Road-traffic-related mortality in European Union, Croatia and Split-Dalmatia county (2010-2020) : Did COVID-19 lockdown lower road traffic deaths?

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TABLE OF CONTENTS

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First and foremost, praises and thanks to the God, the Almighty, for everything.

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LIST OF ABBREVIATIONS

EU - European Union

RTA(s) - Road traffic accident(s)

RTADs- Road traffic accident deaths

SDC - Split-Dalmatia county

1. INTRODUCTION

1.1. Epidemiology of the road traffic deaths

Road traffic accidents (RTA(s)) are one of the leading causes of injury and death worldwide (1). Children and young adults aged 5 to 29 die most frequently from RTA(s), which are also the eighth biggest cause of mortality globally for persons of all ages. It comes behind prevalent conditions including COPD, stroke, and ischemic heart disease. The number of fatalities attributable to RTA(s) varies greatly between areas and nations. The level of income in a nation has a significant impact on the morbidity and mortality of RTA(s). In low-income countries, the risk is more than three times greater than in high-income countries (2). RTA(s) are thought to have economic effects that range from one to three percent of each country's gross domestic product. Costs associated with this would exceed $500 billion globally (3).

Road accidents claimed the lives of an estimated 19,800 persons in European Union (EU) in 2021. In EU in 2021, there were 44 road deaths per million people on average, which was a 13 percent decline from 2019 before the pandemic but a 5 percent increase from 2020 (4,5).

In 2021, Croatia had 72 road deaths per million residents, which is much higher than the EU average and the fourth highest rate among the EU-27. Road fatalities surged by 23% in 2021 after reaching their lowest level on record in 2020 (5).

The total number of the RTA(s) in Split-Dalmatia county (SDC) in 2020 was 2,296 and 25 people were killed in these RTA(s) (6).

1.2. Risk factors for road traffic accidents

1.2.1. Alcohol

Alcohol intake can be considred as one of the risk factors for RTA(s). At the moment of the collision, many at-fault drivers are under the influence of alcohol (7).

The impairing effects of alcohol on attention and cognitive function while driving have been demonstrated in earlier researches. Driving while intoxicated with alcohol is frequently accompanied by not wearing a seatbelt in the USA and 19 other high-income nations, which raises the risk of injury. Alcohol intake has been linked to not wearing a driving helmet in Thailand, whereas high-speed driving has been linked to driving under the influence of alcohol in the UK (8).

1.2.2. Speed

Speeding is another risk factor for RTA(s). “Speeding - which encompasses excessive speed (i.e. driving above the speed limits) or inappropriate speed (driving too fast for the prevailing conditions, but within the limits) - is dangerous” (9).

The number one issue with road safety is excessive and unsuitable speed, which can be to blame for up to one third of fatal accidents and aggravates all accidents. The whole road system (motorways, main highways, rural roads, urban roads) is impacted by excessive speed. 50 percent of drivers usually exceed speed restrictions at any given moment. All motor vehicle types and user groups on the road are affected by speeding. The group that engages in speeding behavior the most is young drivers, though (9).

Numerous studies have demonstrated that increased vehicle speeds have a considerable negative influence on road safety. Many scholars have developed models that relate major injury accidents, fatal accidents, and speed. The number of accidents causing injuries and fatalities rises by around 10% and 20%, respectively, with every 5% increase in average speed. Around 10% fewer accidents result in injuries, and 20% fewer accidents result in fatalities for every 5% decrease in average speed (9).

1.2.3. Non-use of seat belts, kid restraints and motorcycle helmets

By using a seatbelt, you can cut your chance of dying or suffering serious injuries in half for front-seat passengers and drivers, and by 25% for rear-seat passengers. Laws requiring the use of seat-belts are a practical way to cut down on injuries and accidents caused by motor vehicle accidents (10). In the UK and other nations with similar legislation, the mandated usage of seat belts has significantly reduced the road traffic fatality rates (11). As shown in Figure 1, when a vehicle driver is unrestrained, after a deceleration impact many different parts of his or her body can get injured.

Figure 1. Major points of injury to an unrestrained driver of a vehicle in deceleration impact
Source: Saukko P, Knight B. Knight's forensic pathology. 4th ed. Boca Raton: CRC Press; 2016.

Child restraints are quite effective at lowering child occupant injury and mortality rates (10). At least 60% less deaths may result from the use of child restraints (12). It has been demonstrated that younger kids, especially those under the age of four, benefit most

from child restraints (13). Compared to using a seat belt alone, using a booster seat has been linked to a 19% lower odds of injury in children aged 8 to 12 years (14).

Correct helmet use resulted in a 69 percent decrease in the risk of head injuries and a reduction of 43 percent in the risk of fatal injuries. For users of two- and three-wheeled motor vehicles, head injuries account for the majority of fatalities and serious injuries. Thus, wearing a helmet is crucial in reducing fatal accidents on the road (10).

1.2.4. Inadequate law enforcement of traffic laws

Traffic regulations cannot result in the anticipated decrease in road traffic fatalities and injuries linked to certain behaviors if they are not implemented. This includes legislation relating to drinking and driving, seat belt use, speed limits, helmet use, and kid restraints. As a result, it is likely that traffic laws won't be followed and won't have much of an impact on behavior if they aren't enforced or are believed to be ignored (10).

Establishing, maintaining, and enforcing laws that address the aforementioned risk factors at the federal, municipal, and local levels are all components of effective enforcement. The definition of appropriate sanctions is also included (10).

1.2.5. Congestion

An intriguing factor that may affect the chance of a road collision is congestion (15). There are different results in various studies regarding the association between the congestion and RTA(s). The majority of the literature indicates that as traffic congestion rises, accidents rise as well (15).

1.3. Categories of road traffic accidents

1.3.1. Motorcycle accidents

Despite the fact that there are fewer motorbikes than four-wheeled cars, particularly in affluent nations, motorcycle riders have more injuries and fatalities than automobile drivers. In comparison to drivers of other types of motor vehicles, motorcyclists in the USA have a 34-fold higher risk of dying in an accident per vehicle mile traveled. In Great Britain, the number of fatal motorcycle accidents decreased by 9% from 362 in 2011 to 328 in 2012. Over the same time period, there was a 2% decline in motorcycle traffic (16).

In motorbike collisions, the two extremities of the body suffer the most damage, while a research also found that the chest and abdomen frequently sustain serious injuries. Head injuries, which are frequent and often severe because the rider will certainly fall to the ground, account for the majority of fatalities. Less frequently than the extremities, any area of the body might get hurt. The "tailgating" accident is a frequent injury in motorcycle accidents (16).

1.3.2. Pedal cycle accidents

Cycling is an ubiquitous form of transportation and a popular recreational activity, however accidents sustained while cycling can be fatal (17). Other road users, primarily motor vehicles, are at blame for the majority of fatalities and severe injuries to pedal cyclists (18).

Because pedal cycles have the same instability as motorcycles but travel at much slower speeds, pedal cycle injuries are a less severe counterpart to motorcycle lesions. Once more, head traumas play a significant role in accidents. Other injuries result from the primary impact of a colliding vehicle, which may strike the rider at the level of the thigh, hip, or chest. In situations when friction grazes are frequent, secondary injuries to the shoulder, chest, and arm may result from striking the ground (16).

