Analysis of road traffic fatalities in Norway in 2017 with comparison to Croatia

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ANALYSIS OF ROAD TRAFFIC FATALITIES IN NORWAY IN 2017 WITH COMPARISON TO CROATIA

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Table of contents

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This thesis is dedicated to my mother, who tragically lost her life in an RTA in Norway in 2007.

Abbreviations

RTA – Road traffic accident

RTAs – Road traffic accidents

SES – Socioeconomic status

1. INTRODUCTION

1.1. Epidemiology

1.1.1. The global burden of road traffic accidents

Fatalities caused by road traffic accidents (RTAs) globally still remain unacceptably high, with an estimation of approximately 1.35 million people dying each year. Additionally, between 20 and 50 million suffer non-lethal injuries, of which many are associated with disabilities as a result of the endured injury. RTAs are also said to be the leading killer of children, adolescents and young people, aged 5-29 years old (1). To put these numbers in perspective, there are today more people dying from the result of RTAs, than from infectious diseases, such as AIDS, tuberculosis and diarrhea (2). It has also been estimated that RTAs have caused a total of 60 million deaths during the 20^{th} century, which is the same number of fatalities occurring during World War II (3).

Low income countries have been associated with the highest mortality rate in traffic accidents at 29.4 per 100 000 people (as of 2016). Also, in countries with medium to low and medium-high incomes, RTAs are among the 10 most common causes of death (4).

1.1.2. Road Traffic in Norway

The Kingdom of Norway covers a total area of 365,268 km2 located at the westernmost and northernmost portion of the Scandinavian Peninsula, and has a population of 5.3 million (as of June 2019). Driving is a great way to explore Norway outside of the major cities. Spread across this long, slim country, there are approximately 92,946 kilometers of roads, of which 72,003 kilometers are paved, and 664 kilometers are motorways. The roads in Norway are divided into four different tiers of routes; national, county, municipal and private. Of these routes the most important, nationally speaking, are those that take part in the European route scheme (E-roads). As in most of Europe, Norway has right hand driving (6).

Norwegians have been described as a generally reserved and calm people, and the same can be said of the Norwegian traffic. Most drivers are disciplined, defensive and law-abiding to the traffic rules (7). Rules are strictly enforced, and all kinds of aggressive and unsafe driving behavior is regarded as an offence, and punished by the police with fines varying from 100 to 1000 EUR (8). For young drivers, who have recently received their driving license for passenger car (class B), the punishment is even stricter. In fact, new drivers are officially on a probation period, a “trial”, for two years to prove that they can drive and behave safely in traffic. If they are involved in accidents, speeding or other traffic offenses, they will often lose their license for a period of approximately 6 months as a punishment, with an additional fine (9).

The number of fatalities from RTAs has decreased over the last decade, making Norway one of the countries in the world with the lowest risk of being injured or killed in traffic (10).

1.1.3. Road Traffic in The Republic of Croatia

The Republic of Croatia is located in the north-western part of the Balkan Peninsula. This crescent-shaped country has a total area of 56,594 km^2 and a population of 4.1 million (as of 2017). As in Norway, driving is also a great way to explore Croatia, and there are about 29,958 kilometers of roads in this country. The public roads in Croatia are classified into the following four groups: highways, state roads, county roads and local roads. The highways make up around 1,416 km and are the main transport network in Croatia (11).

However, being a participant of the Croatian roads does not come without risks. RTAs are one of the most common causes of death in the Republic of Croatia, which makes it a significant public health problem. From 2010 and up until 2016, Croatia made good progress in lowering the number of fatal traffic accidents with a reduction of 22%. However, in 2017, the number of fatalities went up again by 8%, giving rise to the rather dark number of fatalities, at 80 per million inhabitants in Croatia (12).

The reason for choosing Croatia as the population to be compared with Norway, is not only that it is a popular tourist destination for Scandinavians, but also that it is a student-friendly country offering several English-language study programs.

1.2. Definitions

Traffic accident – an incidence occurring on the road, caused by violation of traffic regulations, involving at least one vehicle on the move and at least one person injured or killed (13).

Traffic death = when it comes down to the definition of *Road Traffic Death*, some countries only include the deaths at the scene of a crash. WHO, however, has promoted a definition that includes all people who die up to 30 days after an accident. As of today, 92 countries use the definition created by WHO (14). Norway and Croatia are both using the definition promoted by WHO.

Alcohol-related fatality = any death occurring within 30 days as a result of a fatal road crash, in which any active participant is found to have a blood alcohol level above the legal limit (15).

Participant in road traffic – a person who, in any way, participates in road traffic (13).

Driver – person on the road driving the vehicle (13).

Young driver – driver up to the age of 24 years (13).

Passenger – a person who is in or on a road vehicle, or is in the process of entering or leaving the road vehicle (13).

Pedestrian – a person, engaged in traffic, but not as a driver or passenger in, or on a vehicle (13).

Road – any public road, street in a settlement, and unmarked roads where traffic is being trafficked (13).

Motorway (highway) – a public road, specifically constructed and intended, solely for motor vehicle traffic, which has two physically separated carriageways (green belt, protective fence, etc.) for traffic from the opposite directions, with at least two traffic lanes of width of at least 3.5 m and considering terrain configuration (13).

"A fast road" – a public road intended for the exclusive use of motor vehicles with one or two separate trolleys having all intersections of two or more levels on transversal roads and other roads (railway or tramway strips), as a rule, does not have stopping strips (13).

The state road – a public road linking the entire territory of the Republic of Croatia and linking it to the network of major European roads (13).

County road – a public road connecting the area of one or more counties (13).

Local Road – a public road that is part of a county road network, and connects the area of a city or municipality (13).

1.3. Risk factors

When an RTA occurs, there are often several factors in play contributing to the event. These can be combinations of conditions relating to traffic participants and their behavior in traffic, conditions of the road and its environment, factors related to the vehicles, or external conditions, such as weather. Some factors are said to be contributing to the occurrence of a collision, and factors like these are therefore part of the crash causation. Other factors, such as speed of the involved vehicle(s), for example, can be said to have aggravating effect on the collision, and thus contribute to the severity of the trauma, or severity of endured injury. Needless to say, it is of uttermost importance to identify risk factors that contribute to RTAs, so that interventions to reduce the associated factors can be initiated, and accidents prevented. This part of the paper is devoted to discussing the different risk factors associated with fatalities in road traffic in general (16).

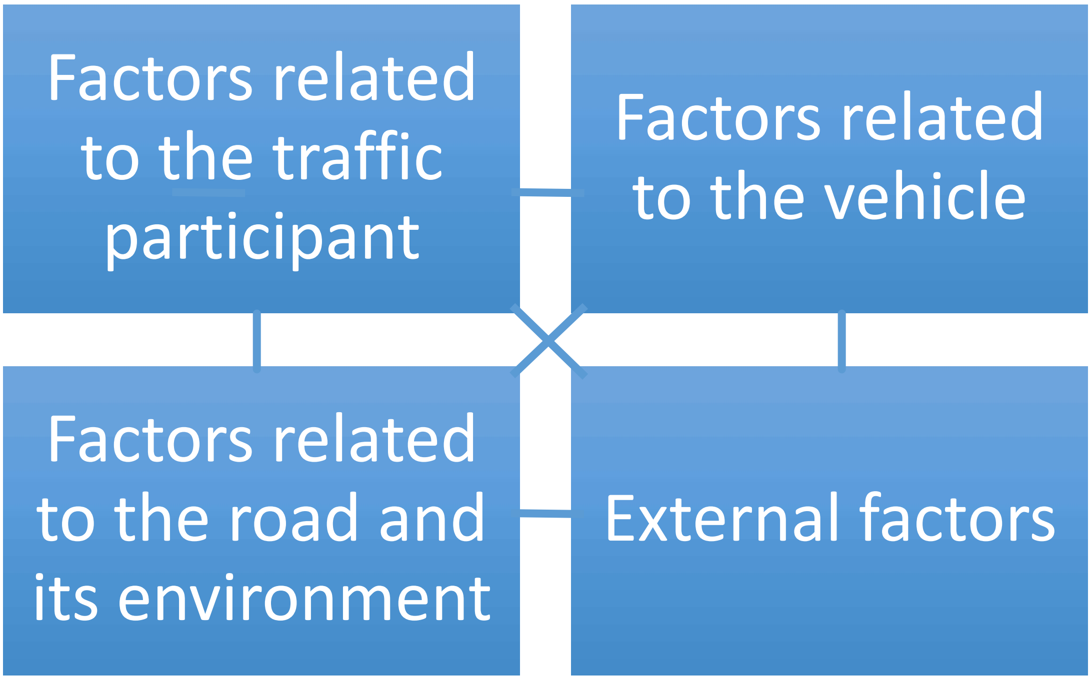

Figure 1. Risk factors associated with RTAs (Reproduced from: In-Depth Analysis of Fatal Accidents in the year 2017, Svein Ringen jr., Transportation Department, Traffic Safety, Norwegian Public Roads Administration).

The major risk factors associated with road traffic crashes are illustrated in Figure 1. Of the many factors contributing to fatal road crashes in Norway, those related to the driver has shown to be most important. Especially high yield factors associated with the driver, are driving skills, high speed, fatigue and intoxication (17).

1.3.1. Factors related to traffic participant

Gender

In regards to demographic factors, such as gender, it is well known from the international knowledge of road safety that women's traffic safety is significantly better to that of men. The explanation behind this has commonly been that women tend to show a higher concern for safety when on the road, in addition to having a safer driving behavior than men, especially in regards to taking risks. Women have also been shown to generally be more compliant towards traffic rules. An important point to the statistical over-representation of men in traffic fatalities, it is also known that men tend to go on longer road trips than women. In other words, men tend to be more exposed to being involved in traffic accidents since they drive more kilometers than women tend to do (18).

Age

Another demographic risk factor for RTAs is age. Traffic crashes are, according to the annual report on road safety from IRTAD, said to be the single greatest killer of young adults in the age group 15 to 24-year-old. It has been well known for decades that young drivers are more commonly involved in RTAs than the rest of the population. Typically, it has been observed that the risk of young people dying in an RTA is twice as high as for the average population. The reason behind these high crash rates among young drivers has, so far, partially been explained by high-risk behavior, inadequate experience in traffic and also lifestyle (19).

Older drivers are generally involved in fewer RTAs; however, they are still said to be one of the highest risk groups for being killed in traffic. According to the annual report on road safety from IRTAD, the risk of dying in traffic increases substantially with age. So, in people older than 75 years, the traffic-related mortality is much higher compared to the age group 65-74 years (19). The reduction in visual functioning and cognitive abilities are also risk factors associated with older drivers and their involvement in RTAs (19).

Socioeconomic status

The third, and last, demographic risk factor that will be assessed is the socioeconomic status (SES). According to WHO more than 90% of deaths caused by road traffic injuries take place in low- and middle-income countries. Even within high-income countries it has been shown that people with a lower socioeconomic background are far more likely to be involved in RTAs (1).

In high-income countries young drivers have been overrepresented in many causality figures with an overall increased risk of involvement in RTAs. There has also been an increase in the number of older people holding on to their driving licenses for a longer time in high-income countries, such as Norway. This differs greatly from that of low-income countries, where the older population may never have driven in the first place. The expectation is that in low-income countries, there will be a continuation of predominance of the involvement of young drivers in RTAs (16).

The overall general picture emerging from a review on the association between road safety and socioeconomic situation is that in high income countries people with a lower socioeconomic group, have a higher risk of involvement in RTAs than people from higher socioeconomic groups (20).

Type of traffic participant

In general, it can be stated that all participants in traffic are at risk of being both injured and killed in RTAs. However, there are some noteworthy differences in fatality rates between the various traffic participants. According to WHO’s Global Status Report on Road Safety (2018), more than 50% of all road traffic fatalities are among vulnerable road users. Those that are classified as particularly vulnerable in traffic are participants using two-wheelers, such as motorcyclists and moped riders, cyclists and pedestrians. Compared to being inside a vehicle, these road users bear a significantly greater burden of injury if involved in an accident. The number of deaths and injuries among these traffic participants is significant. The burden is significantly increased for these road users in low- and middle-income countries, due to the larger span in variety and intensity of traffic mix, and also due to the insufficient separation from other road users. Of utmost importance is when vulnerable and slow-moving, non-motorized traffic participants are using the same roads as fast-moving, motorized vehicles (21).

Regardless of their role of participation in traffic, elderly, small children and people with disabilities are also especially vulnerable. A special attention should therefore be paid to ensure and promote their safety as participants in traffic. Traffic participants using public transport systems, such as buses, trains, underground trams etc. are also noticed to have an increased risk in low- and middle-income countries (21).

Lack of driver skills

Poor driver skills often result from lack of experience and knowledge, which further contributes to misjudgments and/or irresponsible behavior in traffic. The assessment of driver skills after a fatal accident is, more or less, a subjective assessment after the course of events has been mapped out and understood. It is considered, among other things, whether the situation was too difficult for an average driver, or whether the person should have been able to handle the situation (5).

Assessment of driving skills:

- How long the driver has held a drivers' license
- Unfortunate conditions for the vehicle
- The road environment's complexity
- Information to the driver from the road environment
- Difficult external driving conditions
- How the driver has arranged the driving according to the conditions

Distracted driving

There are no news in stating that all drivers need to keep their attention focused on the road, and on the surrounding traffic at all times. Being distracted when driving is a well-known risk factor for causing harm to yourself, your passengers, your surroundings and other traffic participants. The European Commission has classified distractions into three basic types, and drivers are often distracted by a combination of the following type of distractions (22):

1) **Visual distractions** – drivers taking their eyes off the road
2) **Cognitive distractions** – drivers think about other things than driving
3) **Manual distractions** – drivers take their hands off the steering wheel

Distractions are a common cause of RTAs, and especially those related to the use of mobile devices, radio, CD/cassette or the manipulation of other equipment in the car while driving (5). Mobile devices are a major sinner and source of distraction in these modern times. Smoking and eating are also not uncommon distractions (22).

Fatigue

Fatigue and tiredness can be rather difficult to assess as a factor of fatal RTAs where the party believed to be the cause of the accident has died. However, in many situations one can see several indications that the driver has fallen asleep, including that the vehicle has drifted slowly out of the roadway, or has driven on a road shoulder over a longer distance before finally driving off the road. Other indications pointing towards the driver falling asleep is the obvious lack of skid marks (5).

Intoxication

Alcohol continues to be the most commonly drug associated with RTAs. According to the Global Status Report on Road Safety 2018, it is estimated that of all road deaths, 5-35% are reported as alcohol related. Driving under the influence of alcohol, and other psychoactive substances, is an important risk factor for road traffic fatalities and injuries. Sadly, driving under the influence (DUI) is over-represented in RTAs (23). According to WHO, DUI increases both the risk that a crash takes place, and that death or serious injury will be the final outcome of the crash. Further, the risk is said to be significantly increased when the blood alcohol concentration (BAC) reaches 0.04 g/dL and above (25).

Cannabis is the second most prevalent drug associated with RTAs. A population-based case-control study shed light on this particular matter, stating that there was a significant increase in the risk of RTAs and injuries in habitual use of cannabis. The same study, however, stated that further research is necessary to assess the nature of the relationship between cannabis use and risk-taking in traffic (26). A more recent study concluded that the crash risk in cannabis users increase progressively, with both the increased dose and the frequency. This study also concluded that additional research is necessary to further assess the role of cannabis in traffic participants, and also the combination of cannabis with other drugs (27). Intoxication is frequently associated with driver errors, high speed and lack of seat belt use (28).

Disease and Medication

Disease in the driver of the vehicle can be difficult to detect and assess as a risk factor and causality of RTAs. However, it may still be a significant risk factor, especially among the elderly population. According to a population-based case-control study older drivers with medical conditions, such as heart disease and stroke, pose an increased risk of involvement in RTAs (29).

While alcohol and illicit drug use dominate, some prescription medications may contribute to an increased risk of RTAs, if they are not taken as prescribed. Medications can affect a number of brain functions that further may have an impact on the ability to drive a vehicle, of any kind, safely. Relevant functions that can be altered by medications are psychomotor skills and cognitive functions. Reaction time, and hand-eye coordination, belongs to the psychomotor skills that can be affected, and is an important skill to keep intact while operating a vehicle. Vigilance, and the proper ability to interpret the different traffic situations, are some of the crucial skills required for safe driving (30).

Medications with a depressing effect on the CNS will reduce vigilance, prolong the reaction time, and may even lead to an increase in errors associated with making decisions in traffic, and keeping the appropriate speed (30). Psychoactive medications are a group of medications often used by the elderly population, which has the potential to interfere with, and even hamper their driving ability, and therefore increase their risk of being involved in an RTA (31).

Older drivers with medical conditions, such as heart disease and stroke, have an increased risk of being involved in RTAs (32). It is no secret that with increased age there is a pattern of polypharmacy as well. Psychoactive drug polypharmacy is especially well known to have the potential to cause adverse side effects and interactions, which consequently can lead to an increased risk of RTAs (33).

Use of safety measures

It is no secret that one of the wisest, simplest and safest choices a driver (and the passengers) can do is to buckle up when inside a vehicle. It is, in fact, the easiest and most effective tool to reduce the number of fatalities, and severely injured in traffic accidents. But for the seat belt to fully function, it is crucial that it is used correctly. The seat belt should be fastened tightly to the body and not, under any circumstances, be twisted or tangled. It should be placed tight across the hips, and always across the shoulder. When a seat belt has been fastened (clicked on), it is wise to tighten it afterwards (34).

In Norway, seat belt use is described to be evenly good, but not good enough. The analysis of accidents performed by the Norwegian Public Roads Administration, reveals that in 4 of 10 fatal RTAs, the seat belts were not fastened. 30-40 lives could be spared every year if everyone always used a seat belt, both in passenger cars, and onboard buses. Not only does the seat belt keep the driver or passenger in place in their seat, but it also prevents them from being a potential hazard for others, if an accident were to occur. For example, if the passengers in the back seat are not secured with a seat belt, they can be thrown forward causing injury to the driver and/or passengers in the front seat. A collision at 50 km/h without the use of a seat belt can be compared to a free-fall from 10 meters. At 90 km/h without wearing a seat belt can be compared to a free-fall from 32 meters (34). According to the World report on Road Traffic Injury Prevention, the rates of seat belt use differ greatly among the different countries in the world, and assessing this risk factor will be rather interesting, especially in regards to the variations in laws and regulations (14).

