%) died and 10 (29.0%) survived. No significant impact of age distribution on the outcome of traffic accidents with head injuries was found ($\chi^2=4.971$; $p=0.548$). The day of the accident did not statistically affect the outcome of traffic accidents involving head injuries ($\chi^2=4.322$; $p=0.633$).

The month in which the traffic accident occurred also did not affect the outcome ($\chi^2=11.364$; $p=0.413$). Regarding the season in which a traffic accident with head injuries occurred, the outcome of the accident was not determined ($\chi^2=2.706$; $p=0.436$), but the largest number of traffic accidents is detected in the summer period, which can be explained by increased traffic fluctuations due to the tourist season in the summer months, since Montenegro is a tourist Mediterranean country and an ecological state.

No significant effect of the type of participant on the outcome of traffic accidents involving head injuries was found ($\chi^2=2.812$; $p=0.590$), although the highest percentage of fatalities was found among drivers (39.6%). In terms of survival, 24 (24.0%) participants with diagnosed brain injuries died during transport or on the day of admission, 21 (21.0%) survived, and 55 (55.0%) died later. The presence of combined injuries had a statistically significant impact on the outcome of traffic accidents in the studied population, and a fatal outcome was most common in polytrauma cases. There is a statistically significant impact of the presence of combined injuries on the outcome of traffic accidents in the studied population, specifically in the category of head injuries ($\chi^2=20.572$; $p=0.000$). Fatal outcomes were most common in cases of polytrauma.

DISCUSSION

Increased motorization rates associated with poor road infrastructure and the spread of unsafe modes of transport (e.g., motorcycles), as well as risky behaviors (e.g., driving under the influence of alcohol and excessive speed), are the main determinants of the increased number of fatalities and/or disabilities associated with traffic accidents (11). Some studies from developing countries indicate that traffic-related mortality is attributed to factors such as speeding violations, vehicle overload on roads, low-quality and old passenger vehicles with poorer safety performance and features, increased traffic density due to population migration to larger cities, the growing participation of motorcycles in traffic, and inadequate and untimely access to healthcare due to poor healthcare system organization and lack of adequate medical staff of specific specialties (12, 13).

In addition to these risk factors, there are also concerns about poor road infrastructure and the design of road networks, as well as inaccessibility due to the country's terrain, such as in Montenegro. Therefore, it can be concluded that adequate access to healthcare and road safety management has become a global concern for reducing mortality from trauma in developing countries (14). Despite the fact that trauma represents a burden for public health, road safety has been neglected in developing countries, and the current management of road infrastructure safety is far from international standards (15). In contrast, developed countries have regulated road safety and traffic infrastructure management through the efficient use of computer technology and data collection science, which plays a major role in road safety through data-driven guidelines and evidence-based decisions, as well as the establishment of trauma registries, which is not yet the case in Montenegro (16).

In underdeveloped and poorly developed countries, traffic trauma mortality tends to increase, particularly among individuals aged 40 to 49 years, with a slightly higher increase among the population over 60 years old. Studies show that this is contrary to trends in highly developed countries, where there is a decline in mortality among younger populations, and where individuals over the age of 60 have a significantly higher participation in traffic (17, 18). Literature suggests that the main cause of morbidity and mortality among individuals under 44 years of age is trauma (19). Contributing factors to this issue include the reduced use of seat belts and helmet-wearing, with head trauma being the dominant injury (20, 21). Estimates from many studies related to trauma in Europe indicate that the incidence of isolated brain injuries in hospitalized trauma patients is high, estimated at 262/100,000, with an average mortality of 11/100,000 (22, 23). A large survey-based study identified lifetime prevalence ranging from <1% (China) to nearly 15% (Mexico and Venezuela). Traffic injuries are a significant cause of all head-related trauma (24).

Similar to our results, a Dutch study found that severe brain injuries were responsible for the highest mortality among traffic participants, compared to other types of injuries (25). In Europe, it is estimated that for every fatality, there are 4 permanently disabling injuries, such as brain or spinal cord injuries, and 10 severe and 40 minor injuries (26). Research by Ali Kemal Erenler and his colleagues in a large study in Turkey showed that a total of 1,168,121 people were injured in traffic accidents, and 3,534 lost their lives. The majority of traffic accidents occurred during the summer months, which is confirmed by our results, and the highest number of fatalities were among adolescent males (27). Head trauma is the leading cause of morbidity and mortality among individuals under 44 years of age (6, 19, 28-30).

In conclusion, the study demonstrated a statistically significant impact of associated injuries on traffic accident outcomes, particularly in the case of head injuries, with fatalities being most common in polytrauma cases. Based on these findings, it is crucial to establish a network of trauma centers in Montenegro, especially those capable of treating central nervous system (CNS) injuries, as the nearest institution capable of treating such injuries is the Clinical Center of Montenegro in Podgorica. Additionally, the establishment of a "Trauma Registry" is needed to systematically monitor traffic trauma and improve measures to reduce morbidity and mortality.

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