1.3.3. Motor vehicle (except motorcycles) accidents

The type of vehicle (aside from motorcycles) should not significantly affect the mechanism of injury, but most statistical surveys classify them into lighter vehicles, such as cars and light vans under 1.5 tonnes, and heavier ones, such as trucks and buses, even though the latter have features more similar to passenger aircraft. Due to their significantly greater bulk, strength, and height above the ground, heavy goods vehicles inherently sustain less damage in collisions than cars and light vans. Impacts with smaller vehicles result in less structural damage, which frequently occurs below the level of the driver. Regarding the people in the front seats, light vans are almost equivalent to cars. The driver, rear-seat occupants and front-seat passenger can all get injured in motor vehicle accidents (16).

In an unconstrained accident, several injuries are anticipated to occur. The unrestrained impact can lead to the various injures, including fractures of the skull and face, injury to the brain and its coverings, damage to the cervical or thoracic spine, damage to the sternum and ribs, injuries of the heart and liver, dislocations, aortic tear and fractures of the legs and knees. In addition, the risk of secondary injuries or being ran over by another automobile increases if the car's passengers are ejected out through the windscreen (11).

1.3.4. Pedestrian accidents

Around the world, pedestrian accidents are by far the leading cause of road traffic fatalities, and pedestrians and cyclists account for more than one-third of all traffic fatalities in low- and middle-income nations. Pedestrian fatalities make up a large portion of the overall mortality in highly populated regions of the world where people outnumber automobiles, such as Southern Asia, portions of Africa, the Middle East, and Central America. For instance, 38% of all traffic fatalities in Africa involve pedestrians. The majority of pedestrian accidents involve cars or trucks, and the type of vehicle has an impact on how the collision unfolds (16).

When pedestrians are struck by moving vehicles, they may get injuries from the first impact with the vehicle (primary injuries) or from subsequent contact with other objects or the ground (secondary injuries) (11). It has been stated, “The most frequently injured body

regions were the lower extremities (50% of victims), the head/face/neck (38%) and the upper extremities (27%)" (19). Women had pelvic injuries much more frequently. For all categories of road users, the most serious injuries (AIS4+) were predominantly to the head and thorax. However, head injuries occurred twice as frequently in pedestrians as thoracic injuries (19).

1.4. European Union road safety program 2011-2020

A significant societal problem is road safety. Over 35,000 people—the equivalent of a medium town—lost their lives on EU roads in 2009. 130 billion euros are thought to be the annual economic cost to society (20).

The European Commission launched an ambitious road safety program on July 20, 2010, with the goal of halving the number of traffic fatalities in Europe within the following ten years. The program outlines a variety of national and European activities with a focus on enhancing infrastructure safety, driving behavior, and vehicle safety (20).

Seven strategic goals were set: "Improved Safety Measures for Vehicles", "Building safer road infrastructure", "Boost Smart Technology", "Strengthening education and training for road users", "Better enforcement", "Establishing a Road Injuries Target" and "A new focus on Motorcyclists" (20).

In terms of lowering fatalities and serious injuries from RTA(s), the EU already leads the globe. The number of deaths on the roads decreased by 36% between 2010 and 2020. The EU continues to be the continent with the safest roads in the world, with 42 road traffic fatalities per 1 million residents. Although it came close, more work still has to be done to reach the goal of 50% fewer fatalities set for that decade. By supporting the "safe system" of safer vehicles, safer infrastructure, safer road users, and better post-crash care, as well as by putting its Sustainable and Smart Mobility Strategy into practice, the European Commission is aiming to deliver all parts of its 2019 Road Safety Policy Framework (21).

1.5. COVID-19

1.5.1. Epidemiology of COVID-19

Globally, more than 6.3 million deaths and over 567 million confirmed cases have been documented as of July 24, 2022 (22).

1,182,836 verified COVID-19 cases and 16,277 deaths have been reported in Croatia between 3 January 2020 and 5:33 PM CEST on July 29, 2022 (23).

1.5.2. Chronology of the COVID-19 pandemic in the world

In December 2019, a virus outbreak in Wuhan, China, led to the first identification of this novel pathogen. Since COVID-19 first appeared in China, the virus has evolved over the period of four months and has quickly moved to other nations, posing a threat on a global scale. The WHO finally determined that COVID-19 qualifies as a pandemic on March 11, 2020 (24).

1.5.3. Chronology of the COVID-19 pandemic in Croatia

Compared to other other European nations, like Italy or Spain, Croatia was less impacted by the initial wave of the COVID-19 pandemic. However, in terms of cases and deaths per 100,000 people, it was more impacted by the second wave than the EU average (25).

The nation responded quickly to the initial wave, implementing a number of preventive and protective measures to stop and control the virus's spread (Figure 2). Closing educational facilities, placing specific areas under quarantine, limiting international travel, limiting local movement, and self-isolation measures were some of these. On March 23,

2020, a first full lockdown was implemented. In April and May of that same year, limitations were gradually relaxed. In contrary, the response to the COVID-19 second wave (starting in September 2020) was more reluctant, as was the case in some other EU nations, and was characterized by hesitance to reintroduce the strict regulations implemented in the first wave. However, several preventive measures were put in place, such as the requirement to wear face masks inside of buildings beginning in October 2020 and the closure of bars and restaurants starting in November 2020. In December 2020, a second lockdown was implemented. In April and May 2021, the number of cases climbed once more, but a third lockdown was not implemented. Both lockdowns influenced many aspects of life in Croatia, including socioeconomic conditions, mobility and traffic and etc (25).

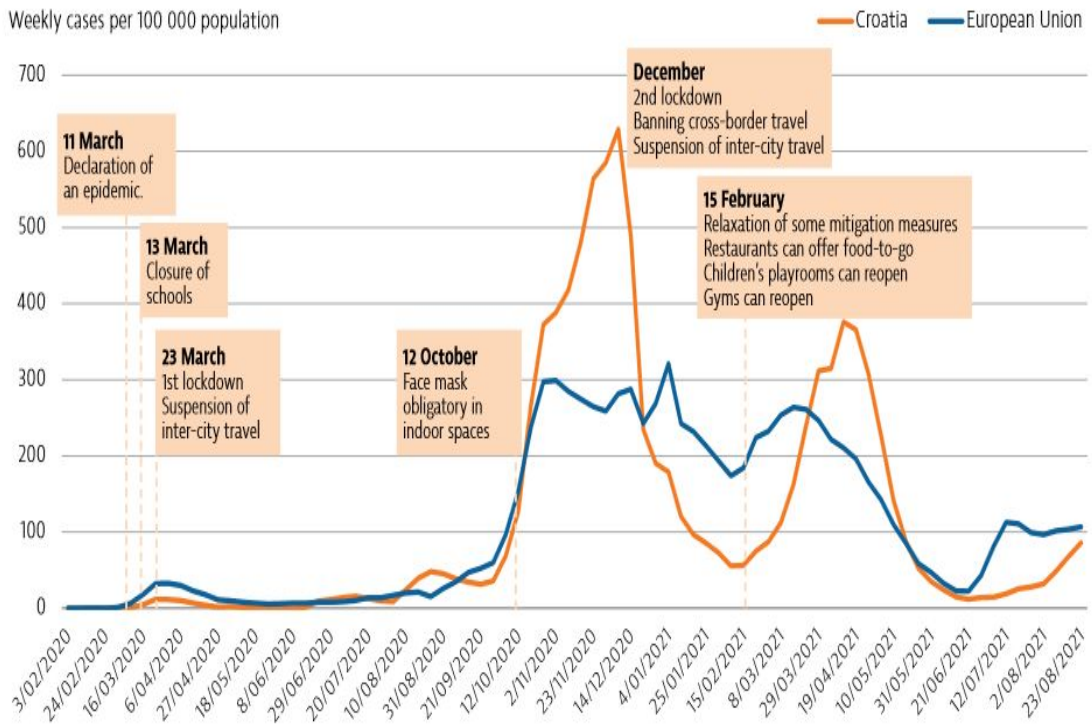

Figure 2. Mitigation measures helped to bring down the number of COVID-19 cases

Note: The EU average is unweighted (the number of countries used for the average varies depending on the week)