Children, as participants in road traffic, are especially vulnerable and can be seriously injured, even in low velocity crashes. They are even more exposed to injury and death, if they are not properly secured in restraints (safety seats). The use of child restraints is known to offer a high level of protection, especially in preventing fatalities from RTAs. Restraining children in vehicles work in the same way as seat belts does for adults, and rear-facing seats have been particularly effective in regards to safety (14). The child should be fitted correctly into a child restraint according to the manufacturer’s instructions. All child seats are divided into different weight classes, and it is crucial to follow these classes for optimal safety of the child (35). The different methods and regulations of restraining children in vehicles vary between countries, and may be an interesting factor to assess. It is known that in high-income countries, such as Norway, the use of child restrains is high and strictly regulated. Whilst in low-income countries the use of child restrains is rather rare (14).

Motorcyclists, moped riders and other users of two-wheelers, tend to sustain fatal injuries to the head. Trauma to the head and brain is known to be the main cause of death and morbidity among users of two-wheelers. One of the main risk factors for operating a two-wheeler in road traffic is therefore the non-use of helmets. According to literature, using a helmet is known to reduce both the fatal outcome, and the severe head and brain injuries from an RTA (14). A study by Kulanthayan et al., discovered that the risk of sustaining head injuries when not wearing a helmet weas three times more likely, compared to wearing a helmet. However, a huge variation has been observed in use and non-use of helmets between high-income countries (where the helmet-laws often are strictly enforced) and low-income countries (36). Different studies on the use and non-use of helmets in low-income countries, has revealed that more than 50% do not wear their helmets properly secured (36, 37).

Another fundamentally essential way to be safe in traffic, for all road users, is to see and be seen. Inadequate, or lack of visibility in road traffic, is therefore considered to play a crucial role in the cause of road traffic crashes and collisions (38). According to a study performed in Detroit, inadequate visibility is thought to be of utmost importance for the occurrence of three different types of RTAs; crashing into a vehicle that is moving slowly or standing still on a roadway at nighttime, head-on or angled crashes during the daytime, and rear-end collisions during challenging weather, such as fog (39).

Pedestrians, cyclists and users of two- and four-wheelers, also pose a special vulnerability related to visibility in traffic (40).

Speeding

It is no secret that the speed of a motorized vehicle is one of the core problems associated with RTAs and their outcomes. In fact, inappropriate speed is estimated to be the cause of 20-30% of all fatal road accidents occurring (41). Increasing the average speed is directly related to the likelihood of an RTA to take place, and to the severity that may follow as a consequence of the crash. According to WHO, every 1% increase in mean speed will lead to a 4% increase in the risk of a fatal RTA to occur, and a 3% increased risk of a serious RTA occurring (1).

The greater the vehicle's speed, the shorter the driver's reaction time need to be. For example, when a car is travelling at 40 km/h it will require less than 8 meters, on a dry surface, to stop. A car going 10 km/h faster, that is 50 km/h, may need up to 13 meters to stop. Speed of the vehicle also has a huge impact if the RTA involves a pedestrian being hit. The risk of fatality rises rapidly with the increase in velocity. In fact, a pedestrian has a good chance (around 90%) to survive a car crash that occurs with a vehicle going 30 km/h or less. However, as the speed increases to 45 km/h or more, the chance of survival is reduced to less than 50% (1).

In Norway, speeding well above the speed limit, or high speed in relation to the surroundings, external factors (that would require a lower velocity, such as demanding weather) is often a contributing factor to fatalities in RTAs. High velocity is also, naturally, a significant contributing factor to the extent of damage of the crash (5).

Type of traffic accident

There seems to be no limits to the different ways to classify types of traffic accidents today. Some examples are to classify according to the damage severity of the vehicle, type of vehicle transportation type, number of vehicles involved, first harmful event, location, and type of motor vehicle involved (42). For the sake of simplicity, and possibility for later comparison between different populations, the types of traffic accidents will, in this paper, be classified accordingly (5):

- **Same driving direction collisions** (rear-end collision)
- **Head-on collisions** ("meeting collisions")
- **Accidents associated with crossing and turning**
- **Accident involving pedestrian(s)**
- **Run-off accidents** (driving off the road)
- **Other accidents**

1.3.2. Factors related to the vehicle

The use of safe vehicles certainly plays a critical role in preventing traffic crashes, and also reducing the likelihood of victims sustaining serious injuries (1). Today there are a number of UN regulations on vehicle safety. WHO states that if these regulations were to be applied to countries' manufacturing and production standards, many lives could potentially be spared (43).

Active Safety of the vehicles

Active safety, also called "primary safety system" by some manufacturers, includes the safety features of the vehicle which reduce the chances of an RTA to occur in the first place. Active safety features will be active before the accident takes place, and therefore works to prevent, or avoid accidents. The most common factors are defects, faults or weaknesses in the active safety equipment in the vehicle, such as the Electronic Stability Control (ESC) or the

Anti-lock braking system (ABS). Other technical vehicle factors also commonly implemented, are cars with a narrow axle track/track gauge (the distance between the centerline of two road wheels on the same axle) and cars with a high center of gravity (5).

Passive safety of the vehicles

Passive safety, refers to the protection that the vehicle itself gives the driver and passengers when RTAs occur. It does not do any "work" until it is called into action. The effects of passive safety come into function during an accident, to minimize the damage, and also to reduce the risk of injury to the people inside the vehicle at the time of impact. Some of the passive safety systems found in vehicles are seat belts, airbags and, last but not least, the construction of the vehicle itself (5).

Newer cars have also been constructed in a specific way to cause less injury to pedestrians, cyclists and other vulnerable traffic participants. The vehicles are built with a stiffer cabin, and a softer front, thereby achieving a deformation zone in front of the cabins. Older vehicles often lack this energy-absorbing deformation zones, and people in older cars are therefore more prone to suffer from greater deceleration forces. Some older vehicles also lack air bags, side air-bags, belt tensioners and extra stiffeners in the doors, which makes them less safe to be involved in an accident with (5). The "critical hit point" on a vehicle is defined as a point outside the deformation zones, where the chassis (framework) of the vehicle does not absorb the energy from the collision, causing an increase in the injury impact. When the built-in chassis is poorly constructed, it contributes to a reduction in passive safety of the vehicle, and may be a contribution to the extent of damage in collisions (5).

Another important factor is when there is a great difference in energy quantity. The energy of a vehicle in motion depends on the vehicles mass (weight) and speed. When a crash occurs, the kinetic energy is converted into mechanical deformation. As a consequence of this, heavy-weighing vehicles will, naturally, represent a larger quantity of energy than a vehicle with a smaller mass. In an RTA between two vehicles, the lightest of them will sustain the greatest damage, which is due to the increased negative deceleration load (5).

Growth in number of vehicles

Globally, one of the main factors known to contribute to the increase in RTAs is the growing number of motor vehicles. Needless to say, the increase in number of vehicles in traffic can lead to problems for pedestrians, cyclists and other over-exposed participants in traffic (14).

1.3.3. Factors related to the road

Apart from the traffic participants and vehicles, road infrastructure is a major factor contributing to road safety. It is well known that roads that are well-designed, well-built and, last but not least, properly maintained, play a great role in road safety (21).

Type of road

According to the annual road safety report from IRTAD, most traffic fatalities take place on rural (country) roads. Fatal RTAs are also increasing in urban areas. Motorways are the safest roads to drive on, and the risk of fatalities ranges from two to six times lower than on the whole network (19).

According to WHO's Global Report on Road Traffic Safety (2018), road infrastructure poses a great link to the causation of fatalities and serious injuries in RTAs. Research done on this matter has revealed that improvements in road infrastructure are essential, and critical in making roads safer. Of particular importance is the design standards that include the safety of all road users (2).

Road and road environment

Road and road environment are rarely a direct cause of RTAs, but they can certainly contribute along with other factors. The three conditions of the road, and its environment, that have most often contributed to fatal accidents, are the road's alignment, sight obstruction and road surface/cover (5).

- **Unfortunate alignment of the road –** When the road has a straight route and tends to be monotonous, the risk of drivers falling asleep is increased.
- **Sight obstructions and obstacles**
- **Road cover –** The driving conditions in Norway tend to change rapidly, hence, a road that is seemingly dry can suddenly turn out to be quite slippery, and even icy. This can be said especially for the roads located in the mountainous and coastal areas, which tend to be generally narrower and curvier than most roads in Europe and North America (7).

According to a paper written about Internationalization in Road Transport of Goods in Norway it is stated that a higher number of RTAs occur during winter, compared to summer, in Norway. Driving during the winter has also been found to be one of the main safety challenges related to foreigners driving in Norway. Norwegian drivers are better equipped, more competent, and experienced to master winter driving (44). Nonetheless, this does not eliminate the fact that the road cover/surface does, in fact, contribute to fatal RTAs (5).

1.3.4. Miscellaneous factors

External conditions include various factors related to weather, road conditions, road environment and the traffic participant. Distractions along the roads, such as advertising etc., will also be included in this part. As for conditions related to road and road environment, the external factors only have an indirect contribution to RTAs. Nevertheless, they may play a crucial role in the way a dangerous situation could develop into a fatal affair (5). The most dangerous times during the day, the week, and the year will also be assessed in this section. Traffic regulations and restrictions will also be discussed in this section.

Weather

The weather is considered to be a factor contributing to RTAs and fatalities, and according to literature, weather may explain approximately 5% of monthly accident/fatality variability. Based on this fact, it is important to include the weather conditions when analyzing the trends of RTAs, in order for the challenge to be better understood, and also prevented. The climate also pose different effects on road safety depending on the type of road, such as motorways, rural or urban roads. Mobility is also stated to have been affected by the weather. This study concluded that the number of RTAs affected by the weather is partly due to changes in mobility happening simultaneously (45).

It is not, however, an easy task to capture and measure the climatic factor. It also raises a number of issues, one being how to determine which meteorological phenomena that will have a significant influence on road safety and the risk of RTAs to occur. Other issues that must be assessed are which variables to use for the measurement of these climatic factors. The time scale to measure weather should also be determined in such a way that it will be significant on a monthly time scale (45).

According to Brodsky and Hakkert rain has been considered as the major meteorological explanatory factor for the risk of an RTA to occur (46). Several other studies also conclude that increased rainfall often is associated with an increased frequency of RTAs. On the contrary, a study performed by Karlaftis and Yannis, stated the opposite; that an increase in rainfall also has been observed to reduce the number of RTAs (47). An interesting study by Eisenberg regarding the time-varying effects of rainfall revealed that the driver is likely to adapt when it rains over time, so in other words, the impact of the rain was reduced when it had been raining the previous days (48). Another study performed by Brijs et al., confirmed this finding, stating that the longer the period since the previous rainfall ("dry spell"), the higher the number of RTAs happen when it starts to rain again (49).

The increase in temperature has also been associated with an increase in the risk and frequency of RTAs. Additionally, the total number of hours that the sun had been shining on the road was interestingly found to increase. Temperatures that are deviating from the mean daily, or mean monthly anticipated degrees, have also been related to an increase in RTAs. Extremely low temperatures in the winter and extremely high temperatures in the summer have also been positively correlated with RTAs. However, a reduction in RTAs have been observed, when the monthly number of days with sub-zero temperatures increase, which is believed by the authors to be due to lower exposure (50).

Geographical differences and the exposure to adverse weather conditions is also an important factor to keep in mind, when assessing the impact of extreme weather conditions as a risk factor. For example, RTAs in Northern Europe, Scandinavia and mountainous areas elsewhere in Europe, tend to be more frequently associated with strong winds, snow and icy roads, that can be both a primary cause, and contributing factor to RTAs (51).

Brijis et al. stated that an increase in maximum wind gusts is correlated with an increase in the number of RTAs. The same study assessed the duration of sunshine and global radiation, and found it to have a significantly negative impact on the safety of the road. The most significant factor was, however, also concluded to the duration, not the amount, of the rainfall (49).

Time of year

Among the many factors affecting traffic flow, seasonality and time of year, has been observed to be of them. A study by Murat et al., found that a reduction in traffic flow is seen during the winter in cold climate zones, and increase during the summer months. In tourism areas, and outside of cities, traffic also tends to increase during the summer months. The same trend has been observed for the distribution of accidents; they tend to occur more frequently in summer months than in winter months (52).

Another study that took place in Ankara, concluded that seasons have less effect on the prevalence of road traffic crashes than other factors, both in and outside of cities (53). As already mentioned in the previous section, meteorological conditions may have a negative effect on drivers and increase the risk of RTAs, especially in the summer and winter (52).

Time of the week

The distribution of traffic flow and RTAs is not equally distributed throughout the week. A report from the European Road Safety Observatory, states that since there are 168 hours per week, the average distribution fatalities would be 0.6% per hour through the week, if equally distributed. However, they are not equally distributed since there is a daily afternoon peak in RTAs from Monday to Thursday, and few fatalities occurring during nighttime. This report also found that the highest number of fatalities were observed early in the morning on Saturdays and Sundays (54).

Time of day

Traffic flow during the day has been known to correlate with sunlight (55). Traffic flow tends to increase, and be denser, with sunrise and decrease with sunset. By nighttime the traffic flow, more or less, disappears. Movements of the sun have, therefore, been said to have a close relation to the periodical variations observed in the flow of traffic (52).

A study performed in England concluded that most RTAs tend to occur in the daylight during clear weather conditions. This study also found that when the weather conditions are bad, drivers tend to be more careful, and so the accident rate drops (56).

In this paper the different times during the day has been divided according to the degree of lighting; 1) daylight, 2) twilight (dusk), 3) darkness with external lighting and 4) darkness without external lighting of roads.

Traffic regulations and restrictions

Norway. Norway is a country known for its serious law enforcement and regulations of the traffic system. If rules are not obeyed, strict punishments follow. Most of the Norwegian roads are dual-lane with a yellow centerline. The general Norwegian speed limit in rural areas is 80 km/h and in urban areas it is 50 km/h (7). The speed limit can be as low as 30 km/h, often seen in residential and school areas, and on the motorways (and certain dual carriageways) situated around the capital the speed limit is 110 km/h. This is the highest speed limit allowed on Norwegian roads. Vehicles classified as *heavy* (weighing more than 3.5 tonnes) and trailers may not exceed the speed limit of 80 km/h regardless of the local limit. An exception from this rule apply for camping vehicles under 7.5 tonnes, who are allowed to follow the given speed limits (57).

If you fail to comply with the traffic rules and regulations in Norway, you will receive a fine, penalty points to your driving license, and a prison sentence – for the most serious violations that is. There are many traffic laws and regulations in Norway that must be followed, to avoid getting punished. Speeding is one of the offenses that are strictly punished in Norway. If the speed limit is 60 km/h and the speeding is up to 10 km/h above, the fine is 2100 NOK (215 EUR), up to 20 km/h above, the fine is 5500 NOK (860 EUR), and up to 25 km/h, the fine is set to 8500 NOK (860 EUR). When the speed limit on a motorway is 90 km/h or higher, and the speeding is between 36 and 40 km/h above, the fine is 10650 NOK (more than 1000 EUR) (8).

Another important traffic law in Norway, that is strictly punished compared to what it is in other countries, is the distance you keep to the vehicle in front of you. You should have at least 3 seconds between your vehicle, and the vehicle in front of you. If the distance you keep is too short you will be fined with 6500 NOK (660 EUR) (8).

If you are not using your seat belt, and are caught by the Norwegian police, or the Norwegian Public Roads Administrations who are also allowed to give fines in this particular matter, you will receive a fine of 1500 NOK (150 EUR). This law also applies to passengers on busses (58).

In Norway it is mandatory to secure children in vehicles, and there are two different regulations approving safety equipment for children. ECE R 44-04 and ECE R 129 (i-Size). It is mandatory to secure infants rearward in proper accordance with these current regulations. According to R 44, a child must be secured rear-facing until they weigh more than 9 kg. And according to R 129, children must be secured rear-facing until they are over 15 months. The regulations state that children under the height of 135 cm should always use approved child restraint systems, that are appropriately adjusted for both the height, and the weight of the child. Children that are between 135 and 150 cm must also use approved child safety equipment. All equipment used for securing children in cars must bear the relevant approval mark, which indicates which weight and height class the used equipment applies to (35).

There is also a law stating that children should never be transported in a reversed car seat in the front of a vehicle where there is an airbag. One exception to this rule is if the airbag is disabled manually or automatically. If there are no seat belts available to use in a vehicle, children are not to be transported under any circumstances. Children older than 3 years should not be seated in the front seat without using a seat belt, even over short distances (35).

The legal limit for blood alcohol concentration (BAC) in Norway is 0.02 g/dL (0.2 ‰) (59). However, this limit used to be 0.05 g/dL (0.5 ‰), but on January 1st 2001 it was reduced to the current limit. To assess the effects of this reduction, concerning knowledge, behavior and accidents, a before-and-after telephone survey was performed. A total of 3001 drivers were interviewed both before, and after the new law was set in motion. The results of this survey revealed that the percentage of drivers claiming that they will not drink alcohol before driving, has gone up from 82% to 91%. In other words, the distinction between operating a vehicle, and drinking alcohol has become clearer after lowering the legal BAC limit in Norway (60).

For driving in Norway there are specific demands for the safety of the vehicle, specifically when it comes down to having sufficient grip on the road surface. The tire requirements for vehicles weighing up to 3500 kg are as follows: 1) the tread depth must be a minimum of 3 mm during the winter season, 2) studs may only be used on winter tires (an exception to this rule apply for motorcycles) and 3) if studs are to be applied to a light vehicle all four tires must be equipped with studs. Using studded tires (and snow chains) is not permitted up to and including 31th of October, and from the second Monday following Easter Sunday. There are, however, no limitations to the use of winter tires without studs (and they can be used all year around). Outside of the winter season the tread depth should be a minimum of 1.6 mm. Heavy vehicles have their own requirements for winter tire. When the surface is especially slippery a sufficient adherence can be established by the usage of studded or non-studded winter tires, chains or similar devices, such as snow socks etc. (61).

Croatia. In inhabited areas in Croatia, the recommended speed limit is set to 50 km/h, but if conditions allow it, one can drive 80 km/h. On other than fast roads, highways and roads in inhabited areas, the limit is 90 km/h. On roads designed for motor vehicles the limit is 110 km/h, and on motorways it is 130 km/h (62).

In Croatia speeding more than 10% above the speed limit is tolerated on regular roads. On the motorways 20 km/h above the speed limit, which is 130 km, is allowed. If the speed limit is 40 km/h the police will tolerate a speed of 50 km/h without giving fines. If a driver is speeding in the inhabited area, the fines are as follows: 10 km/h over the limit: 300 HRK (40 EUR); 10-20 km/h over: 500 HRK (approx. 70 EUR); 20-30 km/h over: 1000 HRK (135 EUR); 30-50 km/h over: 2000 HRK (270 EUR) and more than 50 km/h above the speed limit 5000-15000 HRK (675-2000 EUR) or 60 days in jail. In the inhabited areas, the fines for speeding are: 10-30 km/h: 500 HRK; 30-50 km/h: 1000 HRK; more than 50 km/h: 3000-7000 HRK (400-945 EUR) (62).

In Croatia it is mandatory to use seat belts if they exist (art. 163 of the Traffic security law) except if health reasons exist (passenger needs a certificate from doctor) (62).

In Croatia, children under the age of 3 years should be placed in special chairs. If the child is between 135-150 cm a booster seat can be used in the rear seats. Children taller than 150 cm can sit in the front seats (62).

In the EU the legal limit for alcohol consumption are not the same in all of its united countries. It is, like in Norway, measured in standard BAC in g/dL, and varies between 0 in countries like Hungary, Czech Republic, and Slovakia. Whilst countries like Malta and the UK has the highest allowed limits with a BAC of 0.08 g/dL. In Croatia the allowed blood alcohol concentration is 0.05 g/dL (0.5 ‰). Unfortunately, almost none of the countries in Europe systematically takes alcohol blood tests of all traffic participants who are involved in RTAs, which is why RTAs related to the use of alcohol is underreported in the official statistics in most countries (23).

Tires. There are areas of Croatia and periods in year when it is mandatory to have winter equipment (tires or chains). Winter tires and headlights during the day are required from November 15^{th} to April 15^{th} in Croatia (62).

In this paper the focus has been assessing the most important risk factors associated with fatalities in road traffic crashes. Other factors, such as the time for first responders to reach the victims, has been thought of, but will not be discussed in this paper due to limited time and capacity.

2. OBJECTIVES

The aim of this research was to perform an analysis of the risk factors associated with lethal RTAs in the Kingdom of Norway in 2017, and compare it to the fatalities in the Republic of Croatia. Another matter to be assessed was whether Norway is a safer country when it comes down to road traffic, by comparing of the different risk factors between the two populations, and to find the significant risk factor that should be assessed for prevention in the future.

My hypothesis is that it is safer to be a traffic participant in Norway compared to Croatia.

3. SUBJECTS AND METHODS

This work was organized as a cross-sectional research. The analyzed data was supplied with the courtesy of the Norwegian Public Roads Administration, the Norwegian Cause of Death Registry and the Norwegian laws and regulations. Necessary data from the Republic of Croatia was collected from the Ministry of Internal Affairs, Department of Statistics and from the Croatian laws. Analyzed data was also collected from WHO for a global overview. The statistical analysis were performed using an online chi-square calculator (from the following web page: https://www.socscistatistics.com/tests/chisquare/default.aspx) and p value <0,05 was considered to be statistically significant. Graphs were produced using Excel. The investigation included the fatalities in road traffic in Norway and Croatia in the year 2017.

4. RESULTS

4.1. The Kingdom of Norway

In Norway in the year of 2017, 102 fatal RTAs occurred, and a total of 106 people were killed as a result of these accidents. The total number of severely injured were 665, 28 less than the previous year. In 2017, there were 20 deaths per million inhabitants in Norway. Figure 2 illustrates the extent to which the different types of risk factors has contributed to RTAs in Norway in 2017.

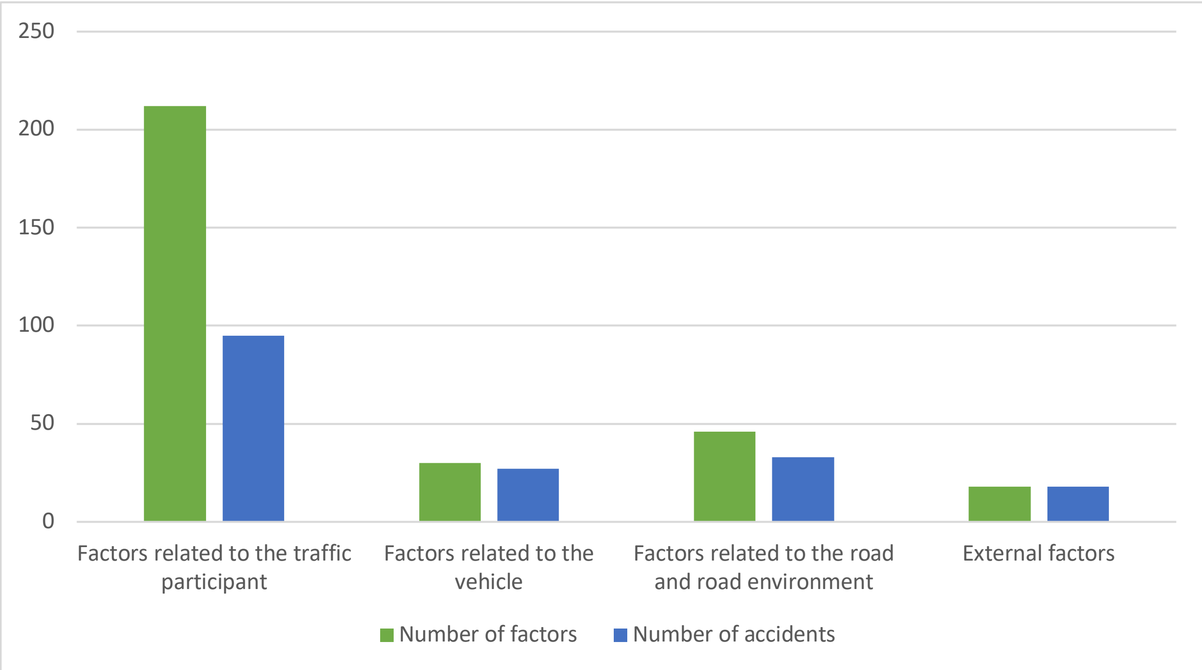

Figure 2. Number of contributing factors to the lethal RTAs in Norway in 2017. Illustrated in green are the total number of contributing factors, and in blue are the number of accidents that occurred. (Reproduced from: The In-Depth Analysis of Fatal Accidents in the year 2017, Svein Ringen jr., Transportation Department, Traffic Safety, Norwegian Public Roads Administration).

Gender. Of the 106 fatalities in Norway in 2017, 74 were men and 32 were women. Looking at the statistics for severely injured, men were largely over-represented with 450 of the total 665 severely injured.

Age. In Norway in 2017, 17 persons under the age of 25 years were killed in RTAs, which is the lowest number of persons in the time range of 2005 to 2017. Of the young people killed, there were; 7 drivers, 3 passengers, 3 motorcyclists, 1 moped rider, 1 pedestrian and 1 bicyclist. Children and adolescents younger than the age of 25 make up approximately 30% of the Norwegian population. However, the highest number of fatalities were seen in people aged 45-64 (33 fatalities). 41 traffic participants aged 70 years or older, were involved in 32 fatalities.

And among these 41 elder victims, 25 were involved as a driver, 12 as a passenger and 4 as pedestrians.

Type of traffic participants. Among the 106 fatalities in Norway in 2017, 51 of them were drivers of a car, 12 were passengers, 21 used a motorcycle or a moped, 20 were pedestrians or cycling/riding and 2 belonged to an unspecified category (*Figure 3*).

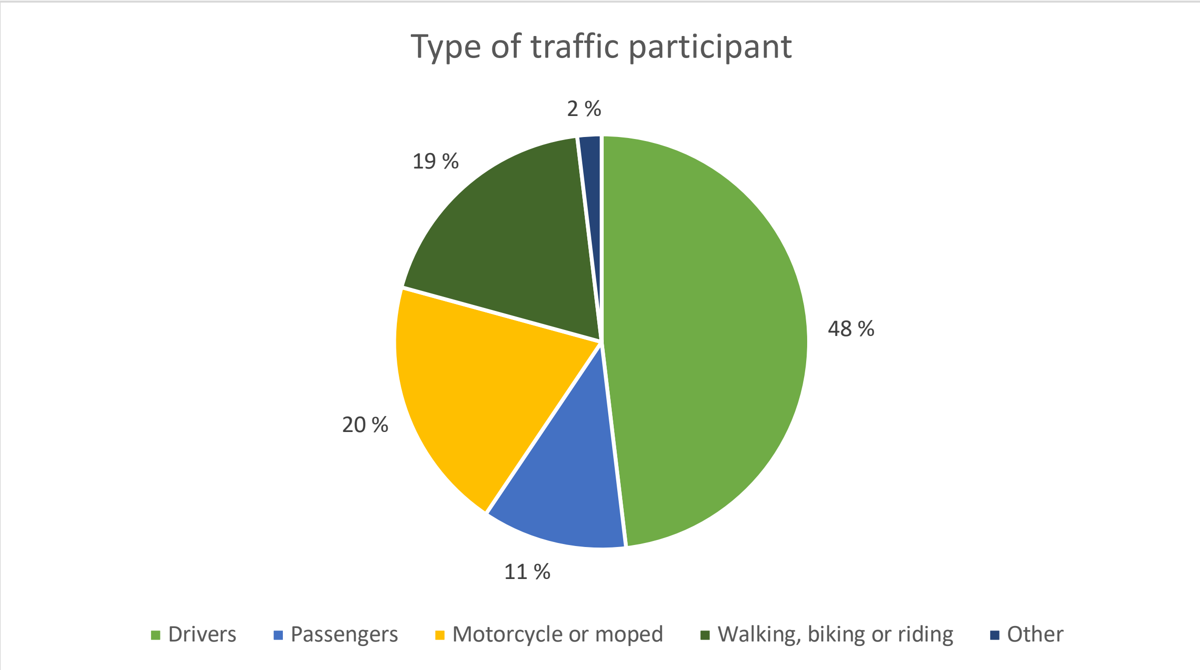

Figure 3. Type of traffic participant in lethal RTAs in Norway in 2017. (Reproduced from: In-Depth Analysis of Fatal Accidents in the year 2017, Svein Ringen jr., Transportation Department, Traffic Safety, Norwegian Public Roads Administration).

A total of 180 traffic units (road vehicles) were involved in the fatal RTAs in 2017 (Figure 4). Of the 180 units involved, 53% were passenger vehicles and vans (96 units in total). Passenger cars and vans were involved in a total of 76 accidents, which correspond to 75% of all fatal accidents in 2017. Heavy vehicles (such as trucks, busses and trailers) made up 19% (34 units in total), and were involved in 33 fatal accidents (32%) in 2017. A total of 54 people died in passenger cars in 2017, which corresponds to 51% of the fatalities. Of the fatalities in RTAs in Norway in 2017, 61% were drivers or car passengers.

Lack of driver skills. One or more factors related to lack of driver skills contributed to 44 fatalities in 2017. The most common factors are the lack of gathering information and hazardous driving (Figure 5).

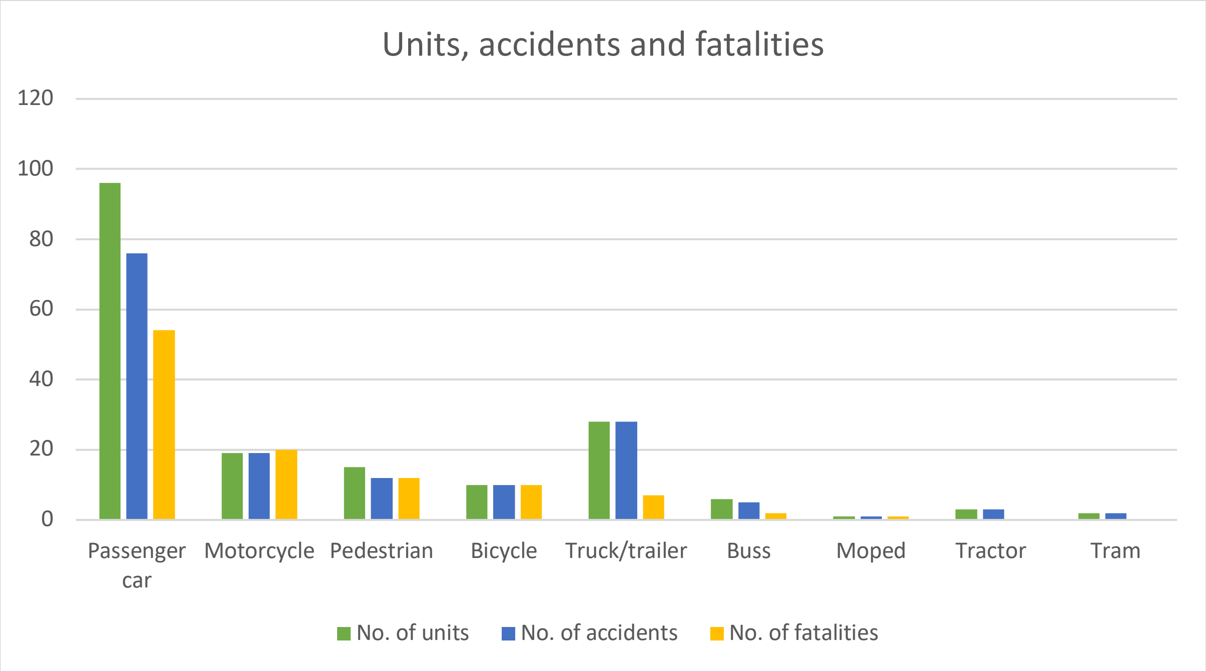

Figure 4. Number of traffic units, number of accidents and number of fatalities in Norway in 2017. (Reproduced from: In-Depth Analysis of Fatal Accidents in the year 2017, Svein Ringen jr., Transportation Department, Traffic Safety, Norwegian Public Roads Administration).

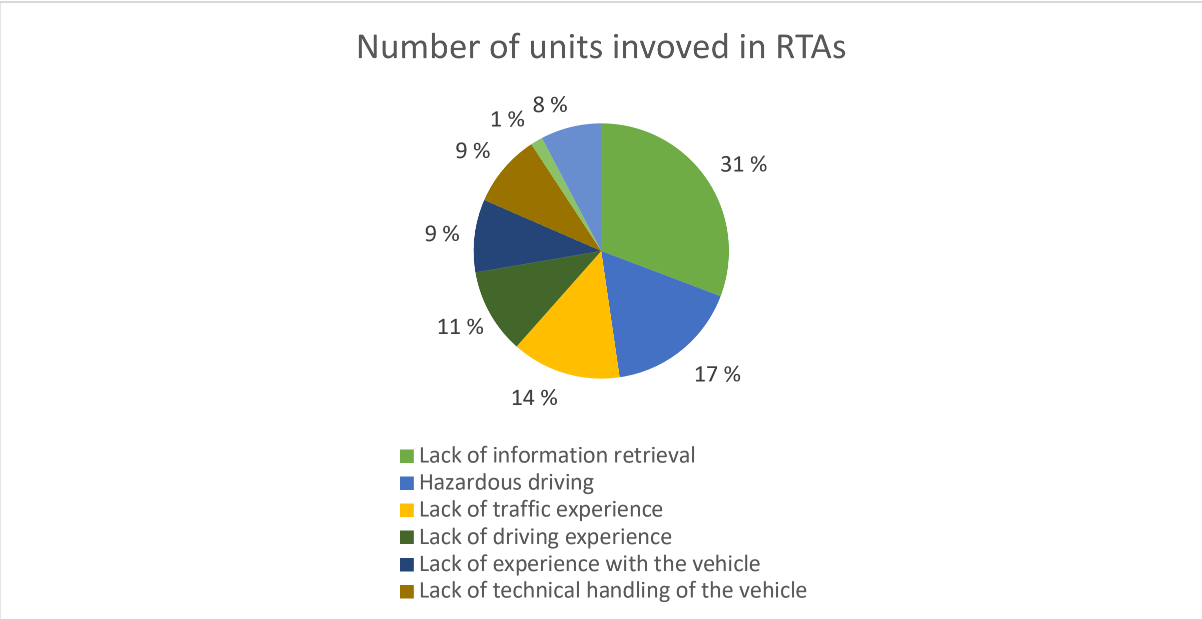

Figure 5. Number of units involved in RTAs in Norway in 2017 where the associated contributing factor was lack of driver skills (more than one factor can occur in one single accident). (Reproduced from: In-Depth Analysis of Fatal Accidents in the year 2017, Svein Ringen jr., Transportation Department, Traffic Safety, Norwegian Public Roads Administration).

Intoxication-related death crashes. In Norway in 2017, 20% (20 accidents) of the fatal RTAs were most likely associated with intoxication. Of these 20 accidents, 21 alcohol-influenced people were involved, there were, 9 drivers, 1 passenger, 4 pedestrians, 4 motorcyclists and 3 bicyclists. Of the 9 intoxicated drivers, 3 were under the influence of alcohol, the remaining 6 were under the influence of other substances, or a mixed intoxication. Of these 20 fatal RTAs, there were 13 run-off accidents, 1 head-on collision, 1 rear-end collision, 4 pedestrians and 1 fatality belonging to the group "other accidents".

Diseases. In Norway in 2017, 17% of the fatal RTAs (17 accidents) were associated with disease.

Use of safety measures. Of the 63 people killed in passenger vehicles, 12 did not wear seat belts at all, and 4 did not wear it correctly. Of all fatalities occurring on a motorcycle, everyone wore helmets. However, 2 of the victims did not wear the helmet correctly (10%). The person (only 1 fatality) on a moped did wear a helmet. In the bicycle-related fatalities, 5 of the 10 did not wear helmets (50%).

Speeding. In 32 of the fatal RTAs in Norway in 2017, one or more vehicles were going too according to the conditions (causing 25 accidents), or drove above the speed limit (leading to 7 accidents).

Type of traffic accident. Looking at the fatal RTAs in 2017, head-on collisions (36% of the fatal accidents, and 39% of the fatalities) and "run-off accidents" dominate (Figure 6). These types of accidents represent more than 70% of all fatalities. The 3rd most common accidents are those involving pedestrians. Together, these three types of accidents make up a total of 85% of all fatalities in this time period.

The regions in Norway (Eastern, Southern, Western, Middle and Northern regions) differ in distribution of type of fatal RTAs. As illustrated in Figure 6, most of the head-on collisions occurred in the Western region (11 fatalities), whilst the Southern region had the lowest number of this accident (only 6 fatalities). The other three regions all had 9 fatalities each, caused by this type of accident. For run-off accidents, most of them occurred in the Eastern region (24%). The Eastern region was also the region with the highest number of pedestrian-related accidents (42%). The Northern region had no pedestrian accidents with fatalities in 2017.