Source: OECD/European Observatory on Health Systems and Policies (2021), Croatia: Country Health Profile 2021, State of Health in the EU, OECD Publishing, Paris/European Observatory on Health Systems and Policies, Brussels.

2. OBJECTIVES

The aim of this study was to analyze the number of RTADs in SDC, the entire Croatia and the EU region and compare them with each other over a ten-year period (2010-2020). In addition, in this study we aimed to analyze the RTADs by user type in the whole Croatia during the same time frame and investigate the impact of the COVID-19 lockdown on the total number of RTADs in EU, Croatia and SDC in 2020 and Croatia's road-traffic-related mortality by user type in the same year.

Hypothesis

We hypothesize that there will be an overall downward trend in the number of RTADs for all three of the previously mentioned regions and for each RTA(s) category. Furthermore, in 2020, COVID-19 lockdowns will reduce not only the total number of RTADs in EU, Croatia and SDC but also road-traffic-related mortality by user class in Croatia.

3. SUBJECTS AND METHODS

The presented research is a retrospective cross-sectional study. Data was gathered using Eurostat, Splisko-Dalmatinska County Police Administration and Croatian Bureau Of Statistics databases, which are offered for public access. This work concentrates on a ten-year period (from 2010 till 2020). The investigation included data about the number and percentage of RTADs, different categories of RTA(s) and the years, in which these phenomena occurred. In this study, three different regions, namely EU, Croatia and SDC were investigated.

Microsoft Excel and MedCalc® Statistical Software version 20.013 (MedCalc Software Ltd, Ostend, Belgium) have been used to do descriptive statistics.

4. RESULTS

4.1. Road traffic deaths in European Union, Croatia and Split-Dalmatia county on a yearly basis

Figure 3 gives an overview of total number of RTADs in EU and Croatia as an annual measure. In 2010 there were 426 and 29,576 people in total killed in RTA(s) in Croatia and EU respectively. At first both of these numbers decreased gradually and after fluctuating for several years, in 2020 they finished at their lowest points in the ten-year period (18,786 for EU and 237 for Croatia). The drop in the total number of RTADs for both regions was the most substantial from 2019 to 2020 (there was another substantial reduction in this number in Croatia from 2013 to 2014). The year, in which there was the highest point for total number of RTADs, was 2010 for both regions. The trendline for Croatia was a bit steeper than it was for EU from 2010 until 2020.

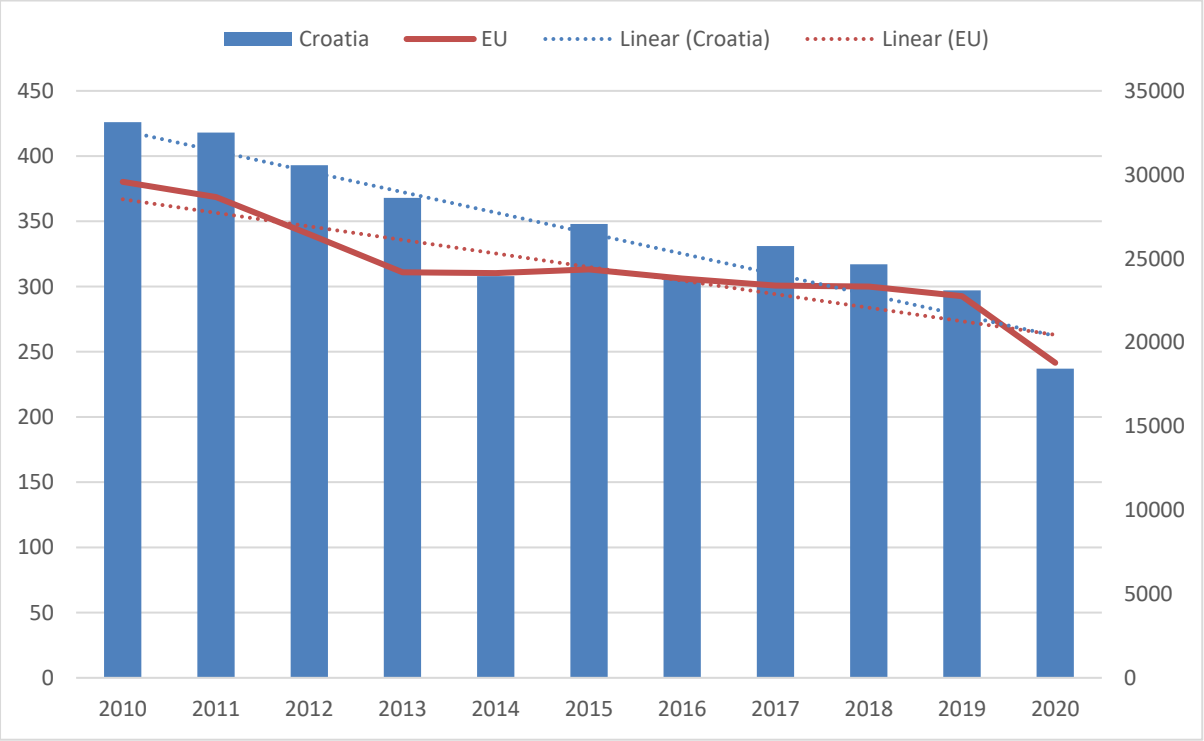

Figure 3. Total number of road traffic accident deaths in Croatia and European Union on a yearly basis, from 2010 till 2020

The contribution of Croatia in the overall number of annual road traffic fatalities in the EU is clearly displayed in Figure 4. Croatia accounts for 1.44% of total number of RTADs in the entire EU in 2010. Although this percentage increased gradually over the course of three years to the peak of 1.52%, this continous rise ceased in 2013 and there were fluctuations in the Croatia's percentage of total number of RTADs in EU from 2013 till 2017. Croatia made up 1.41% of the EU's total number of RTADs in 2017, after which there was a steady reduction in this proportion until it reached the lowest point (1.26%) in this ten-year period in 2020. The trend for Croatia during the first three years was completely in contrast to the one during the last three years as depicted in the following bar chart.