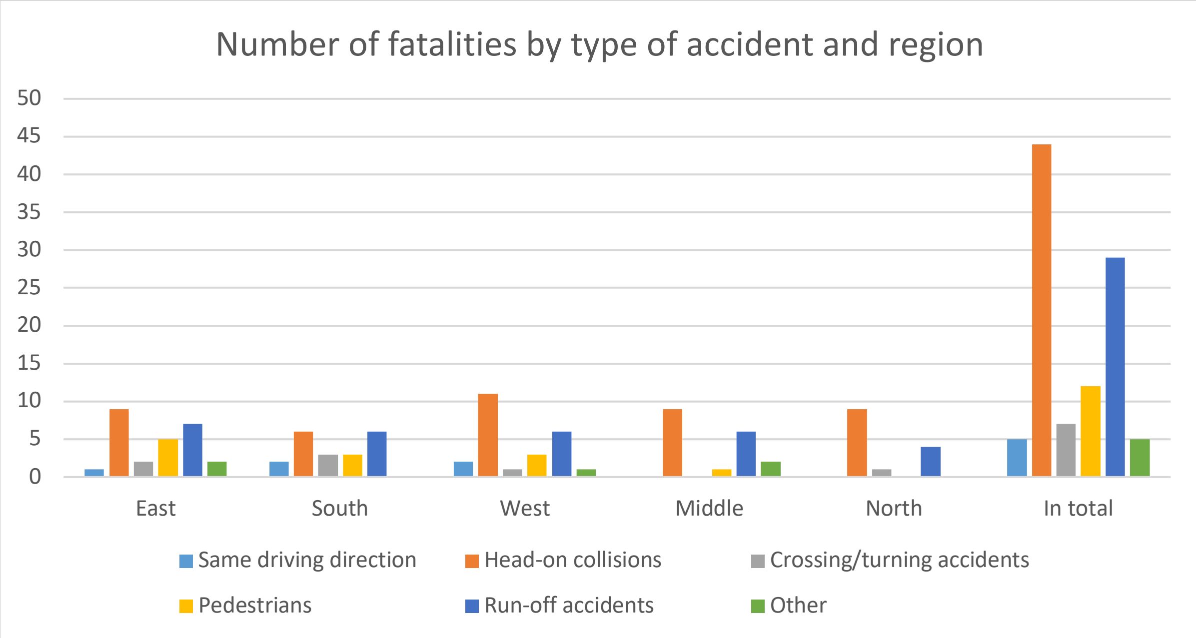

Figure 6. Number of fatalities in 2017 according to type of accident and in which region in Norway it occurred in. (Reproduced from: the In-Depth Analysis of Fatal Accidents in the year 2017, Svein Ringen jr., Transportation Department, Traffic Safety, Norwegian Public Roads Administration).

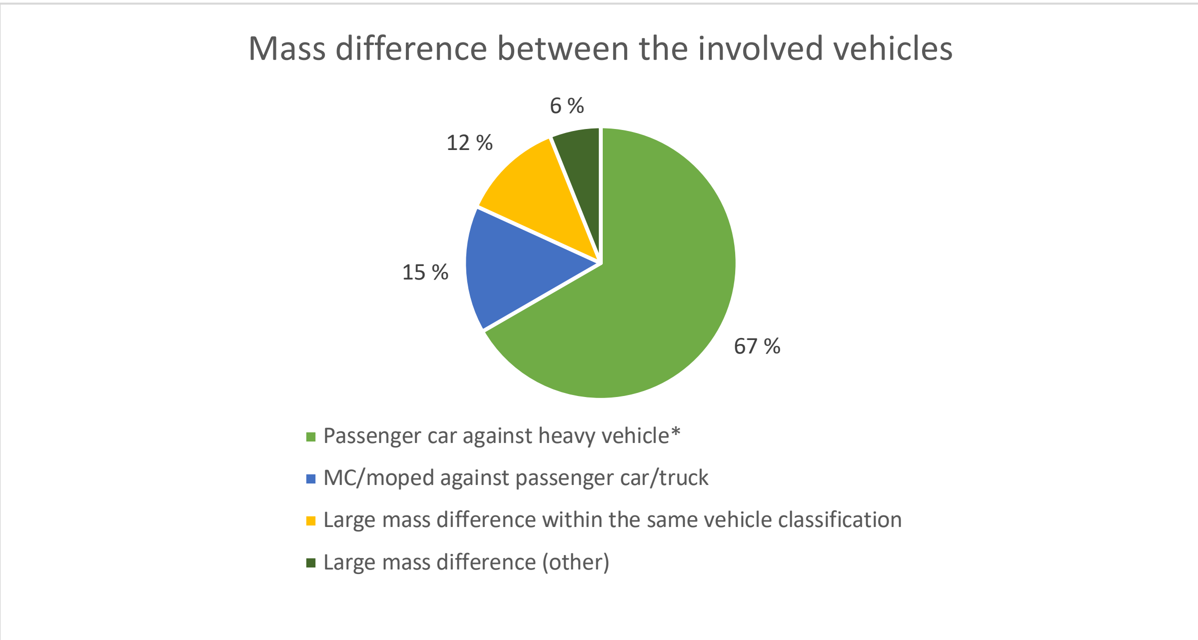

Figure 7. Number of fatal RTAs where the mass difference between the involved vehicles contributed to the outcome. (Reproduced from: In-Depth Analysis of Fatal Accidents in the year 2017, Svein Ringen jr., Transportation Department, Traffic Safety, Norwegian Public Roads Administration). *Heavy vehicle = truck, buss or trailer.

Active safety of the vehicle. Errors or deficiencies occurring in vehicles may have contributed to as many as 27 of the 102 RTAs in Norway in 2017.

A great difference in mass (weight) between the vehicles involved is believed to have contributed to 32% of the fatal RTAs. Of these 33 accidents, a total of 22% had a great difference in mass between the passenger car and a heavy vehicle (Figure 7). 5% of the fatal accidents occurred between a motorcycle and a passenger car or truck.

Passive safety. Factors related to passive safety may have contributed to a total of 29 fatalities in RTAs in Norway in 2017. As illustrated below in Figure 8, the most important factor is the critical hit points on the vehicle during a collision or run-off accident.

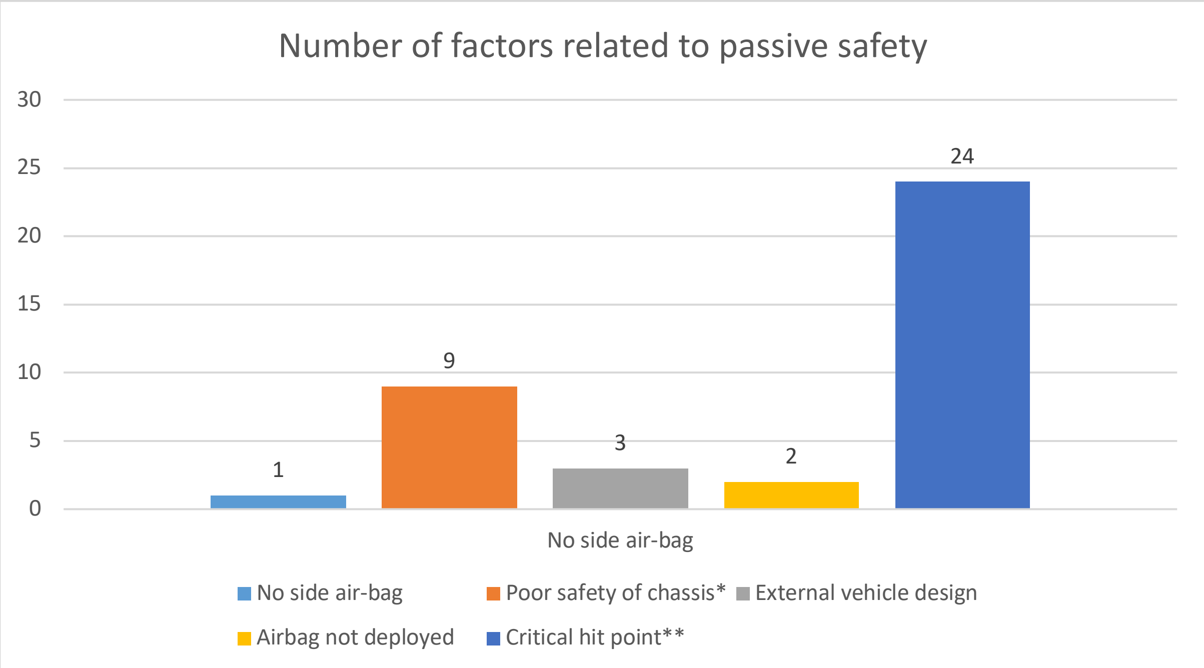

Figure 8. Number of factors related to passive safety in vehicles that may have contributed to the extent of damage in road traffic crashes in Norway in 2017. (In-Depth Analysis of Fatal Accidents in the year 2017, Svein Ringen jr., Transportation Department, Traffic Safety, Norwegian Public Roads Administration). *Heavy vehicle = truck, buss or trailer. *Vehicle frame, **Point outside the deformation zones.

Differences in energy quantity. Great differences in mass (weight) between involved vehicles in collisions, is believed to have contributed to the extent of damage in a total of 32% of all fatal accidents. This is illustrated below in Figure 9.

Number of vehicles. In 2017, the were in total 5 444 740 vehicles, of which 2 719 395 were passenger cars.

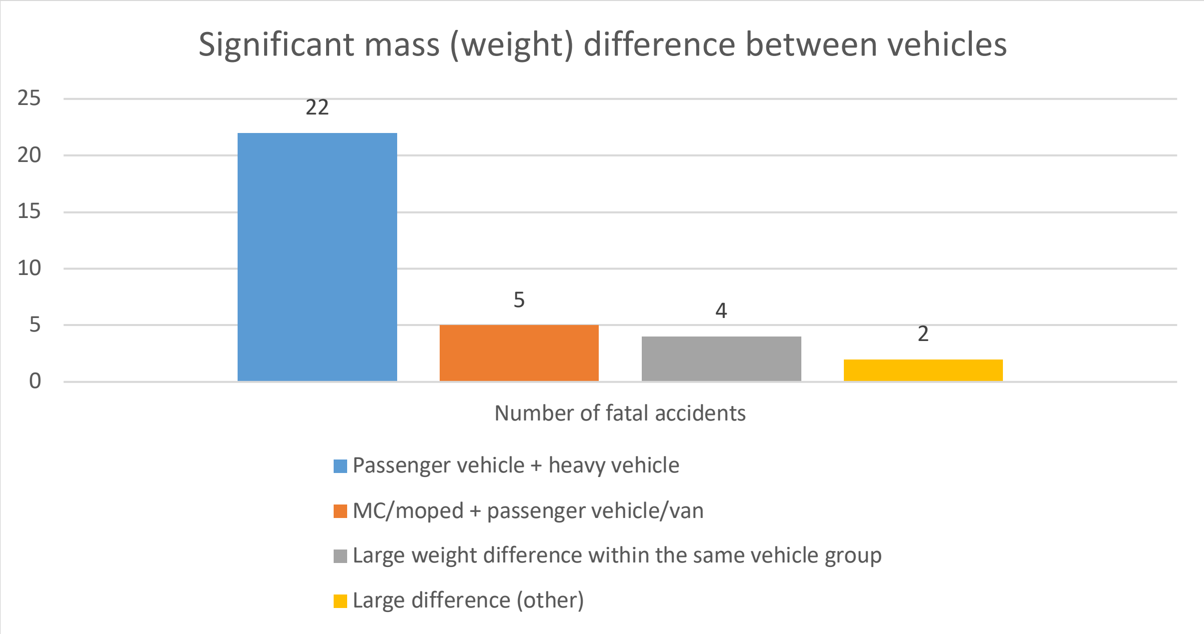

Figure 9. Number of fatal accidents where the weight difference between involved vehicles contributed to the extent of the damage, in Norway in 2017. (In-Depth Analysis of Fatal Accidents in the year 2017, Svein Ringen jr., Transportation Department, Traffic Safety, Norwegian Public Roads Administration). *Heavy vehicle = truck, buss or trailer.

Type of road. On a national basis, 48% of the fatal accidents, occurred on national roads, while 37% took place on county roads. 11% occurred on municipal roads, and only 4% on private roads. There are also a few regional differences in the overview of accidents this year. The Southern region had most of the fatal accidents occur on the county road network. Whilst in the other regions (Northern, Western and Eastern) the fatalities mostly occurred on the national roads.

Road and road environment. Issues and challenges associated with the road and the road environment may have contributed to a total of 33 of the 106 fatal accidents, which corresponds to 32% of all fatal accidents. Unfortunate alignment on the road, was a road condition said to cause 7 of the fatalities. Sight obstructions and obstacles were said to cause 5 fatalities, and road cover also caused 5 fatalities.

Table 1. Number of external factors that may have contributed to the fatalities in 2017 (more than one factor may occur at each accident). (Reproduced from: In-Depth Analysis of Fatal Accidents in the year 2017, Svein Ringen jr., Transportation Department, Traffic Safety, Norwegian Public Roads Administration).

External factors	Total
Animals in the roadway	1
Distractions along the road	1
Driving conditions (ice or snow)	10
Visibility (due to light or weather)	5
Variable road conditions	1
Total number	**18**
No. of accidents where one or more of the factors contributed	**18**
Percentage of fatalities	**18 %**

Road surface. The majority of fatal road crashes in Norway occurred on dry roads in 2017 (Figure 10).

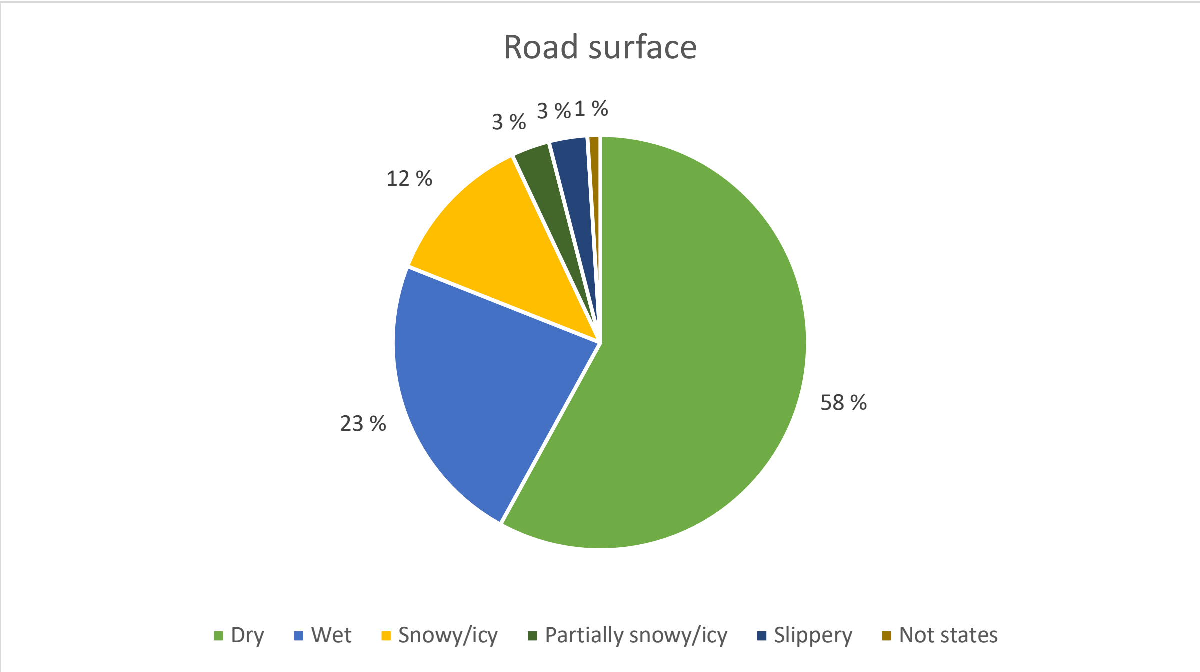

Figure 10. Number of fatalities distributed according to road surface in Norway in 2017. (In-Depth Analysis of Fatal Accidents in the year 2017, Svein Ringen jr., Transportation Department, Traffic Safety, Norwegian Public Roads Administration).

External factors. Conditions described in the section regarding external factors, turned out to have contributed to a total of 18 fatalities (18%) in 2017. Difficult and challenging road conditions with poor visibility, snow, ice and slippery roads are believed to have contributed to 16% of fatal accidents in Norway the same year. Most fatalities occurred under conditions with good visibility and no precipitation (Figure 11).

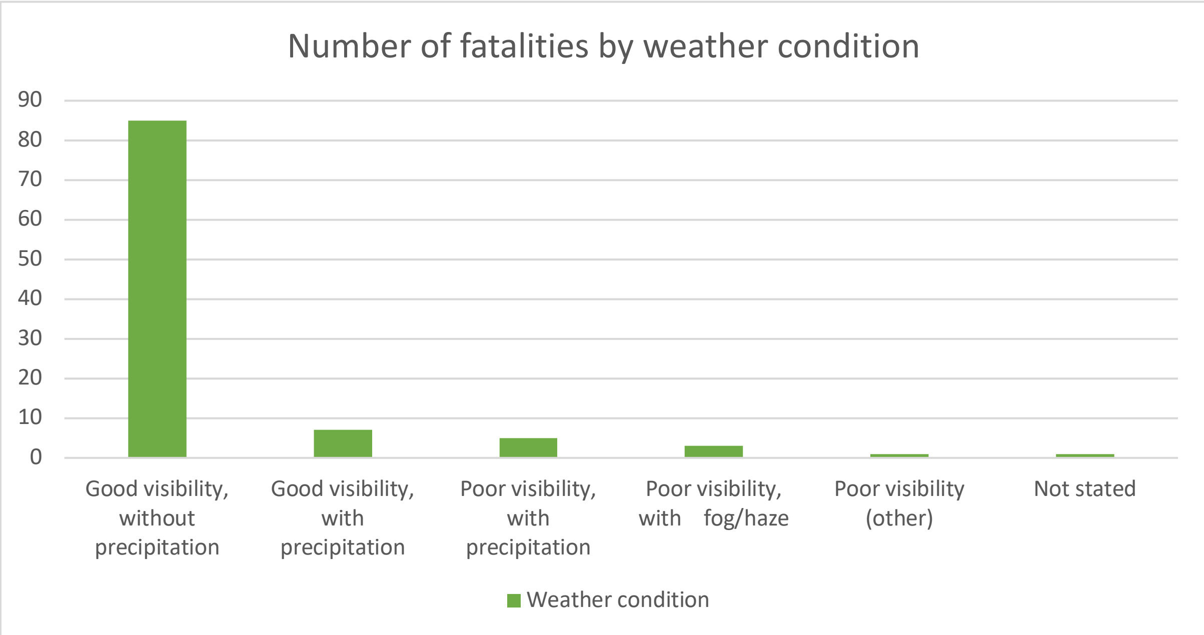

Figure 11. Number of fatalities in Norway in 2017 distributed according to visibility. (In-Depth Analysis of Fatal RTAs in the year 2017, Svein Ringen jr., Transportation Department, Traffic Safety, Norwegian Public Roads Administration).

Time of year. In Norway, May and December had a slightly higher frequency of RTA fatalities in 2017. The summer months, May to August, proved to be the season with the highest frequency of fatalities. This was followed by a sudden drop in September (with only 3 fatalities occurring this month), and a progressive increase towards the end of the year (Figure 12). The findings were not significant.