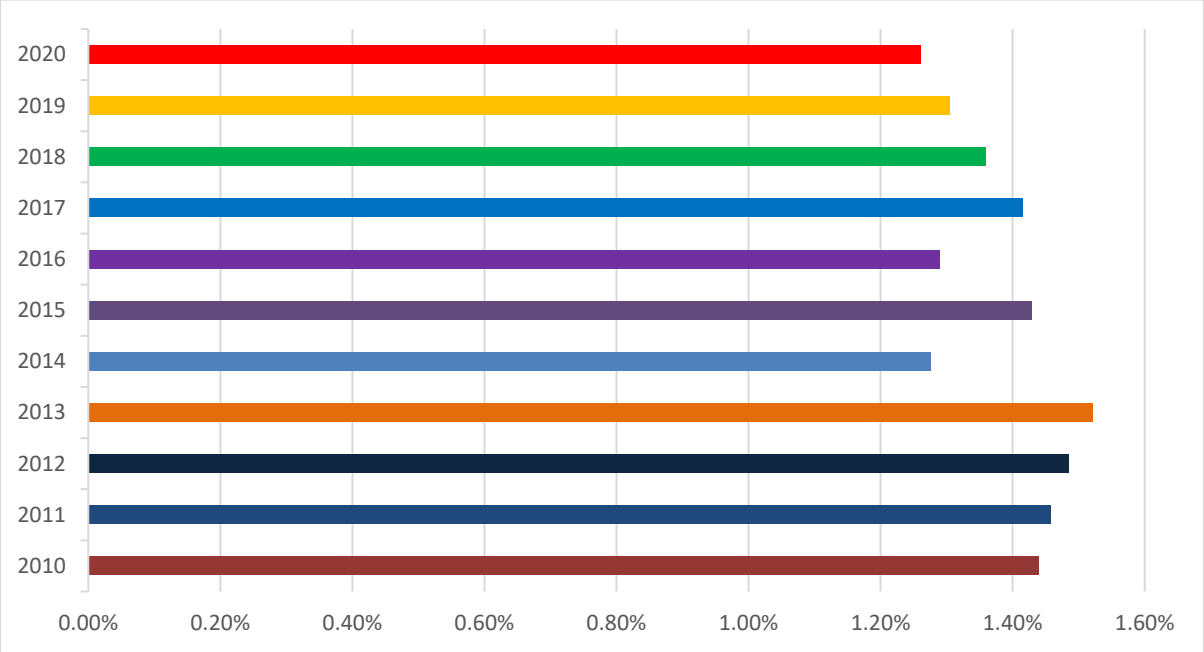

Figure 4. The percentage of Croatia in the entire European Union (for total number of road traffic deaths) on a yearly basis, from 2010 till 2020

Table 1. shows that the total number of RTADs was 26 in SDC in 2010. The highest increase in the total number of RTADs in SDC from 2010 to 2020 happened beween 2012 and 2013; it rose from 25 in 2012 to 33 in 2013. There were 25 people in total killed in RTA(s) in SDC in 2020, which was the lowest total number of RTADs in SDC in this ten-year period (there was another lowest total number of RTADs in SDC and this was in 2012). SDC made up 6.1 percent of total number of road traffic deaths in Croatia in 2010. Except for four periods (2011-2012, 2013-2014, 2014-2015 and 2016-2017), in the remaining periods there was always an increase in the percentage of total number of RTADs in SDC. The largest decrease in the percentage of total number of road traffic deaths in SDC during the entire ten-year period was 1.3%, which happened between 2011 and 2012. From 2017 onwards SDC constituted more than one tenth of the total number of RTADs in Croatia. The highest and lowest proportions for SDC were 10.55% in 2020 and 6.1% in 2010 respectively.

Table 1. Road traffic accident deaths in Split-Dalmatia county

Year	Total N of Deaths	Percentage of total N of RTD*
2010	26	(6.1)
2011	32	(7.66)
2012	25	(6.36)
2013	33	(8.97)
2014	27	(8.77)
2015	34	(9.77)
2016	27	(8.79)
2017	28	(8.46)
2018	32	(10.09)
2019	31	(10.44)
2020	25	(10.55)

Data are presented as general numbers or as (%)
* Road traffic deaths

4.2. Road traffic deaths in Croatia on a monthly basis

Tables 2 and 3 provide a breakdown of the number of deaths based on month as a descriptive representation of RTA(s) fatalities in Croatia. Among all the twelve different months of eleven years, there was specifically only one of the three months, namely July, August or September, when the number of RTADs was the highest for that certain year, with the exception of two particular years (2013 and 2019). Except for three specific years (2011, 2017 and 2020), out of the twelve different months of those eleven years, only one of the two—February or March—saw the lowest number of RTADs for that certain year.

Table 2. Road traffic deaths for the first six months of every year of the ten-year period (from 2010 till 2020)

	Jan.	**Feb.**	**Mar.**	**Apr.**	**May**	**June**
Year:						
2010	(5.87)	(8.92)	(4.93)	(9.86)	(10.80)	(7.28)
2011	(8.13)	(7.66)	(5.26)	(7.18)	(5.02)	(9.57)
2012	(4.58)	(3.56)	(6.62)	(6.62)	(8.4)	(11.45)
2013	(5.43)	(3.8)	(6.52)	(5.16)	(8.15)	(9.24)
2014	(5.52)	(4.87)	(9.42)	(5.19)	(10.06)	(7.14)
2015	(7.18)	(4.02)	(4.31)	(5.17)	(11.21)	(7.47)
2016	(7.49)	(7.82)	(4.23)	(5.54)	(11.07)	(8.47)
2017	(3.63)	(6.65)	(5.44)	(5.44)	(11.78)	(8.16)
2018	(5.36)	(6.94)	(3.79)	(9.46)	(11.67)	(8.2)
2019	(7.41)	(4.71)	(4.04)	(8.75)	(8.08)	(9.76)
2020	(9.7)	(7.59)	(5.06)	(6.75)	(8.02)	(11.39)

Data are presented as (%)

Table 3. Road traffic deaths for the second six months of every year of the ten-year period (from 2010 till 2020)

	July	**Aug.**	**Sept.**	**Oct.**	**Nov.**	**Dec.**
Year:						
2010	(11.27)	(6.57)	(8.69)	(9.86)	(6.81)	(9.15)
2011	(11.24)	(10.29)	(11.96)	(8.37)	(6.22)	(9.09)
2012	(11.7)	(9.92)	(10.18)	(9.67)	(7.89)	(9.41)
2013	(11.68)	(10.6)	(12.23)	(12.23)	(6.52)	(8.42)
2014	(14.29)	(9.09)	(8.44)	(11.04)	(8.44)	(6.49)
2015	(11.78)	(11.21)	(12.36)	(8.62)	(8.91)	(7.76)
2016	(7.17)	(13.36)	(9.77)	(11.4)	(5.21)	(8.47)
2017	(11.78)	(12.69)	(6.95)	(12.08)	(7.25)	(8.16)
2018	(10.09)	(14.2)	(7.26)	(9.78)	(7.26)	(5.99)
2019	(8.08)	(9.43)	(10.1)	(11.78)	(5.39)	(12.46)
2020	(15.61)	(9.28)	(8.02)	(5.49)	(8.02)	(5.06)

Data are presented as (%)

The overall number of road traffic fatalities in Croatia in 2020 is shown in detail in Figure 5 on a monthly basis. In January 2020 total number of RTADs in Croatia stood at 23 and then reduced steadily over the next two months to 12. In the following four months this number rose by 15 points and reached the peak of 37 in July. Right after reaching the highest point in July 2020, there was a continuous fall in the number of RTADs in the following three months to 13 in October. There were 12 people in total killed in RTA(s) in the last month of the year. March and December had the lowest number of road traffic fatalities in Croatia in 2020.

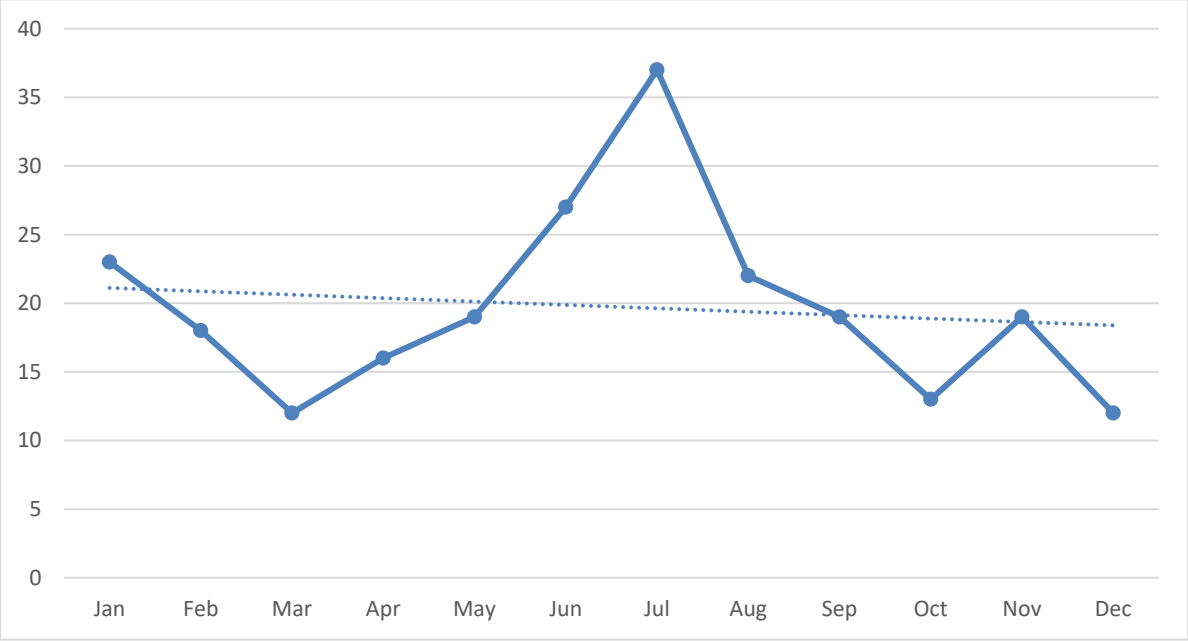

Figure 5. Total number of road traffic deaths in Croatia in 2020 on a monthly basis

4.3. Different categories of road traffic accidents

As shown in Figure 6, road traffic deaths can be illustrated by category of RTA(s) scattered throughout a ten-year period. At first glance, it is evident that all categories reached different points at the end of this time frame, which were lower than their respective starting

points in 2010. Compared to the five other categories, "Passenger cars" category had the highest number of RTADs all the time during this ten-year period. This category began the period with 205, which was approximately two times and four times greater than the numbers for the “Pedestrians” and “Motorcycles“ categories respectively. This figure then rose slightly to 215 (highest point for "Passenger cars" category between 2010 and 2020) in 2011, fluctuated for the next several years until it reached 187 in 2017. After having a continuous fall in the number of RTADs for "Passenger cars" category between 2017 and 2020, this category finished the period at 126 (lowest point for "Passenger cars" category between 2010 and 2020) in 2020. Pedestrians stood at 105 at the beginning of the period, which was almost twice as high as the number of RTADs for “Motorcycles“ category in 2010. After one year, the number of RTADs for Pedestrians fell from 105 to 71. This category maintained almost the same level between 2011 and 2014, after which the number of RTADs for this category fluctuated for the next four years until it reached 65 in 2018. This figure went down by 27 points to 38 from 2018 to 2020. Over the course of these ten years, the "Pedestrians" category consistently had the second-highest number of RTADs among all the other categories, with the exception of 2011 and 2020. Motorcycles began the period at 51. Afterwards, this number increased by 25 points to 76 and overtook the "Pedestrians" category’s number in 2011. Over the next three years, this figure plummeted to 44. After climbing to 58 in 2015, it dropped to 38 in 2016. The pattern that the number of RTADs for this category followed for the last 4 years was almost similar to the one it had between 2014 and 2016. This category ended the time frame at 44, which was higher than the figure for "Pedestrians" category in 2020. “Bicycles”, “Other” and “Mopeds” categories began the period at 28, 22 and 15 respectively. The numbers for all these three categories finished the period at the values (N for “Mopeds” = 5, N for “bicycles” = 9 and N for “Other” = 15), which were lower than their respective figures in 2010.

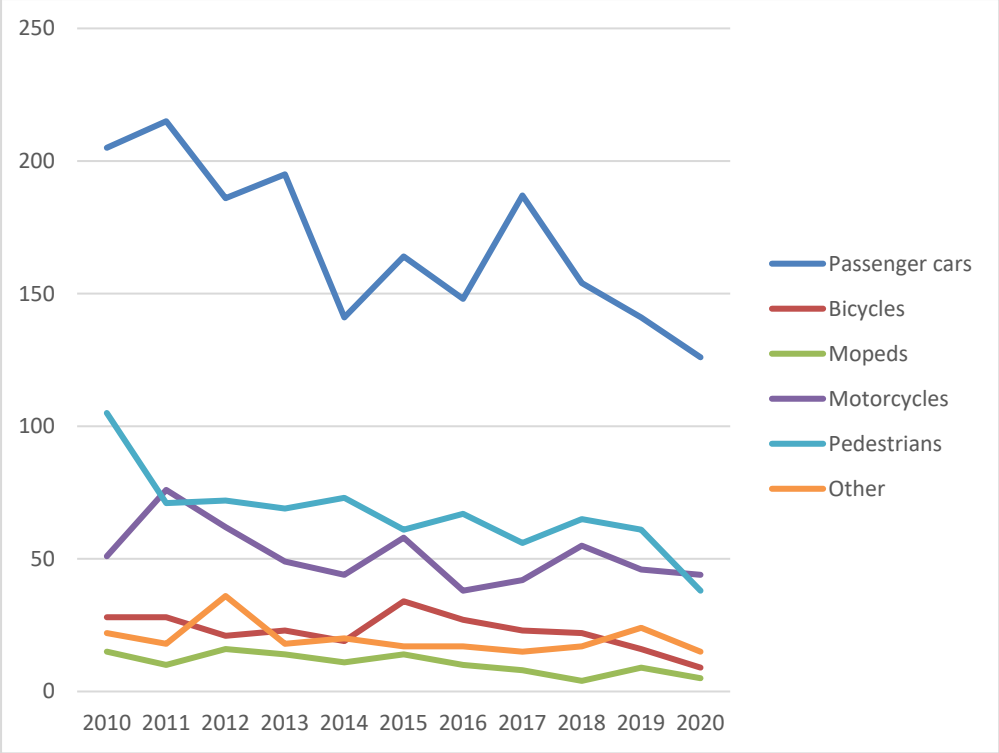

Figure 6. Total number of deaths in each category of road traffic accident in Croatia on a yearly basis, from 2010 till 2020

Note: Data for "Goods vehicles" and "Buses and coaches" are missing. Both car drivers and passengers are included in "Passenger cars" category.