Time of week. The majority of RTAs with fatal outcomes occurred during the weekdays (Monday to Friday). 74 of the fatal accidents in Norway in 2017 occurred during the weekdays, and 28 occurred over the weekends (Saturday – Sunday). The day with the highest number of fatalities was Tuesday, with a total of 24 deaths (Figure 13). The findings were not significant.

Time of day. The majority of fatal accidents occurred in daylight, 65 of 102 accidents (Figure 14). The lowest incidence was seen during twilight. The findings were not significant.

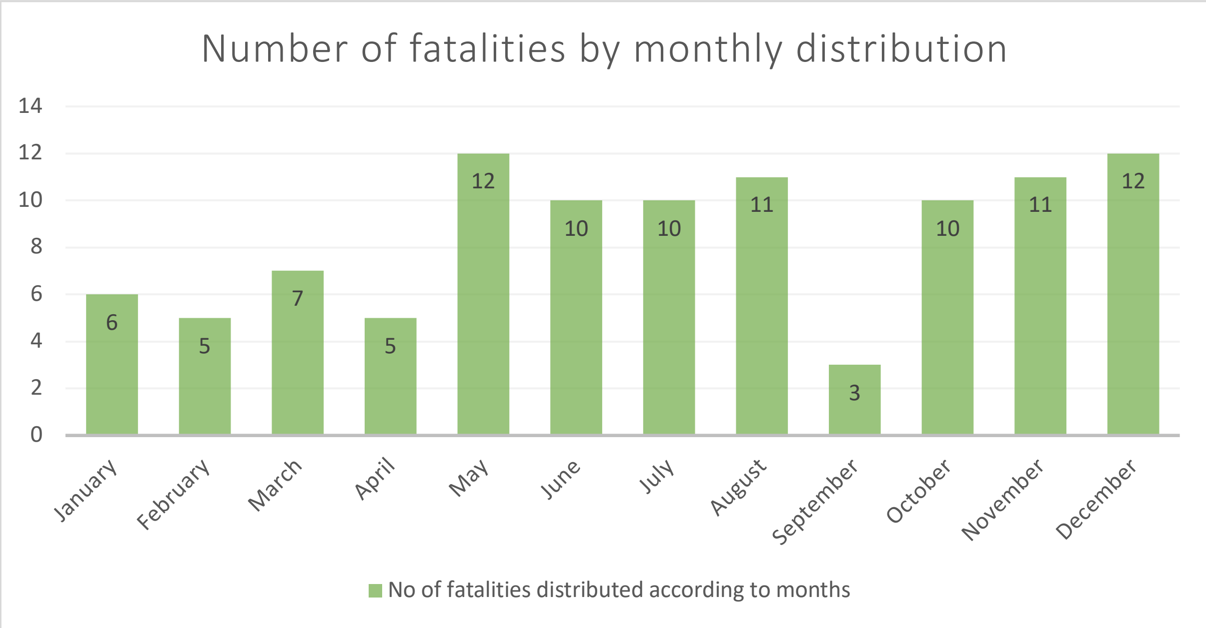

Figure 12. Number of fatalities according to a monthly distribution in Norway 2017. (In-Depth Analysis of Fatal Accidents in the year 2017, Svein Ringen jr., Transportation Department, Traffic Safety, Norwegian Public Roads Administration).

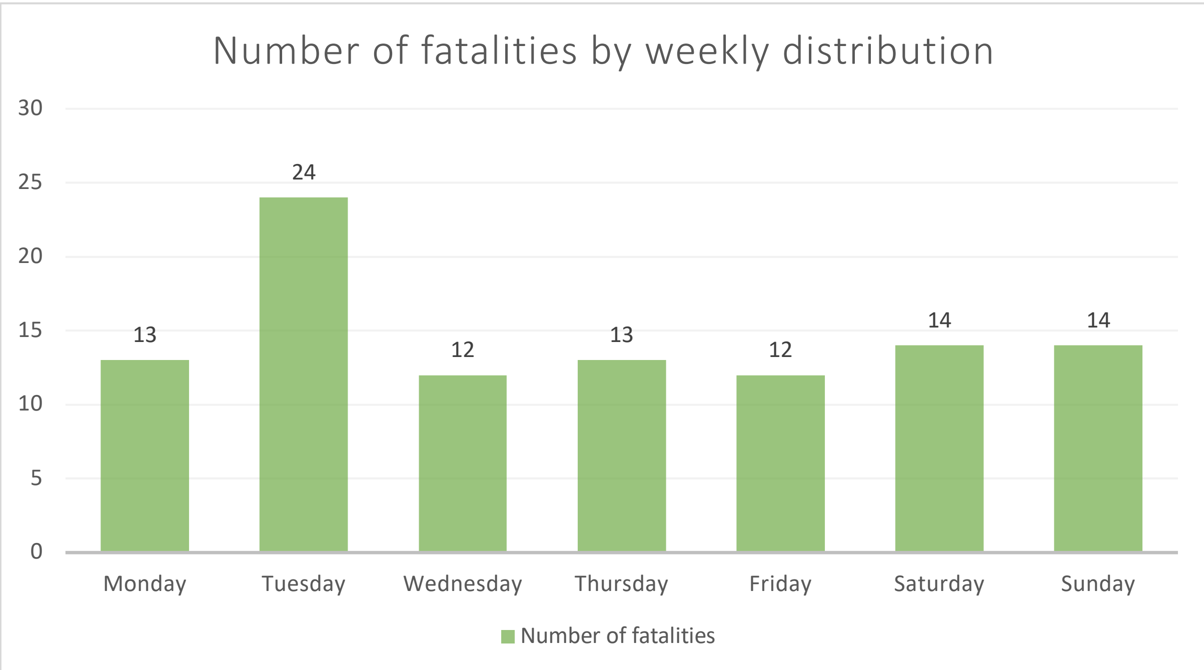

Figure 13. Number of fatalities distributed by day of the week in Norway in 2017. (In-Depth Analysis of Fatal Accidents in the year 2017, Svein Ringen jr., Transportation Department, Traffic Safety, Norwegian Public Roads Administration).

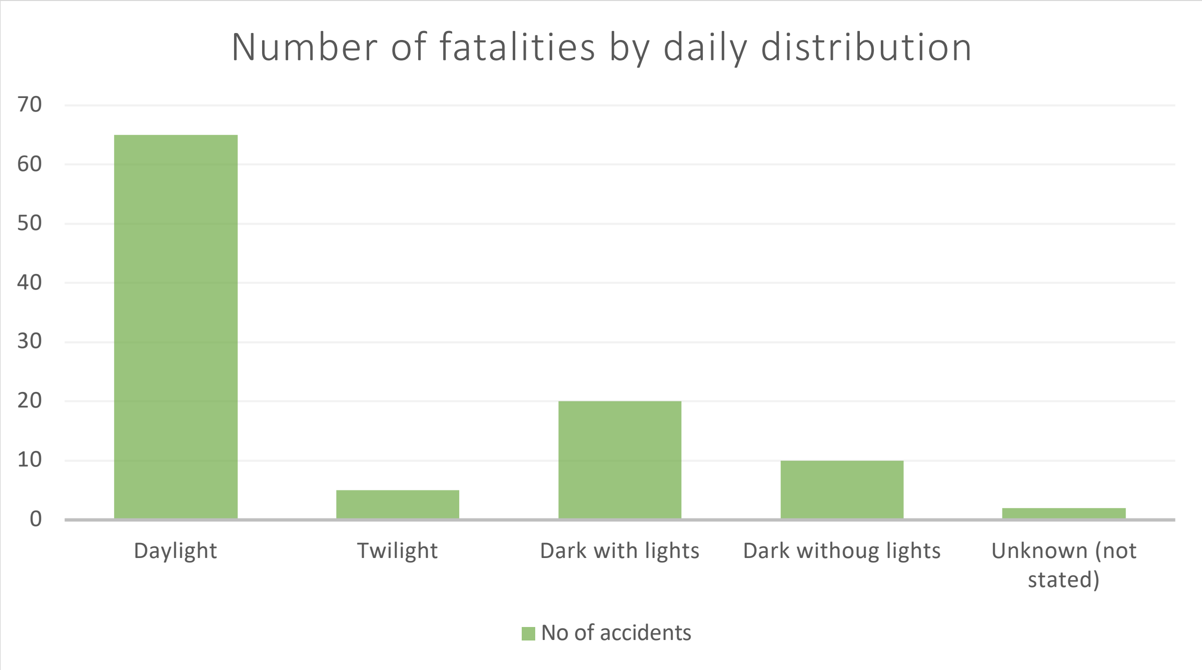

Figure 14. Number of fatal RTAs distributed by time of day (lighting conditions) in Norway in 2017. (In-Depth Analysis of Fatal Accidents in the year 2017, Svein Ringen jr., Transportation Department, Traffic Safety, Norwegian Public Roads Administration).

4.2. The Republic of Croatia

Overview and age. A total of 331 RTAs occurred in 2017, which gives a total of 80 deaths per million inhabitants. Of the 331 road deaths a total of 268 were men. The total number of injured in 2017 was 14 608. Men were also shown to be over-represented among the severely injured, as 8771 of the severely injured were men, and only 5837 were women.

Age. The highest number of fatalities occurred in persons aged 25-44 , with a total of 98 fatalities. Runner up with 93 fatalities, occurred in persons aged 45-64, lastly, 79 fatalities occurred in persons aged 65and up. In the age group 16-24 years old, there were 53 fatalities. The lowest number of fatalities occurred in people younger than 15 years old.

Type of traffic participants. Among the 331 fatalities in RTAs, 187 were drivers or passengers of passenger vehicles, 50 were motorcyclists/moped riders or passengers, 56 were pedestrians, 23 were bicycle riders or passengers, and 15 fatalities belonged to the group “others” (Figure 15).

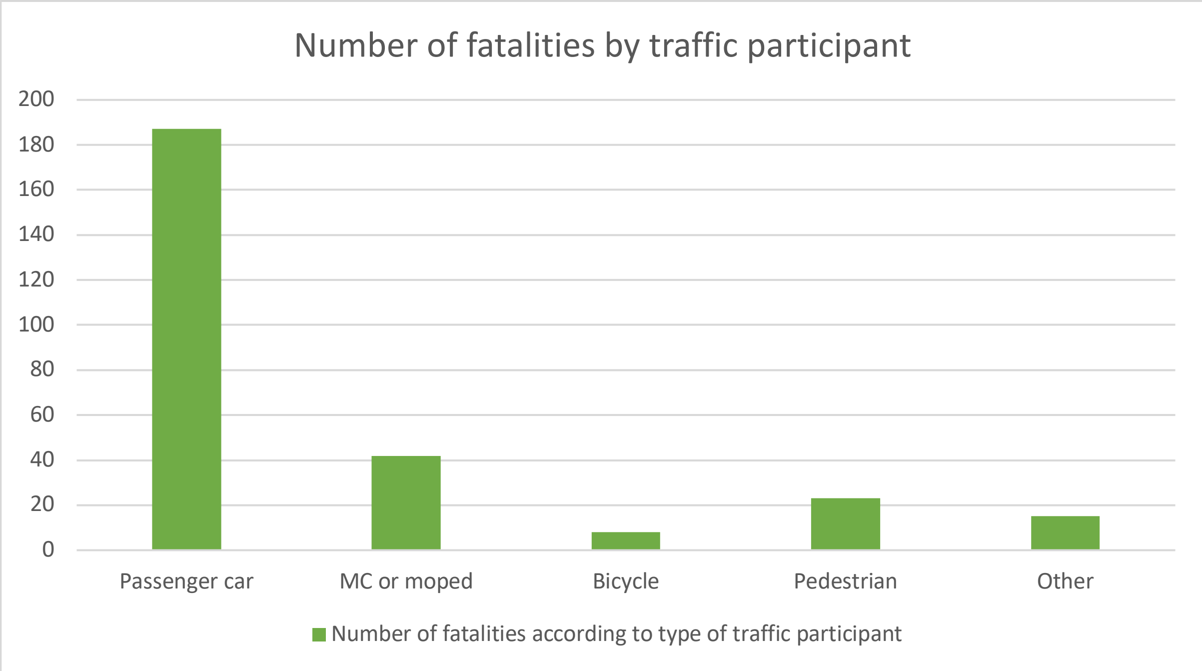

Figure 15. Number of fatalities in Croatia in 2017 according to type of traffic participant (Bilten o sigurnosti cestovnog prometa za 2017).

Intoxication-related death crashes. A total of 64 of 331 fatalities were associated with intoxication.

Seat belt use. Of the 187 fatalities in passenger vehicles in Croatia, 66 people did not wear their seat belt, or did not wear it correctly. In 50 of the fatalities it is unknown whether the driver/passenger wore a seat belt, or not. Of the 50 fatalities on motorcycles or mopeds, 8 did not wear a helmet, or wore it incorrectly.

Speeding. A total of 117 fatalities were associated with speed. Among these RTAs, 102 were associated with speeding under inappropriate conditions, and 15 were associated with to high speed.

Type of traffic accident. Of the total 331 fatalities, the accidents are dispersed as follows; 53 between a vehicle and a pedestrian, 116 run-off accidents, 83 head-on collisions, 15 rear-end collisions and 31 caused by crossing or turning. 33 of the fatal accidents belonged to the group of "other type of accident".

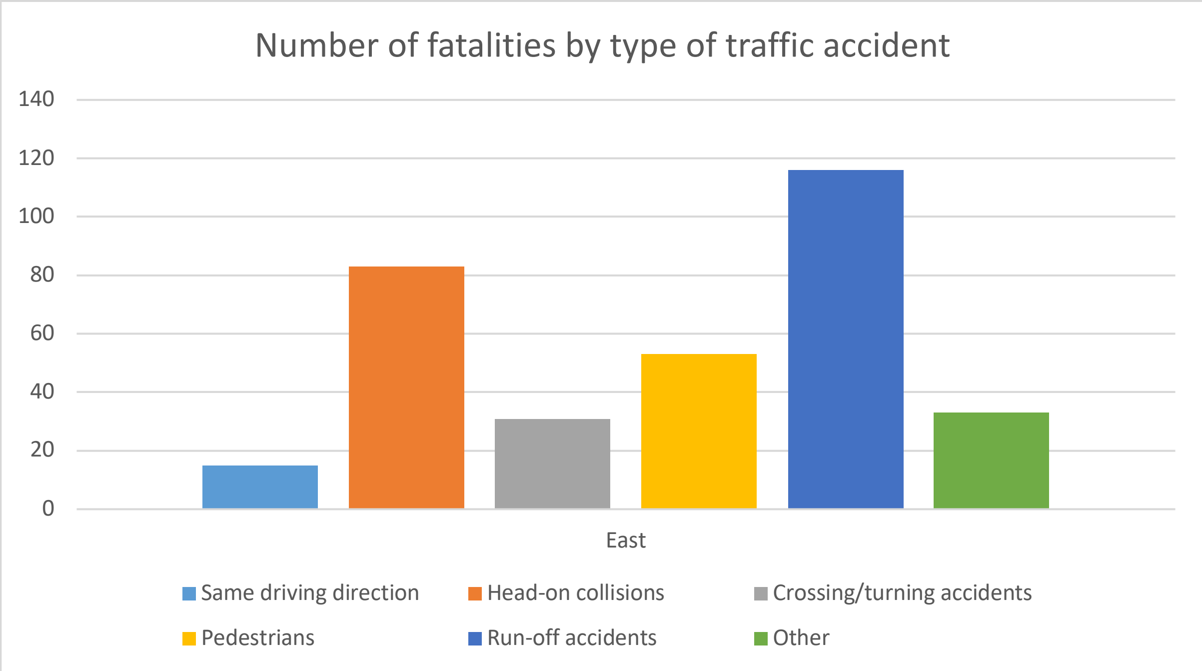

Figure 16. Road traffic fatalities in Croatia according to type of traffic accident (Bilten o sigurnosti cestovnog prometa u 2017).

Number of vehicles. In 2007 there were 1 491 127 passenger vehicles registered. In 2017 the number increased to 1 596 087 passenger vehicles.

Type of road. 138 of the fatal accidents occurred on national roads, 49 on county roads, 12 on municipal roads and 132 on private roads.

Road surface. A total of 277 of the fatal accidents occurred on dry road surface, and 54 fatalities occurred on wet roads.

Weather. A total of 224 fatalities occurred during clear weather conditions. 75 fatalities occurred during cloudy conditions, 29 during rain, and 3 fatalities during foggy conditions.

Time of year. The distribution of fatalities by month and seasonality demonstrates that the overall occurrence takes place in the summer months, May to August, and another overall peak in October. Especially in Croatia, a significant increase is observed in the mentioned summer months, especially May, July and August. The increase is followed by a decrease in September, before an additional increase in October (Figure 17).

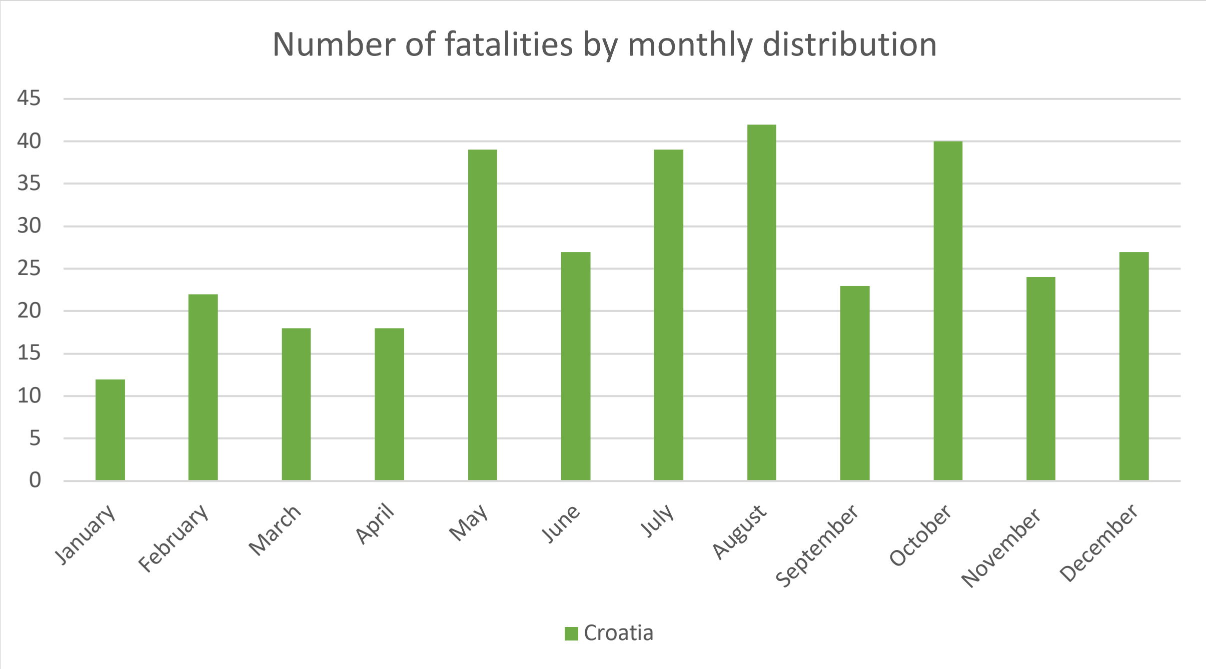

Figure 17. Road traffic fatalities in Croatia according to the time of year (Bilten o sigurnosti cestovnog prometa u 2017).