Figures 7, 8 and 9 clearly illustrate the distribution of road traffic deaths by type of road user in Croatia in 2010, 2019 and 2020 respectively. 48.12% of total number of RTADs in Croatia in 2010 was caused by road traffic collisions involving passenger cars and this proportion was the highest among all the other categories of RTA(s). Pedestrians was in the second place with 24.65% constituting almost one fourth of the total. The amount for "Motorcycles" category was 11.97% of the total number of RTADs. While the proportion for RTA(s) involving bicycles was 6.57%, the amount for "Mopeds" category was almost two times less than that (3.52%). Lastly, "Other" category made up 5.17% of the total. In 2019 the categories in order of decreasing amounts are as follows: "Passenger cars" (47.47%), "Pedestrians" (20.54%), "Motorcycles" (15.49%), "Other" (8.08%), "Bicycles" (5.39%) and "Mopeds" (3.03%). In 2020 "Passenger cars" category contributed the biggest percentage of RTADs in Croatia (53.16%) out of all the other RTA(s) types, as it did in 2010 and 2019.

With 18.57% of the total, or nearly one fifth, motorcycles came in second. The proportion for "Pedestrians" category accounted for 16.03% of the total number of RTADs. The amounts for “Other” and “Bicycles” categories were 6.33% and 3.80% respectively. Mopeds constituted 2.11% of the total and had the lowest proportion among all the other categories in 2020.

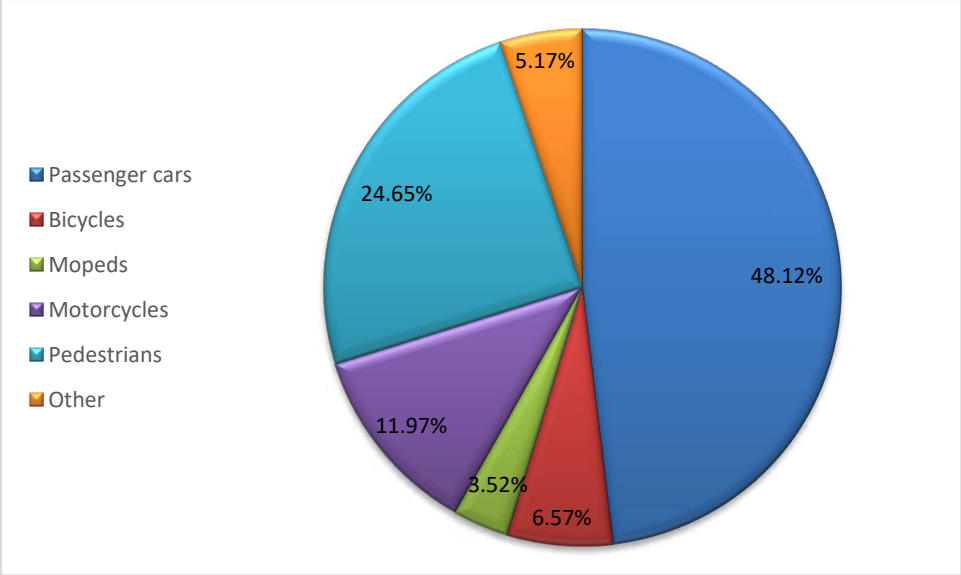

Figure 7. Distribution of road traffic deaths by type of road user in Croatia in 2010

Note: Data for “Goods vehicles” and “Buses and coaches” are missing. Both car drivers and passengers are included in “Passenger cars” category.

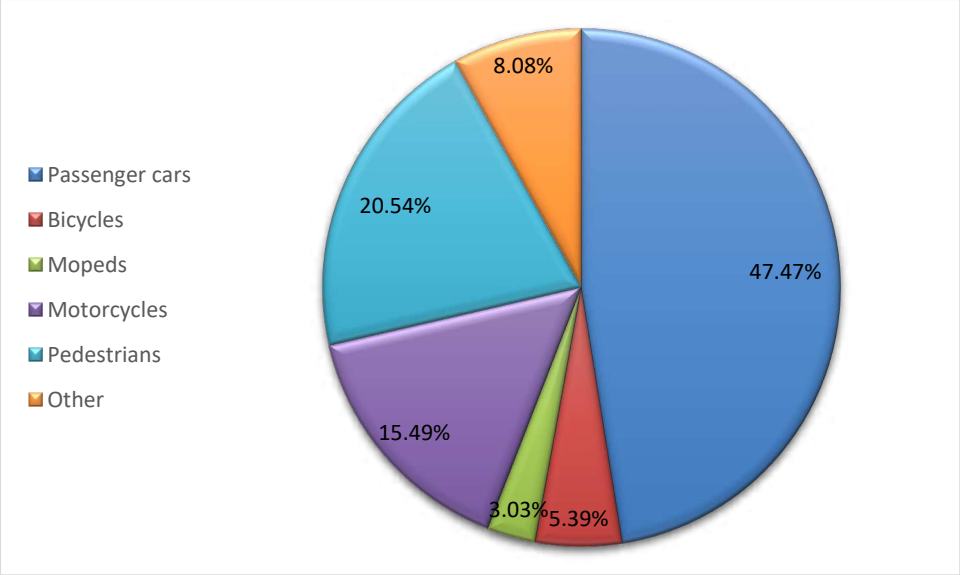

Figure 8. Distribution of road traffic deaths by type of road user in Croatia in 2019

Note: Data for "Goods vehicles" and "Buses and coaches" are missing. Both car drivers and passengers are included in "Passenger cars" category.

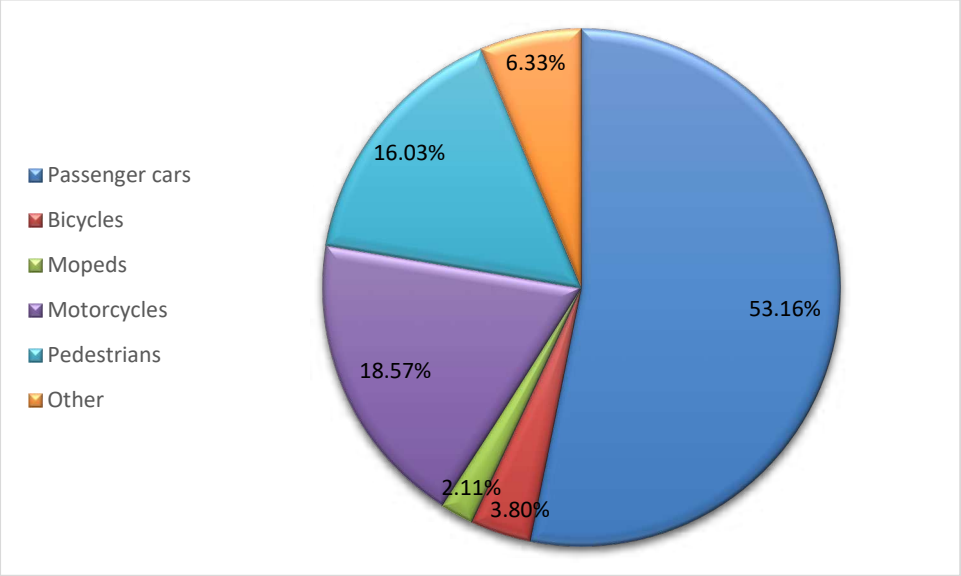

Figure 9. Distribution of road traffic deaths by type of road user in Croatia in 2020

Note: Data for "Goods vehicles" and "Buses and coaches" are missing. Both car drivers and passengers are included in "Passenger cars" category.