Time of week. The majority of RTA fatalities in 2017 occurred during the weekends, with 74 fatalities on Saturdays, and 58 on Sundays (Figure 18). During the weekdays the number of fatalities was the following; Monday = 38, Tuesday = 46, Wednesday = 37, Thursday = 34, Friday 44.

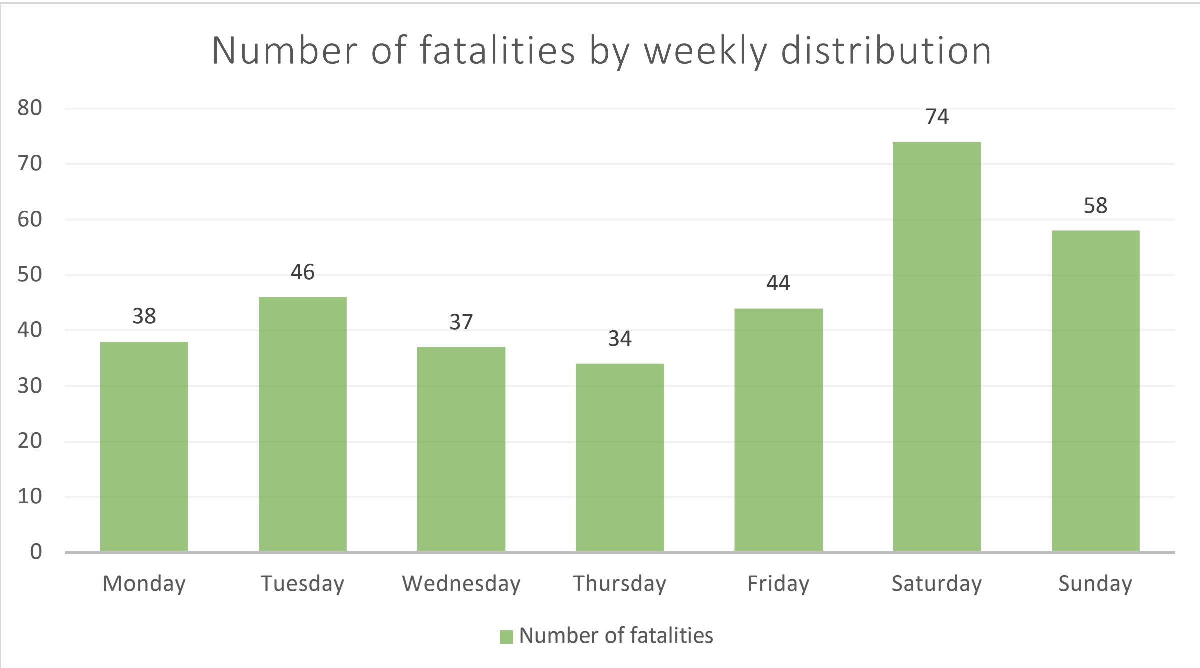

Figure 18. Road traffic fatalities in Croatia according to the time of the week (Bilten o sigurnosti cestovnog prometa u 2017).

Time of the day. There were 190 fatalities occurring during daytime. 129 fatalities occurred at nighttime, 6 at twilight and another 6 at dawn (Figure 19).

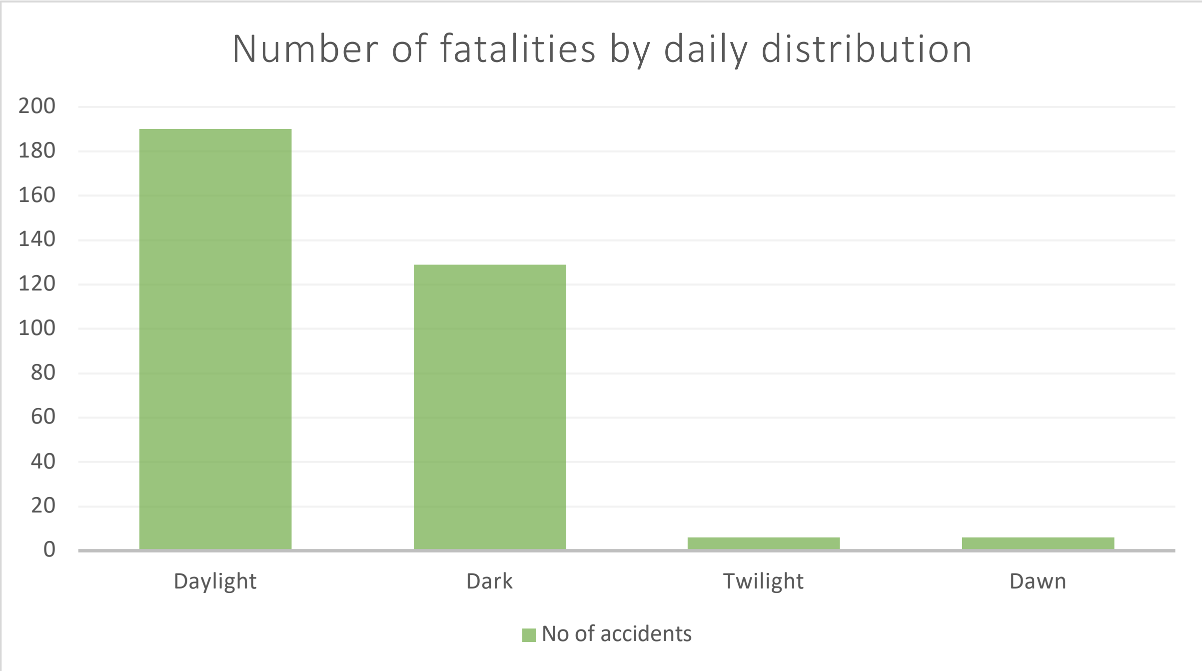

Figure 19. Road traffic fatalities in Croatia according to time of the day (Bilten o sigurnosti cestovnog prometa u 2017).

4.3. Comparison of Norway and Croatia

This research covered all road traffic fatalities in Norway and Croatia in the year 2017. Altogether there were 437 fatalities in the investigated year; 106 fatalities (caused by 102 accidents) in Norway, and 331 fatalities in Croatia.

Gender. A total of 342 men and 95 women died in the compared populations in 2017. In Norway 74 men and 32 women were killed, and in Croatia 268 men, and 63 women killed (Figure 20).

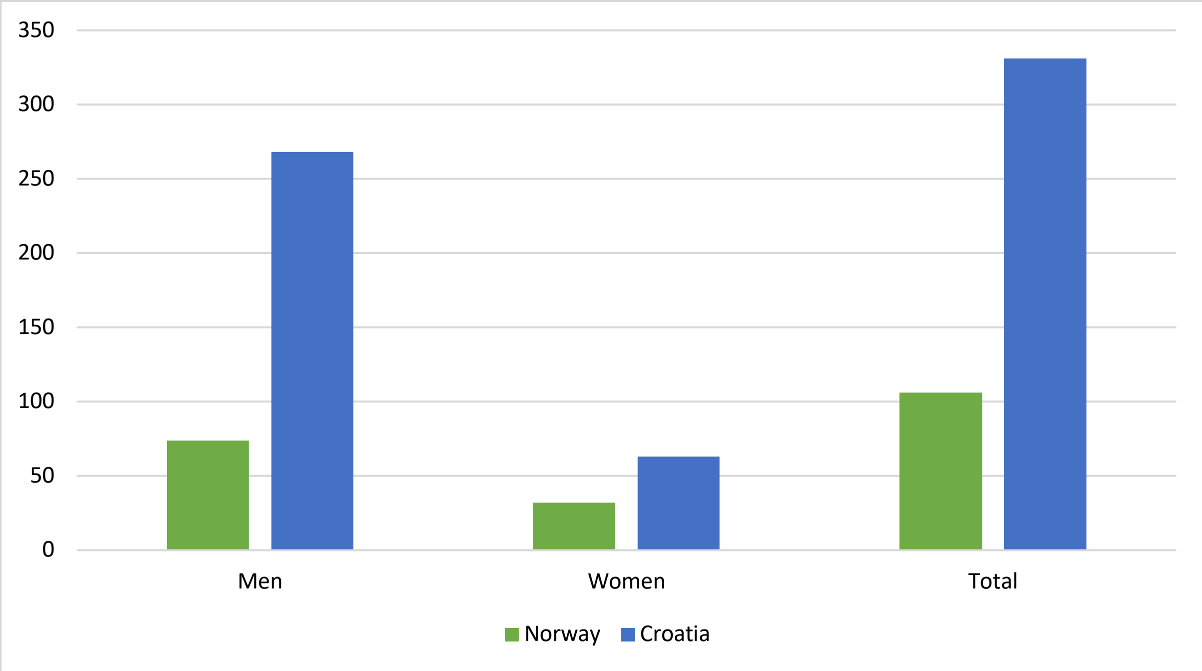

Figure 20. Gender distributions of fatalities in road traffic in Norway and Croatia in 2017. (In-Depth Analysis of fatal RTA in Norway in 2017 and Bilten o sigurnosti cestovnog prometa u 2017).

The gender distribution was shown by chi-square calculations (Table 2) to be a significant risk factor when comparing fatalities in road traffic in Norway and Croatia. The results revealed a *P*-value of 0.015, which means that there is a higher risk factor for being involved in a fatal RTAs for males in Croatia, and lower risk for males in Norway.

Age. In this paper the age groups were classified accordingly: 0 to 15 years old, 16 to 24 years old, 25 to 44 years old, 45 to 64 years old and 65 years old or older. In Norway and Croatia, the number of fatalities according to age can be seen below in Figure 21. Comparing young age (younger than 25 years with older than 25) to fatalities, no significant difference was found, $P <.05$. The same applied to old age (younger than 65 with older than 65 years) (Table 2).

*Table 2. **Comparison of all risk factors associated with road traffic fatalities in Norway and Croatia in 2017.** (In-Depth Analysis of fatal RTA in Norway in 2017 and Bilten o sigurnosti cestovnog prometa u 2017).*

		Norway	Croatia	**Total**	*P**
Gender	Men	74 (82.96) [0.97]	268 (259.04) [0.31]	324	0.015
	Women	32 (23.04) [3.48]	63 (71.96) [1.11]	96	
Young age	<25 years	17 (18.92) [0.19]	61 (59.08) [0.06]	78	0.575
	>25 years	89 (87.08) [0.04]	270 (271.92) [0.01]	359	
Old age	>65 years	32 (26.92) [0.96]	79 (84.08) [0.31]	111	0.193
	<65 years	74 (79.08) [0.33]	252 (246.92) [0.1]	326	
Intoxication	Intoxication	20 (19.79) [0]	64 (64.21) [0]	84	0.951
	No intoxication	82 (82.21) [0]	267 (266.79) [0]	349	
Type of traffic participant (1)	Passenger vehicle	54 (58.46) [0.34]	187 (182.54) [0.11]	241	0.317
	Not passenger vehicle (all others)	52 (47.54) [0.42]	144 (148.46) [0.13]	196	
Type of traffic participant (2)	Motorcycle/moped	21 (17.22) [0.83]	50 (53.78) [0.27]	71	0.253
	Not motorcycle/moped (all others)	85 (88.78) [0.16]	281 (277.22) [0.05]	366	
Type of traffic participant (3)	Pedestrian	12 (16.49) [1.22]	56 (51.51) [0.39]	68	0.166
	Not pedestrian (all others)	94 (89.51) [0.23]	275 (279.49) [0.07]	369	
Type of traffic participant (4)	Bicycle	10 (8) [0.5]	23 (25) [0.16]	33	0.399
	Not bicycle (all others)	96 (98) [0.04]	308 (306) [0.01]	404	
Seat belt	Used seat belt	38 (30.82) [1.67]	71 (78.18) [0.66]	109	0.019
	No seat belt	16 (23.18) [2.23]	66 (58.82) [0.88]	82	
Helmet	Used helmet	20 (18.94) [0.06]	42 (43.06) [0.03]	62	0.434
	No helmet	2 (3.06) [0.36]	8 (6.94) [0.16]	10	
Speeding	Speeding	32 (35.1) [0.27]	117 (113.9) [0.08]	149	0.460
	Not speeding	70 (66.9) [0.14]	214 (217.1) [0.04]	284	
Type of accident	Head-on collision	44 (29.92) [6.63]	83 (97.08) [2.04]	127	<0.001
	Not head-on collision (all others)	58 (72.08) [2.75]	248 (233.92) [0.85]	306	
Road surface	Dry road surface	59 (79.15) [5.13]	277 (256.85) [1.58]	336	<0.001
	Other (wet, snowy, icy, slippery etc.)	43 (22.85) [17.77]	54 (74.15) [5.48]	97	
Visibility (lighting)	Daylight	65 (60.07) [0.4]	190 (194.93) [0.12]	255	0.256
	Not daylight (twilight or darkness)	37 (41.93) [0.58]	141 (136.07) [0.18]	178	

*Chi-square calculator (https://www.socscistatistics.com/tests/chisquare/default.aspx).

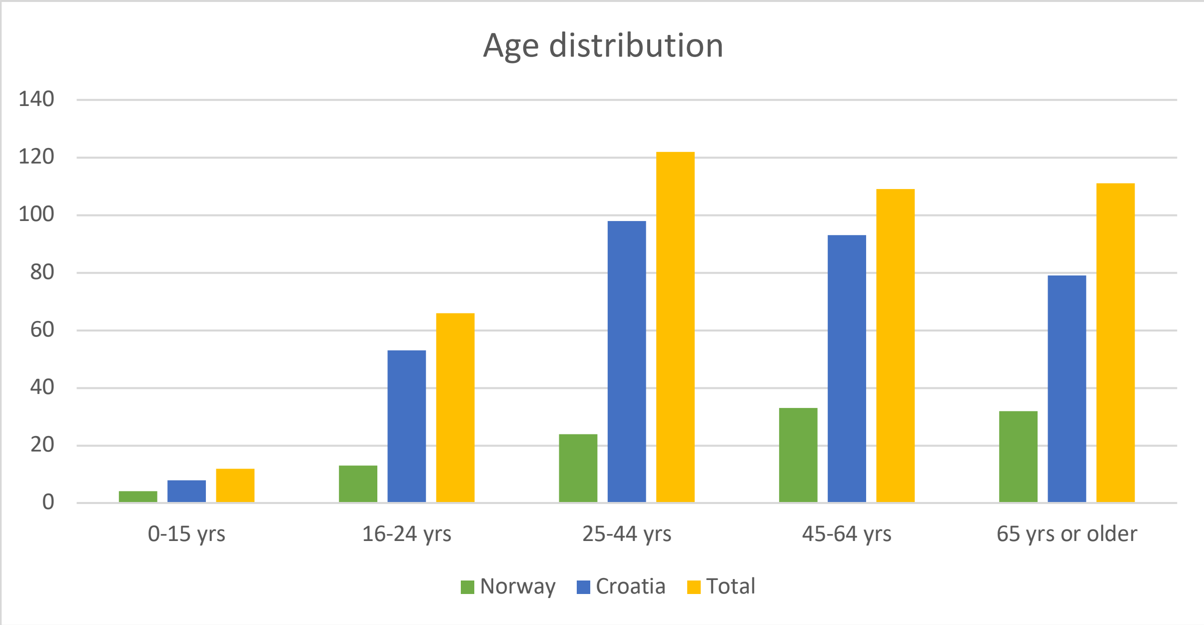

Figure 21. Age distribution of road traffic fatalities in Norway and Croatia in 2017. SSB, Statistics Norway and Bilten o sigurnosti cestovnog prometa u 2017.

SES could not be compared as the data from Croatia was not available for analysis.

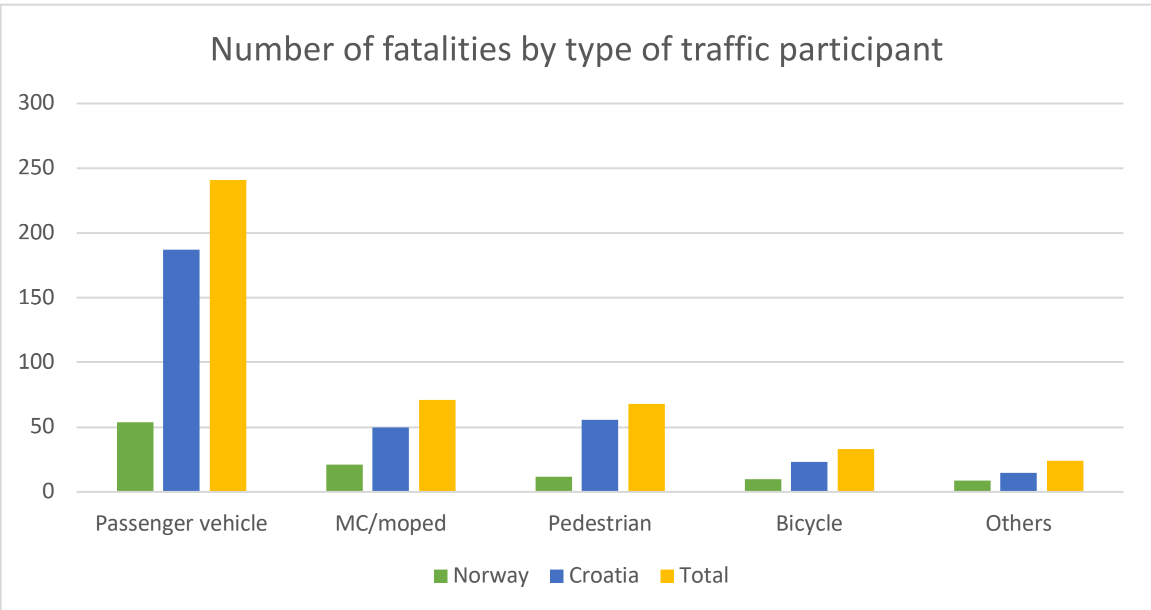

Figure 22. Number of fatalities distributed by type of traffic participant in Norway and Croatia in 2017. In-depth analysis of fatal RTA in Norway in 2017 and Bilten o sigurnosti cestovnog prometa u 2017).

Type of traffic participants. Figure 22 gives and overview of the type of traffic participants involved in fatal RTAs in Norway and Croatia in 2017.