5. DISCUSSION

Based on the following three different findings of our study, we can prove that COVID-19 lockdowns had a positive influence on the reduction of road-traffic-related mortality. Firstly, it is surprising that during the ten-year period (2010-2020) SDC had one of the two lowest total number of RTADs in 2020. Because the numbers for SDC during this entire time frame were not following a stable downward trend and the total number of RTADs for SDC suddenly dropped in that specific year (2020). Additionally, this particular time matched with the chronology of COVID-19 pandemic in Croatia, as shown in Figure 2 (22). Secondly, the total number of RTADs in Croatia in 2020 was the lowest in March and December compared with other months of that year, which again matched with the chronology of the COVID-19 pandemic in Croatia (Lockdowns in Croatia on March 23, 2020 and December 2020) (25). Thirdly, between 2019 and 2020 EU had the most remarkable decrease in the total number of RTADs during the entire time frame form 2010 till 2020. Moreover, this specific time matched with the chronology of the COVID-19 pandemic in the world (24). When we consider that all these three phenomena occurred in the same year (2020), we can say with high probability that this did not happen by chance or randomly. Since our analysis of these findings indicates that COVID-19 lockdowns most likely had an impact on the total quantity of RTADs, it can be inferred that they also had an impact on road traffic fatalities caused by different categories of RTA(s) in Croatia in 2020.

We hypothesized that COVID-19 lockdowns will reduce not only the total number of RTADs in EU, Croatia and SDC in 2020 but also road-traffic-related mortality by category of RTA(s) in Croatia in the same year because we believed that lockdowns inevitably reduced the number of vehicles, which were present on the roads. Consequently, this will lead to a fall in the traffic congestion and RTADs, which is considered as one of the risk factors for the RTA(s) (15). These two postulations are confirmed by our study's previous findings about the impact of COVID-19 lockdowns on road traffic deaths.

Similar to our research's finding about the impact of COVID-19 lockdown on road-traffic-related mortality, a study has demonstrated that RTA(s) and associated mortality have generally decreased as a result of the COVID-19 pandemic (26).

Our study clearly demonstrated remarkable overall downward trend of the total number of RTADs for EU from 2010 till 2020. This finding confirms the success of "European road safety program 2011-2020" (20). Having a similar overall downward trend in the total number of RTADs for Croatia as a member of EU (Croatia entered EU on 1 July

2013), which was depicted in Figure 3, further confirms the previously mentioned statement. However, SDC surprisingly as a city in EU did not have a considerable overall downward trend. The unexpected gradual increase in the percentage of SDC in Croatia regarding road traffic deaths from 2017 onwards can probably be associated with the fact that more and more tourists are coming to this region and this county is considered as one of the favorite tourist destinations in Europe especially in recent years. The same reason may also explain why there were many fluctuations in the total number of RTADs for SDC from 2010 until 2019. 2020 was an exception to this pattern because of COVID-19 pandemic and really strict travel restrictions as a consequence of it.

We postulated that there will be a considerable decrease in the total number of RTADs in EU, Croatia and SDC over the ten-year period (from 2010 to 2020). The reason for this hypothesis was that we assumed "European road safety program 2011-2020" will be effective in decreasing the total number of RTADs in these regions (20). Our study proved this hypothesis for EU and Croatia but not for SDC. In contrary to our belief, SDC followed an unusual pattern. That is, unlike EU and Croatia, it followed a surprisingly unstable pattern throughout the entire ten-year period without having a considerable overall downward trend.

Whereas the number of RTADs for Georgia and Tajikistan had similiar overall downward trends to EU and Croatia from 2010 till 2019, Turkey had a completely opposite overall trend during this nine-year period. (27).

Our study's other finding is about the road-traffic-related mortality by road user class in Croatia over the ten-year period (2010-2020). All the six categories of RTA(s) investigated in our study had overall downward tends from 2010 till 2020. Therefore, this finding also confirms the success of "European road safety program 2011-2020" (20).

We hypothesized that there will be an overall downward trend for each RTA(s) category. Our study's finding about the road-traffic-related mortality by road user class in Croatia (2010-2020) supports this hypothesis. The reasoning behind this postulation was similiar to the one for the previous hypothesis. We supposed that "European road safety program 2011-2020" will be effective in this field as well (20).

In our study July, August or September were mostly found to be associated with the highest number of RTADS in a given year from 2010 till 2020. Furthermore, from 2010 to

2020, the months of February or March were most frequently observed in our study as being linked to the lowest number of RTADS in a given year. The potential explanation for these two findings is similar to the one for SDC. Croatia is one of the favorite tourist destinations during the summer season and this can increase the traffic congestion. As a result, during that particular period RTA(s) and road-traffic-related mortality will increase. But during winter season many people don't prefer to travel to Croatia.

Our research illustrated that in comparison with other categories, "Passenger cars" had the greatest number of RTADs constantly from 2010 till 2020.

Our study's findings about the impact of COVID-19 lockdowns on the number of RTADs suggest that by implementing several appropriate policies and laws, which will reduce the traffic congestion, the officials can effectively lower the number of RTADs. Based on this fact there can be several potential ways to do this. For instance, striving to put some new laws into effect, which will encourage more use of public transportation, designing specific types of roads that can fit more cars without creation of the traffic congestion, limiting the number of cars each household can have and identification of the rush hours in different regions and restricting the unnecessary use of vehicles in such specific times. We require more scientific researches to identify such solutions.

Further research is needed to determine the exact reason for SDC's unusual pattern for the total number of RTADs from 2010 till 2020. By establishing the exact reason for this phenomenon, the authorities might be able to tackle this problem easier and come up with the new reason-specific solutions for it.

Since "Passenger cars" constantly had the largest number of RTADs among all the other categories in Croatia from 2010 till 2020 and also made up the greatest proportion in 2020, it would be logical to direct the future researches toward this category.

One of the potential solutions to reduce the number of RTADs caused by "Passenger cars" category can be more strict implementation of the existing rules related to this field through introducing heavier fines or by other means. Furthermore, passing new laws, which will regulate this field better and more precisely, can be considered as another possible solution.

There are some limitations in our study. In this research some of data are missing. This study is solely a descriptive type of research and no statistical tests have been used in generation of its results, which limits the strength of the study. The reason behind this is that data we were working with was collected retrospectively from publicly available sources, so it has had limitations in analysis. All the data used in this research had been collected and put on the official websites by other authorities, whom we don't know, and there can always be a possibility of existence of a mistake in the process of gathering data that we are not aware of. This research can be limited by underreporting of RTADs.

6. CONCLUSIONS

1. According to our research, COVID-19 lockdowns had a favorable influence in 2020 on not only the overall number of RTADs in the EU, Croatia, and SDC but also Croatia's road-traffic-related mortality by user class.