Passenger vehicle. There were no statistically significant differences in number of vehicles involved in RTAs between the two countries (P>0.05; Table 3).

Table 3. Comparison of the different type of traffic participants in fatal RTA in Norway and Croatia in 2017*. In-depth analysis of fatal RTA in Norway in 2017 and Bilten o sigurnosti cestovnog prometa u 2017.*

Traffic participant	Norway	Croatia	*P*-value*
Passenger vehicle	54	187	0.317
MC/moped	21	50	0.253
Pedestrian	12	56	0.166
Bicycle	10	23	0.399

*Chi-square calculator (https://www.socscistatistics.com/tests/chisquare/default.aspx).

Alcohol-related fatalities. In total 85 fatalities in Norway and Croatia were associated with alcohol. This result was not shown to be significant at P=0.951 (Table 2).

Use of seat belt. In total, 82 fatalities in the compared populations were associated with non-use of seat belt. The chi-square calculations were found to be significant at P=0.019 (Table 2).

Helmets. In Norway 2 of the 20 fatalities associated with motorcycles and mopeds were not wearing a helmet, or did not wear it correctly. Of the 50 fatalities in Croatia in 2017, involving motorcyclists and mopeds, a total of 42 were wearing a helmet, and 8 people were not wearing a helmet. Comparing Norway to Croatia, there was no significant difference, at P=0.434 (Table 2).

Lack of driver skills, distracted driving and fatigue were risk factors assessed and analyzed in Norway, but not in Croatia. So, the comparison could not be done between the two populations for this particular risk factor.

Speeding. A total of 149 fatalities in the compared populations were associated with speeding, or inappropriate speed according to the conditions. The chi-square comparison was, however, not significant at P=0.460 (Table 2).

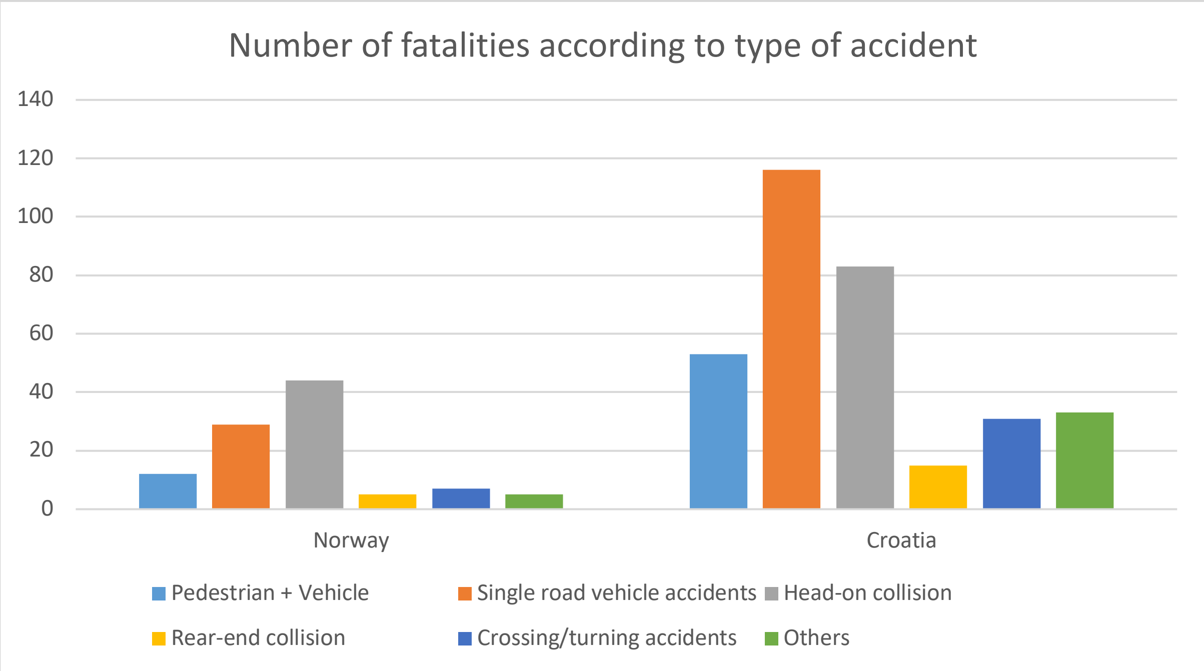

Figure 23. An overview comparison of the distribution of type of RTAs with fatal outcome in Norway and Croatia in 2017. In-depth analysis of fatal RTA in Norway in 2017, and Bilten o sigurnosti cestovnog prometa u 2017.

Type of traffic accident. Figure 23 above illustrates the different types of accidents in Norway and Croatia in 2017. The chi-square comparison of the most common types of accidents, head-on collisions, has been performed. Head-on collisions were proven to be significant with chi-square comparison, at $P<0.001$ (Table 2).

Growth in number of vehicles. In Norway the number of vehicles, over the last 10 years, has grown with 2,2 %. In 2007 there were a total 4 217 563 vehicles, of which 2 154 837 were passenger cars. In 2017, the total number of vehicles had increased to 5 444 740, of which 2 719 395 were passenger cars. In Croatia in 2007 there were a total of 1 491 127 passenger vehicles registered. In 2017 the number had increased to 1 596 087 passenger cars. Figure 24, below, illustrates the growth in number of vehicles in the compared populations.

Type of road (motorway, not motorway). In 2017 a total of 2465 traffic accidents occurred on motorways in Croatia, of which 23 had a lethal outcome. In fact, more fatalities occurred on highways in Norway than in Croatia. And significantly more accidents occurred outside highways (within and outside built-up areas without highway) in Croatia, than in Norway. However, this comparison is inaccurate since the number of participants of the motorways should be taken into consideration as well. In Croatia in 2017, a total of 79 899 357 vehicles used the motorways as estimated from the number of vehicles in toll collection zones.

The estimated number could not be obtained from Norway, therefore the accurate comparison could not be performed.

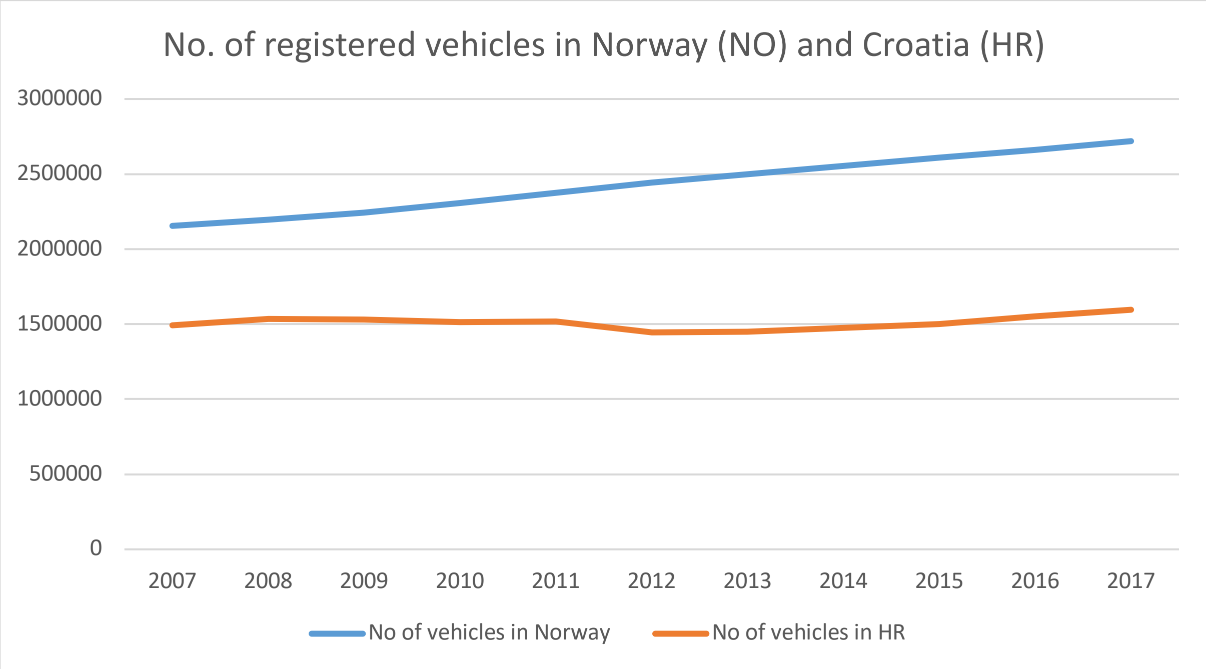

Figure 24. Number of registered passenger vehicles in Norway and Croatia from 2007 to 2017.(www.ceidata.com Croatian Bureau of Statistics / Norwegian Public Road Administration)

Road surface. The comparison between dry and wet surface was proven to be a significant risk factor at $P<0.001$ when comparing Norway and Croatia.

Time of year. The distribution of fatalities by months and seasonality demonstrates that the overall occurrence is more frequent during the summer months, from May to August, and another overall peak in October. The majority of road traffic deaths occurred during the summer months in both Norway and Croatia. Especially in Croatia, a significant increase was observed in the mentioned summer months, especially May, July and August. A decrease is then seen in September followed by another increase in October.

Timing of day (degree of lightning). The time of day associated with the highest number of fatalities in traffic in Norway was observed to be at daylight (65 fatalities of 102 accidents), and the same was seen for Croatia (196 fatalities of 331 accidents).

The degree of lightning was shown not to be a significant risk factor when comparing road traffic deaths in Norway and Croatia, with a chi-square statistic of $P=0.662$ (Table 1).

Day of the week. Most road traffic fatalities in Norway occurred on a Tuesday, whilst in Croatia the most frequent day was Saturdays, closely followed by Sundays.

Finally, an overview of the number of fatalities that occurred in Norway, the European Union and Croatia can be seen in Figure 25.

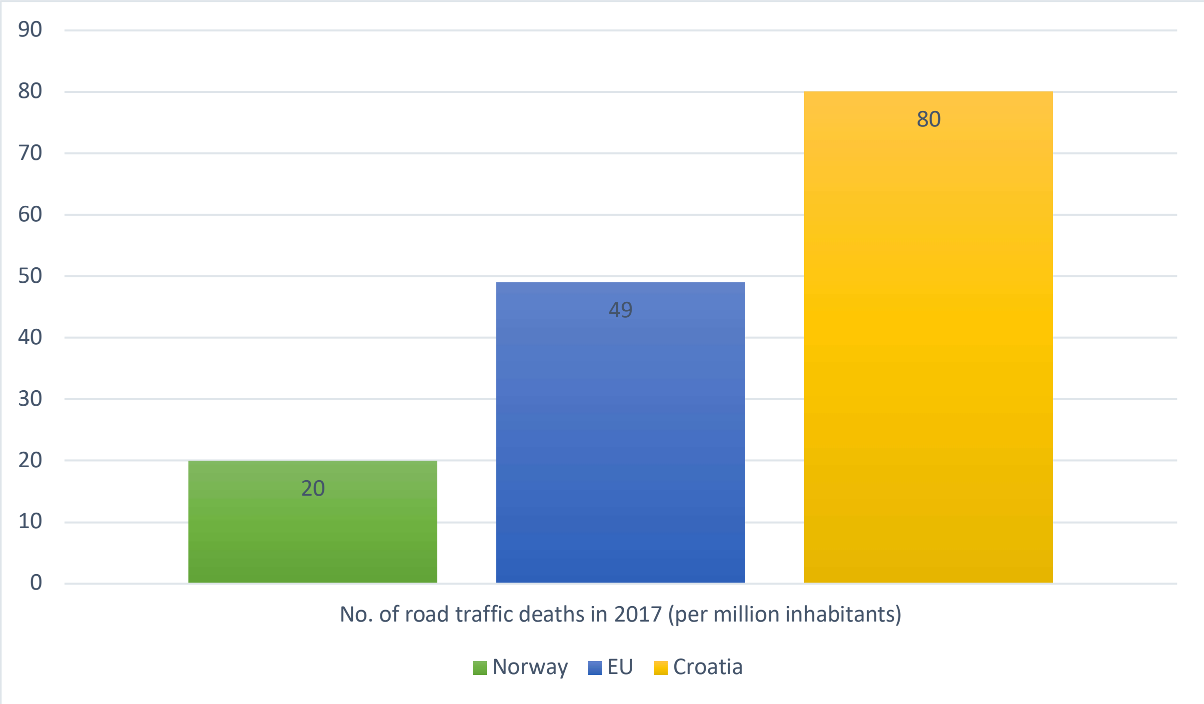

Figure 25. Number of lethal RTAs in Norway, EU and Croatia in 2017

5. DISCUSSION

The risk of being seriously injured or killed in RTAs in Norway is among the lowest in the world. Interestingly, the number of fatalities in traffic in Norway has revealed a decrease over the past years. Compared with the previous year there were, in fact, 29 fewer fatalities than seen in 2016. This makes 2017 the year with the lowest number of traffic related deaths in Norway since 1947 (5, 65).

Gender, as a risk factor for becoming a victim in road traffic fatalities, was proven to be significant in the compared populations. Men are generally over-represented, especially among young drivers. As stated in the results 80% of the people who lost their lives in traffic in 2017 were men. This large number may be explained by the increased risk-taking behavior seen among young men. Another statistical point is that men tend to go for longer road trips than women, this naturally gives men a higher exposure to traffic (66).

Being a young driver in road traffic is a known risk factor due to the lack of both experience and skills. However, being an elderly in traffic also poses a risk for involvement in RTAs, especially when the elderly is a pedestrian (5). This could be explained by the fact that older people mostly participate in traffic as pedestrians, and are often subject to injuries. Even light injuries may have a greater consequence on their health than it would in the younger generation (67). The older generation is also more fragile and has reduced tolerance to withstand injury. Lack of visibility, slower movements combined with reduced reaction time, could also explain why the elderly population is often involved in RTAs as pedestrians.

However, the age groups most frequently associated with road traffic fatalities, in the compared populations, were; 25-44 years (in Croatia) and 45-64 years (in Norway). This can be explained by the fact that in Croatia the largest group of drivers of motorized vehicles is among those from 25-54 years (64), the same applies to Norway, in the age group 45-64 years (5).

Increasing focus on sufficient and correct child restraints is highly effective in reducing death and injuries to children in vehicles. According to WHO's Report on Global Road Traffic Safety (2018), the use of child restraints can lead to at least a 60% drop in child deaths in traffic. Children younger than 10 years, or shorter than 135 cm, should be placed in a child restraint, and should under no circumstances be seated in the front seat. Parents undoubtedly play an important role in reducing and preventing the injury of children and young adults in road traffic (68). Being 65 years, and older, also pose an increased risk of involvement in RTAs. The Norwegian Roads Administration has, therefore, made an easy-to-use navigation for elderly, which they can use to keep their knowledge up to date on traffic regulations etc. (69). This would probably not be a bad idea for other countries to offer their elderly generations as well, as long as they have access to the internet, that is.

It has been observed a higher injury rate among women with higher education in Norway. This was interesting since, in the same study, a reversed pattern was observed in some other countries; Austria, Belgium, Denmark, Finland, Switzerland, Spain and Italy. This was discussed to be related to the fact that Norway is a more equal society compared to the rest of the world (70). The comparison between Norway and Croatia could not be made for this particular matter, since there was a lack of data available from Croatia.

According to the main basic modes of travel – land (road, rail), water (boats, ships) and air (planes, helicopters) – road travel presents the highest risk for accidents in most countries (70). As stated in the introduction, some participants pose an increased risk of being injured and killed more frequently than others. The noteworthy differences observed in the fatality rates between various traffic participants are especially seen among users of two-wheelers, such as motorcyclists and moped riders, cyclists and pedestrians. Compared to being inside a vehicle, these road users are more vulnerable, because they are significantly more exposed, and less protected than those that are inside a vehicle.

The risk was also found to be significantly increased for road users in low- and middle-income countries, which, most likely, is due to the larger span in variety and intensity of traffic mix, and also due to the insufficient separation from other road users. According to the World Report on Road Traffic Injury Prevention, it is of utmost importance when vulnerable and slow-moving, non-motorized traffic participants use the same roads as fast-moving, motorized vehicles. This challenge is often observed in low- and middle-income countries. In high-income countries, such as Norway, users of two-wheelers have the highest level of risks (24).

Regardless of their role of participation in traffic, elderly, small children and people with disabilities are also exceptionally vulnerable in RTAs. This can be explained simply by the fact that they are less resistant to injury. Children are especially vulnerable to sustaining injuries, and being killed in RTAs, because they are not fully developed physically, nor cognitively. Additionally, they have a significantly smaller stature, making it harder for them to see and be seen in traffic, especially as pedestrians. Attention should therefore be aimed at ensuring and promoting their safety as participants in traffic (35, 70).

Traffic participants using public transport systems, such as busses, trains, underground trams etc., have also been observed to have an increased risk in low- and middle-income countries. In many low- and middle-income countries bicycles are often the most affordable way to get around, and these traffic participants often have to share the road with two- and four-wheelers, as well as heavy vehicles, which naturally expose them to an increased risk when RTAs occur. As stated in the introduction, traffic participants using public transport systems pose an increased risk in low- and middle-income countries. This could be explained by the fact that these systems are not as well developed as they should be, and a marked lack of safety is a major challenge (20).

To reduce the fatalities among bicyclists, several interventions are highly likely to be effective and beneficial, especially those changes that can be applied to the road environment. First of all, bicycles should be separated from other forms of traffic, and in cities there should be bicycle lanes (as seen in countries such as Denmark and The Netherlands) with painted lines on the side of the road. It would also be effective to have laws mandating helmet use, speed restrictions and also a strict limit on drink driving on bicycles (37, 40).

In 2017, distractions such as already mentioned in the introduction was considered to have contributing factors in fatal RTAs in Norway. These distractions can easily be avoided with small efforts. If a driver needs to use his mobile device to make a phone call, a "hands-free"-method should always be used. And if the driver needs to eat, smoke or deal with the screaming children in the backseat, the car should be pulled over, in a safe manner that is, to reduce the risk of an accident (22). The comparison between the researched populations could not be made, since there was a lack of data from Croatia on the matter. It would, however, be interesting if research were performed on this particular matter in low- and middle-income countries, as well to assess if this is a significant risk factor.

As stated in the introduction, fatigue was thought to have been a contributing factor in 14% of fatalities in RTAs in Norway in 2017. In some accidents, fatigue has coincided with other factors such as intoxication and illness of the driver. Looking at the period from 2007 to 2017, fatigue was a contributing factor in 13% (mean) of the fatal RTAs, in a fluctuating pattern (5). Fatigue being a risk factor for fatal RTAs can be explained by straight, monotonous roads increasing the risk for drivers to fall asleep. It could also be argued that not taking enough breaks, especially when driving at nighttime, could be the reason. This risk factor can easily be reduced if drivers are better at taking breaks when driving, avoiding DUI and during illness. Fatigue could not be compared between the two populations, since data from Croatia was not available.

In the fatal RTAs in Norway is 2017, alcohol was found to be the most common substance used in intoxication-related accidents. Drivers who have been drinking alcohol has a higher risk of being involved in crashes because their central nervous system is impaired. Alcohol has the potential to cause recklessness and impairing decision-making, blackouts and memory impairment, which naturally can be fatal when participating in road traffic. For chronic and/or heavy drinkers, alcohol also diminished the gray matter in the brain, cause inability to think abstractly and may cause a loss of visuospatial abilities. These are all important functions of the brain necessary to have intact when participating in traffic, and especially when operating moving vehicles (71).

An important challenge is the current problem with underreporting RTAs related to intoxication (15). To improve the analysis of alcohol as a contributing risk factor it is crucial to gather more reliable and comparable data. Underreporting must be identified and limited as much as possible, in order for the registration rate for alcohol-related road deaths to be maximized, and the numbers accurate. There should be strict procedures and methods existing for checking the drivers under the influence of alcohol. This will of course require knowledge on the matter, training and good technical support with precise devices to measure the BAC. One possible way to perform this quite simply could be to have a systematically check for the BAC in all serious RTAs (all that cause fatalities and serious injuries). Needless to say, it is always best to not drink and drive.

As explained in the introduction, disease in the driver of a vehicle is a factor that can be difficult to detect and assess. Nonetheless, it can still be a significant risk factor for RTAs, especially among the elderly population. The Norwegian accident analysis group, working for the Norwegian Public Roads Administration, previously based their assessment of this factor on witness statements and events of the RTAs. As of 2010, this group received medical expertise to enhance their team for further elaboration of diseases and other conditions related to RTAs. Adding medical expertise has, so far, significantly improved the quality of the analysis work (5). The comparison between the researched populations could not be made, since there was a lack of data from Croatia on the matter. Looking at a 10-year period, disease was observed to be a contributing factor in a fluctuating pattern, which is difficult to explain.

As stated in the introduction the overall use of seat belts in Norway is good, but not good enough. According to the Norwegian Public Roads Administration, 30-40 lives could be spared every year if everyone always wore a seat belt, both in passenger vehicles and onboard buses. Not only does the seat belt keep the driver or passenger in place in their seat, but it also prevents them from being a potential hazard for others if an accident were to occur.

Needless to say, it is crucial that everyone always wears their seat belt. In comparison between Norway and Croatia, the non-use of seat belt was found to be significant as a risk factor. However, there were 50 fatalities in Croatia where it is unknown whether a seat belt was worn or not. Hence, the comparison is not as accurate as it could be, and the number of people not wearing a seat belt in Croatia could be even higher than stated in this paper.

As presented in the introduction, speeding above the legal limit, or going to fast according to the conditions, is strictly regulated in Norway with high fines. In Croatia the price for speeding is significantly lower than in Norway. This difference may be discussed to be a contributor to more speeding in Croatia than Norway, but the comparison between the two populations revealed to not be significant. In some countries, such as Finland, the fine is also adjusted to personal income and net worth, so that rich law offenders must pay much more than poorer offenders. This phenomenon is widely in use in Finland, however, it is not in use neither Norway nor Croatia (72). It could, however, be beneficial for both of these countries to do as Finland, and link speeding tickets to your income or net worth. To assess this, it would be necessary to compare the number of wealthy people who are speeding, before and after the law has been set in motion. It would also be interesting to assess the number of accidents, and or fatalities they are involved in, according to income status. Further research is therefore needed on this matter.

Head-on accidents were the dominating type of fatal RTA in Norway. This may be explained by most accidents occurring on the rural roads, where the lanes are not separated from each other, additional to the roads often being narrow. This increases the risk of collisions with traffic in the opposing lane significantly. Another possible explanation to why head-on collisions are the most common type of traffic accidents resulting in fatalities, could be camber turns and elevations in the road. This type of collision is considered to be very fatal, especially when the RTAs involve vehicles travelling at high speed (73).

An increase in head-on RTAs, and reduction of run-off RTAs, were observed in comparison to the previous year. Fatal accidents involving pedestrians has had a decreasing tendency over the years, and 2017 had the lowest number of recorded so far (5). This positive pattern could be explained by enhanced planning from the Norwegian Public Road Administration, especially with focus on separating vulnerable traffic participants with sidewalks, separators and well-marked pedestrian crossings.

Geographically a difference in the distribution of type of fatal RTAs in the different regions (Eastern, Southern, Western, Middle and Northern) was demonstrated, in Norway. First of all, the difference in pedestrian-related accidents can be explained by the fact that there are much greater distances in the Northern region, and in general fewer pedestrians. The opposite is seen in the Eastern region, where there are many pedestrians, especially in the cities. The traffic is also significantly less dense in the Northern region. In the Southern part of Norway, the situation is completely different with more and bigger cities, therefore the traffic is much denser (5). As illustrated in Figure 6, the dominance of head-on RTAs occurred in the Western region, whilst the Southern region had the lowest amount of this type of accident. This could be explained by the characteristics of the roads in the Western region, which is famous for having curvy, narrow roads. In regards to run-off accidents, most of them occurred in the Eastern region, which could be explained by this being the most dense and populated region. and also that a lot of roads are long and monotonous, increasing the risk of falling asleep.

The use of safe vehicles certainly plays a critical role in preventing RTAs, and also reduces the likelihood of victims to sustain serious injuries (1). Today there are a number of UN regulations on vehicle safety. WHO states that if these regulations were to be applied to countries manufacturing and production standards, many lives could potentially be spared (43). As seen in the results, insufficient built-in passive safety in vehicles may contribute to fatal RTAs (5).

The number of vehicles has significantly increased in both countries in comparison to the previous year. Hence, a preventive challenge when it comes to this matter, would be better planning and maintenance of roads. In this way one can keep up with the growing demand following the increasing number of vehicles.

Difficult and challenging road conditions with poor visibility, snow, ice and slippery roads are believed to have contributed to 16% of the fatal accidents in Norway in 2017 (5). The reason for this is that the different temperatures and precipitation changes the road surface, and its conditions, making it hard for vehicles to constantly have a good grip on the road.

As stated in the introduction and according to literature, weather may have a contributing impact on the occurrence of RTAs. The results from Norway also revealed that weather play a contributing factor in road traffic fatalities. This is because Norway is one of the countries often exposed to adverse weather conditions, such as strong winds, snowy and icy road surfaces, and rapid changes between these. In Norway, it is common knowledge that road friction is at its lowest when the temperature is close to 0 degrees Celsius. Hence, there can rapid changes in road surface friction, making it challenging to keep continuous good grip onto the road. Difficult, challenging and rapidly changing road conditions combined with poor visibility, snow/ice and slippery roads are believed to have contributed to some of the fatal accidents in Norway. The number of weather-related traffic fatalities has been observed to fluctuate, which makes sense since the same can be said about the weather.

Factors related to external conditions were considered to contribute to fatal RTAs. As illustrated in Figure 7, the variations from year to year have been relatively small when compared to the total number of fatal accidents. Hazardous weather causing reduced road friction, such as snow and ice, can be eliminated by proper road maintenance, snow removal, de-icing methods (salting etc.). The effect of strong winds, however, are not as easily avoided. Closing down roads and bridges due to strong winds is sometimes the only preventive measure possible, however this is not the most optimal outcome for the communities affected (45). It is, therefore, essential and highly beneficial to further research and enhance the knowledge on the relationship between strong winds and road traffic safety.

Although one cannot control the weather, it may be beneficial to understand how it affects road safety, in regards to analysis and prevention of RTAs. When extreme weather conditions pose a threat towards road safety, preventive matters, such as effective local warning systems, informative campaigns and road improvements may be beneficial. Performing an analysis of adverse weather conditions on RTAs is also an important way to learn more about the impact weather pose on the traffic system and road safety (45).

As mentioned above, during weather conditions, where the temperature is set to 0 degrees Celsius, the road friction is at its lowest. Even though this is common knowledge among Norwegians, there is still a high incidence of fatalities occurring in December. This could be explained by the fact that December tends to be a rather stressful month for Norwegians, with the holidays, shopping and traveling.

The Norwegian Automobile Association (NAF) has set themselves a goal to reduce the number of traffic accidents occurring during the winter months in Norway. Hence, they offer courses (mandatory for anyone acquiring a driver's license nowadays) where participants can, in a safe and controlled environment, get more experienced in how to handle the car during conditions with low road friction. Participants will also learn and practice on regaining road grip, and control of the car, when it has lost contact with the road surface. These courses also address how to safely secure children in cars. These courses are led by experienced instructors, whom all have plenty of years with experience driving, and teaching how to drive, under these conditions (74).

In Norway the majority of road traffic fatalities occurred in the summer months (with the highest number in May). It can be argued that the increase seen in May is associated with the nice weather that often comes around for the first time, and the increased traveling families do, to go nice places to enjoy the nice weather. Another possibility is that high school graduation is in May, where a lot of teenagers drive around in special vehicles, to celebrate the end of 13-years of schooling. An increase was also observed at the end of the year in (with the highest number in December = same as in May). This might be caused by the holidays and the stress that brings about the population with shopping, stress and also the great possibility of snowy and icy roads in Norway during that particular time of the year. An increase in road traffic fatalities was also seen during the summer months in Croatia, with a significant increase in May, July and August. A decrease is then seen in September, which can be explained by the common holidays where families in Croatia tend to stay at home rather than travel, followed by another increase in October, when families goes back to work etc. The fatality risk of motorcyclists is, not surprisingly, peaking in the summer. This is due to the fact that the summer is the period when the weather and road conditions allow motorcyclist to be on the road.

In Norway there was a significantly higher incidence of RTAs with fatal outcome on Tuesdays (Figure 13). No reasons were found to explain this significant finding, and so further research is therefore necessary to assess this matter. In Croatia the same year, most fatal RTAs occurred during the weekend. This could possibly be related to alcohol consumption and increased vehicle use, due to leisure activities and travel during the weekends. Further research on the alcohol consumption and habits over the weekend would be necessary to assess and analyze in order to make this connection.

As stated in the introduction, traffic flow during the day correlates with sunlight. The results in the comparison between Norway and Croatia revealed that most RTAs occurred during daylight. This could be explained by the fact that visibility is known to be better in daylight, compared to twilight, dawn and nighttime after the sun has set. Another study, performed in England, stated that whenever the visibility is poorer people tend to be more careful in road traffic (56).

The most important traffic regulations and restrictions have been presented in the introduction, for both Norway and Croatia. Norway is a very strict country when it comes to obeying the traffic laws, being the only country in Europe who regularly punish citizens to prison sentences for speeding that is perfectly natural in other European countries (75). This could be a contributing factor to the lower amount of fatalities from RTAs caused by speeding in Norway. Further research would be necessary in order to compare the differences between these populations, and also in comparison with the rest of EU.

It cannot go unmentioned that the most important thing to keep in mind when it comes to RTAs, is that they can be prevented. Road traffic safety needs to be addressed in a holistic manner by governments all around the world, requiring the involvement and cooperation by various sectors, such as transport, police, health and education. There is a need to address, identify and prevent the important risk factors associated with RTAs. As stated in the introduction, the most important factors are those related to the roads, vehicles and, last but not least, the traffic participant on the road (1).

The Norwegian government has set themselves a national ambition, and goal, for the future, something called the "*zero vision*" (in Norwegian: *nullvisjonen*). The "*zero vision*" states that the number of fatalities in traffic in Norway should be greatly reduced, and that there should be no more than 350 fatalities, and severely injured, from RTAs in Norway in the time interval 2018-2029. The main idea and philosophy behind this vision is that it is both morally and ethically unacceptable for people to be killed or severely injured in RTAs (5).

Since 1970, long-term and targeted road safety work has been conducted in Norway, and this has produced results. The number of killed per year has been reduced from 560 in 1970 to about 100 in recent years. This positive development is also due to close and good cooperation between important players, such as the Ministry of Transport and Communications, the Norwegian Public Roads Administration, the police, the Norwegian Directorate of Health, The Education Directorate, municipal and county authorities, *Safe traffic* ("*Trygg Trafikk*" in Norwegian) and a number of other organizations (76).

Perhaps it would not be such a bad idea for countries in the EU, especially Croatia, to use Norway as an inspiration, and learn from this nation on how to increase road traffic safety. All EU countries would benefit from performing an annual in-depth analysis of every RTA causing a fatality (and severe injuries), with specific attention towards identifying the preventable risk factors.

This study showed that road traffic is safer in Norway than Croatia, and also what are the contributing factors to fatal RTA's. However it does have some limitations. First, Croatia unfortunately does not analyze all the RTA data as Norway does so some contributing factors could not be compared (seat belt use, cellphone use, fatigue and disease). Also, it was impossible to obtain the data of the number of users of the each type of the road and how many vehicles were on the road at some point of time so those factors could not be compared together with general numbers. If all of the countries would have the database as there is in Norway it would be easier to draw final conclusions.

6. CONCLUSIONS

1. The hypothesis established has been confirmed – road traffic is safer in Norway compared to Croatia. A difference was observed regarding the number of fatalities among the two compared populations. In Norway a total of 106 fatalities occurred in the year 2017, which makes up approximately 20 deaths per million inhabitants. In Croatia a total of 331 fatalities occurred in traffic in the year of 2017, which means there was 80 deaths per million inhabitants that year.
2. A significant risk factor in comparison of Norway and Croatia was gender, since being a male is associated with a higher risk of road traffic fatality in Croatia than in Norway.
3. Seat belt use was found to be a significant risk factor when compared between the two populations. However, since there were fatalities in Croatia were the use of seat belts was unknown, the accuracy behind this comparison is questionable.
4. Head-on collisions compared between the populations, was found to be a significant risk factor.
5. Dry road surface was proven to be a significant risk factor in comparison between Norway and Croatia. More RTAs occurred when the road surface was dry, compared to other conditions.
6. Norway is a country performing thorough, in-depth analysis of every single fatality caused in RTAs. Many risk factors are assessed and investigated to shed light on the possible preventions that can reduce the number of fatalities and injuries in traffic. Other countries should look to Norway, and be inspired to perform the same analysis of RTAs so that risk factors can be identified and, most importantly, prevented.

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8. SUMMARY

Diploma thesis title: Analysis of road traffic fatalities in Norway and its comparison to Croatia in 2017.

Objective: The main objective of this paper was to analyze the risk factors associated with fatal RTAs in Norway in 2017, and compare it with Croatia.

Subjects and methods: This work was organized as a cross-sectional research. The analyzed data was supplied with the courtesy of the Norwegian Public Roads Administration and the Norwegian Cause of Death Registry. Necessary data from the Republic of Croatia was collected from the Ministry of Internal Affairs. Data was also collected from the World Health organization. The statistical analysis was compared using chi-square calculations.

Results: In Norway in 2017 a total of 106 people were killed on the road. This was 29 fewer fatalities than seen in 2016, which makes 2017 the year with the lowest number of traffic related deaths in Norway since 1947. According to the population size in Norway in 2017 there was 20 deaths per million inhabitants. The total number of severely injured was 665, which is 26 fewer than the previous year. In Croatia the total number of fatalities in 2017 was 331, which according to the population in 2017 means there was 80 deaths per million inhabitants. This number is significantly higher than in Norway. When comparing the different risk factors associated with these fatalities, with chi-square calculations, gender (P=0.015), seat belt use (P=0.019), head-on collisions (P<0.001) and road surface (P<0.001).

Conclusion: The most significant risk factors associated with traffic related deaths on comparison between Norway and Croatia was gender, seat belt use, head-on collisions and road surface. And in general, the risk of being seriously injured or killed in RTAs in Norway is lower than in Croatia. Norway is a country performing thorough, in-depth analysis of every single fatality caused in RTAs. Many risk factors are assessed and investigated to shed light on the possible preventions that can reduce the number of fatalities and injuries in traffic. Other countries should look to Norway, and be inspired to perform the same analysis of RTAs so that risk factors can be identified and, most importantly, prevented.

9. CROATIAN SUMMARY

Naslov diplomskog rada: Analiza smrtnosti u prometu u Kraljevini Norveškoj i usporedba s Republikom Hrvatskom u 2017. godini.

Cilj: Analizirati čimbenike rizika povezanih sa prometnim nesrećama sa smrtnim ishodom u Kraljevini Norveškoj u 2017. i usporediti ih s Republikom Hrvatskom.

Ispitanici i metode: Ovaj rad je organiziran kao presječna studija. Analizirani podaci su pribavljeni iz Ureda za javne ceste Kraljevine Norveške i Matičnog ureda Kraljevine Norveške. Podaci za Republiku Hrvatsku su pribavljeni iz Ministarstva unutarnjih poslova Republike Hrvatske. Preostali podaci su prikupljeni iz baza Svjetske zdravstvene organizacije. Statistička analiza je napravljena korištenjem χ^2 testa.

Rezultati: Ukupno je 106 osoba smrtno stradalo u prometnim nesrećama u 2017. u Kraljevini Norveškoj. To je 29 smrtnih slučajeva manje nego u 2016. te samim time 2017. čini najsigurnijom godinom po tom pitanju još od 1947. Usporedbom s populacijom Norveške to predstavlja 20 smrtnih slučajeva na milijun stanovnika. Ukupni broj teško ozlijeđenih je bio 665 što je za 26 manje nego u prethodnoj godini. U Republici Hrvatskoj ukupan broj smrtno stradalih u 2017. je bio 331 što usporedbom s brojem stanovnika čini 80 smrti na milijun stanovnika. Ovaj broj je statistički značajno veći nego u Norveškoj. Kada se usporede čimbenici rizika značajni su spol (P=0.015), korištenje pojasa (P=0.019), frontalni sudari (P<0.001) i stanje ceste (P<0.001).

Zaključak: Najznačajniji čimbenici rizika povezani s prometnim nesrećama sa smrtnim ishodom između Kraljevine Norveške i Republike Hrvatske bili su spol, korištenje pojasa, frontalni sudari i stanje ceste. U pravilu, mogućnost nastanka teške ozljede ili smrtnog ishoda u prometnim nesrećama je niži u Norveškoj nego u Hrvatskoj. Norveška je država koja provodi cjelovitu, dubinsku analizu svake prometne nesreće sa smrtnim ishodom te se analiziraju i istražuju svi čimbenici rizika kako bi se rasvijetlila sama nesreća i olakšala prevencija koja bi smanjila ukupan broj smrtno stradalih i ozlijeđenih u prometu. Ostale bi se zemlje, u tom pogledu, trebale ugledati na Norvešku i provoditi takve analize kako bi se utvrdili i prevenirali takvi čimbenici rizika.

10. CURRICULUM VITAE

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