2. Our research has demonstrated that whereas EU and Croatia had a remarkable overall downward trend in the total number of RTADs from 2010 till 2020, this wasn't the case for SDC and it followed an unusual pattern.

3. The number of road traffic deaths for all six of the previously described types of RTA(s) in our study had an overall downward trend in Croatia during the course of the ten-year period, according to our investigation.

4. There could be further researches about determination of the exact reason for SDC's unusual pattern for the total number of RTADs from 2010 till 2020, finding effective ways to reduce the RTADs in Croatia caused by road traffic collisions involving passenger cars and identifying some new approaches to decrease the traffic congestion.

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8. SUMMARY

Objectives: The aim of this study was to analyze the number of RTADs in SDC, the entire Croatia and the EU region and compare them with each other over a ten-year period (2010-2020). In addition, in this study we aimed to analyze the total number of RTADs for each year (between 2010 and 2020) in the whole Croatia based on the road user category and investigate the impact of the COVID-19 lockdown on the total number of RTADs in EU, Croatia and SDC in 2020 and Croatia's road-traffic-related mortality by user type in the same year.

Subjects and Methods: The presented study is a retrospective cross-sectional research. Data were acquired using databases from the Croatian Bureau of Statistics, Splisko-Dalmatinska County Police Administration, and Eurostat. The focus of this work is a ten-year span (from 2010 till 2020). The study contained information on the quantity and percentage of RTADs, several categories of road users, and the years during which these phenomena occurred. The EU, Croatia, and SDC were the three regions examined in this study. This study has made use of descriptive statistics.

Results: Looking from an overall perspective, the total number of RTADs for both EU and Croatia followed a similar pattern. RTA(s) killed a total of 426 and 29,576 persons in 2010 in Croatia and the EU, respectively. At first both of these numbers decreased gradually and after fluctuating for several years, in 2020 they finished at their lowest points in the ten-year period (2010-2020); this number was 18,786 for EU and 237 for Croatia. In SDC, there were 26 RTADs overall in 2010. Subsequently, this number followed an unusual pattern over the next ten years and it ended the period at the 25 in 2020. Only one of the three months, either July, August, or September, out of the twelve different months of the eleven years, with the exception of two specific years, saw the highest number of RTADs for that particular year in Croatia. Out of the twelve different months of those eleven years, only one of the two—February or March—saw the lowest number of RTADs for that particular year, with the exception of three particular years. "Passenger cars", "Pedestrians", "Motorcycles", "Bicycles", "Other" and "Mopeds" as the different categories of road users began the period at 205, 105, 51, 28, 22 and 15 respectively. The numbers for all these six categories finished the period at the values (N for "Passenger cars" = 126, N for "Pedestrians" = 38 , N for

“Motorcycles“ = 51, N for “Mopeds” = 5, N for “bicycles” = 9 and N for “Other” = 15), which were lower than their respective figures in 2010.

Conclusions: COVID-19 lockdowns had a favorable influence in 2020 on not only the overall number of RTADs in the EU, Croatia, and SDC but also Croatia's road-traffic-related mortality by user class.. Whereas EU and Croatia had a remarkable overall downward trend in the total number of RTADs from 2010 till 2020, this wasn't the case for SDC and it followed an unusual pattern. Throughout the course of the ten-year period there was an overall downward trend in the number of road traffic fatalities for all categories of RTA(s) in our study in Croatia.

9. CROATIAN SUMMARY

Ciljevi: Cilj ovog istraživanja bio je analizirati broj RTAD-ova u SDC-u, cijeloj Hrvatskoj i regiji EU te ih međusobno usporediti u desetogodišnjem razdoblju (2010.-2020.). Osim toga, u ovoj smo studiji imali za cilj analizirati ukupan broj RTAD-ova za svaku godinu (između 2010. i 2020.) u cijeloj Hrvatskoj na temelju kategorije sudionika u prometu i istražiti utjecaj karantene zbog COVID-19 na ukupan broj RTAD-ova. u EU, Hrvatskoj i SDC-u u 2020. i mortalitet u cestovnom prometu u Hrvatskoj prema vrsti korisnika u istoj godini.

Materijali i Metode: Prikazana studija je retrospektivno presječno istraživanje. Podaci su prikupljeni korištenjem baza podataka Državnog zavoda za statistiku, Policijske uprave splitsko-dalmatinske i Eurostata. Fokus ovog rada je desetogodišnji raspon (od 2010. do 2020. godine). Studija je sadržavala podatke o količini i postotku RTAD-ova, nekoliko kategorija sudionika u prometu te godinama u kojima su se te pojave događale. EU, Hrvatska i SDC tri su regije ispitane u ovoj studiji. Ovo istraživanje koristilo je deskriptivnu statistiku.

Rezultati: Gledajući iz sveukupne perspektive, ukupan broj RTAD-ova za EU i Hrvatsku slijedio je sličan obrazac. RTA(i) su u 2010. u Hrvatskoj ubili ukupno 426, odnosno 29,576 osoba. Isprva su se oba ova broja postupno smanjivala i nakon nekoliko godina fluktuacije, 2020. završila su na najnižim točkama u desetogodišnjem razdoblju (2010.-2020.); taj broj je bio 18,786 za EU i 237 za Hrvatsku. U SDC-u je 2010. bilo ukupno 26 RTAD-ova. Nakon toga, ovaj je broj slijedio neobičan obrazac tijekom sljedećih deset godina i završio je razdoblje na 25 u 2020. Samo jedan od tri mjeseca, ili srpanj, kolovoz ili rujan, od dvanaest različitih mjeseci od jedanaest godina, s iznimkom dviju specifičnih godina, zabilježen je najveći broj RTAD-ova za tu određenu godinu u Hrvatskoj. Od dvanaest različitih mjeseci tih jedanaest godina, samo je jedan od dva — veljača ili ožujak — imao najmanji broj RTAD-ova za tu određenu godinu, s izuzetkom tri određene godine. „Osobni automobili“, „Pješaci“, „Motocikli“, „Bicikli“, „Ostalo“ i „Mopedi“ kao različite kategorije sudionika u prometu započeli su razdoblje na 205, 105, 51, 28, 22 i 15 redom. Brojevi za svih ovih šest kategorija završili su razdoblje na vrijednostima (N za "osobne automobile" = 126, N za "pješake" = 38, N za "motocikle" = 51, N za "mopede" = 5, N za " bicikli” = 9 i N za “Ostalo” = 15), koji su bili niži od odgovarajućih brojki u 2010.

Zaključak: Zaustave zbog COVID-19 imale su povoljan utjecaj u 2020. ne samo na ukupni broj RTAD-ova u EU-u, Hrvatskoj i SDC-u, već i na smrtnost povezanu s cestovnim prometom u Hrvatskoj prema klasi korisnika. Dok su EU i Hrvatska imale značajan sveukupni trend pada u ukupnom broju RTAD-ova od 2010. do 2020., to nije bio slučaj za SDC i slijedio je neobičan obrazac. Tijekom desetogodišnjeg razdoblja postojao je sveukupni trend pada broja smrtno stradalih u cestovnom prometu za sve kategorije RTA-a u našem istraživanju u Hrvatskoj.

10. CURRICULUM VITAE

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