Risk Factors Associated with Fatal and Life-Threatening Road Traffic Injuries in Yerevan, Armenia, 2020-2021

Master of Public Health Integrating Experience Project

Research Grant Proposal Framework

MPH Candidate: Alina Hovhannisyan, MD

Advising team: Vahe Khachadourian, PhD, MD, MPH

Anya Agopian, PhD, MPH

Turpanjian College of Health Sciences
American University of Armenia

Yerevan, Armenia
2022

Table of Contents

Acknowledgments

I would like to express my deepest appreciation to my advisers Dr. Vahe Khachadourian and Dr. Anya Agopian for their guidance, valuable comments, useful critiques, and encouragement throughout my work.

I would like to thank the College of Health Sciences of the American University of Armenia. Dr. Varduhi Petrosyan, Dr. Anahit Demirchyan, and Dr. Tsovinar Harutyunyan have all been extremely supportive and encouraging.

I would like to express my gratitude to Dr. Mher Bisharyan, the head of Armenia's Scientific-Practical Center of Forensic Medicine, and the Division of Investigation of Traffic Crimes in Yerevan, particularly Samvel Samvelyan, for their unwavering support and invaluable assistance.

My friends Gevorg Gafaryan, Sergey Mkhitaryan, Rita Krmoyan, Zarine Simonyan, Sona Tunyan, and Lilit Alavedyan who gave me support and patience throughout this long path, are also to be thanked.

Finally, I am grateful to my family for being with me all this time.

List of abbreviations

AMD	Armenian Dram
CDC	Centers for Disease Control and Prevention
DALY's	Disability-Adjusted Life Years
DITC	Division of Investigation of Traffic Crime
ID	Identification
IRB	Institutional Review Board
GDP	Gross Domestic Product
MVC	Motor Vehicle Crash
RA	Republic of Armenia
SPCFM	Scientific-Practical center of Forensic Medicine
USA	United States of America
WHO	World Health Organization

Executive summary

A motor vehicle collision, often known as a car crash, occurs when one car collides with another car, pedestrians, or other objects. Car crashes frequently result in bodily injury, death, and financial expenditures. Road crashes, including the deaths and injuries that occur because of crashes, are caused by various factors. Risk factors that have been previously shown to be associated with car crashes include the rise in overall speed of the car, driving under the influence of alcohol and/or drugs, the absence of using a seat belt, unpleasant weather conditions, the day of the week, the time of the day, driving with others, the number of vehicles involved in the crashes, use of wrong-hand vehicle, the absence of airbags, and the driver's age, sex, educational status, and level of fatigue.

The number of car crashes is considerable in Armenia, and their potential to result in injuries and fatalities is of concern. It is essential to identify the risk factors that influence car crashes involving life-threatening injuries or deaths as opposed to other injuries among drivers and passengers in order to potentially prevent such occurrences. Thus, the proposed study aims to determine the risk factors associated with sustaining fatal and life-threatening injuries due to a car crash compared with other injuries during 2020-2021 in Yerevan, Armenia.

The design of the study will be case-control. The data collection will be conducted using the printed and scanned reports of the Division of Investigation of Traffic Crimes (DITC) and the Scientific-Practical Center of Forensic Medicine (SPCFM) of the Republic of Armenia. The study population for cases and controls will be drivers and passengers who are 18 years old and above who were in the car during the car crash and sustained fatal or nonfatal injuries in Yerevan, Armenia from January 1, 2020, to December 31, 2021. Cases will include either drivers or passengers with fatal or life-threatening injuries as a result of the car crash. The drivers or passengers who do not meet the definition of fatal and life-threatening injuries but had other types of injuries will serve as the control group. Using the formula for comparing two sample proportions, a total sample size of 394 (197 per group) will be needed. Simple random sampling will be used to select cases and controls from the lists of fatal and life-threatening injury reports and all other injury reports, respectively. The needed information will be collected from the reports by study staff using a self-generated data collection form. Descriptive analysis will be conducted to understand the characteristics of the study population. Multivariable logistic regression will be utilized to determine statistically significant risk factors associated with fatal and life-threatening injuries.

The study was approved by the Institutional Review Board (IRB) within the College of Health Sciences at the American University of Armenia. A pilot study was conducted, which showed that the study is feasible, the proposed variables for inclusion are available in the reports, and provided insight on ways to improve the study design. The proposed study will last 4 months, with an estimated budget of 2,030,000 AMD.

1. Introduction

A motor vehicle collision, often known as a car crash, occurs when one car collides with another car, pedestrians, or other objects.[1] Car crashes frequently result in bodily injury, death, and financial expenditures.[1] According to the Centers for Disease Control and Prevention (CDC), millions of workers use motor vehicles to reach their workplaces, and one of the major causes of death in the United States (US) is motor vehicle crashes.[2] The Association for Safe International Road Travel reported that annually about 1.35 million people's cause of death is attributable to road crashes.[3] Every day globally, an average of 3,700 people die on the road.[3] About 20-50 million people are injured due to road crashes, with many of them leading to disability.[4] In many countries 3% of the total gross domestic product (GDP) costs road crashes as reported by World Health Organization (WHO).[4] The high prevalence of road deaths is reported in low- and middle-income countries.[4] One of the major causes of death among the young population is road traffic injuries based on the data provided by WHO.[4] Road traffic injuries inflict considerable economic damage to people and the government.[4] Low- and middle-income countries have an imbalanced burden, regarding 85% of annual deaths and 90% of disability-adjusted life years (DALYs) lost due to car crashes.[5] From 1990 to 2020 the worldwide burden of disease increased due to road traffic injuries and it is predicted to continue to rise.[5] Road crashes, including the deaths and injuries that occur as the result of crashes, are caused by various factors.[3] A better understanding of these risk factors could result in effective management, and evidence-based solutions, averting part of the road crashes.[3]

1.1 Risk factors

Wrong-hand drive vehicles (right-handed vehicles in right-hand traffic and vice versa) have become a big issue, particularly in post-Soviet Union countries.[6] Due to blind spot areas, wrong-hand drive vehicles are more exposed to get involved in a road crash.[6] For example, in Sweden, left-handed vehicles were used in left-hand traffic until 1967, when they changed the regulations and shifted to right-handed vehicles. As a result, the country experienced a 30% decrease in road crashes and subsequently in their consequences.[6,7]

Gender has also been shown to be a risk factor for car crashes. Males are at a higher risk for car crashes.[8–10] Data provided by the US Department of Transportation shows that males are more likely than females to die in a car crash.[8] Moreover, the outcomes of car crashes are reported to be more severe among male drivers in comparison to female drivers.[11] Nevertheless, in crashes with the same severity, females are more prone to be killed than males.[11]

The absence of using seat belts is another risk factor for fatal injuries.[4,12] The use of seat belts was also linked to a lower number of passenger fatalities per mile.[13] Seat belts appear to prevent all types of injuries in both front and back seat passengers.[14] It's been suggested that improving seatbelt use could reduce fatalities.[15] A longitudinal study in the USA showed that the use of seatbelts and airbags decreases the mortality in motor vehicle crashes.[16]

The rise in the overall speed of a vehicle is directly correlated with the chance of a crash and the severity of the crash's repercussions.[4] Speeding is nearly unanimously acknowledged as the strongest risk factor for road crashes.[15] The likelihood of a pedestrian being killed by a motor vehicle increases considerably with the increase in speed.[15] Approximately a 20% increase in fatal crashes is due to a 5% increase in average speed.[17] Speed and collisions are linked by several factors. The higher the speed of the vehicle is the

longer it would need to travel in order to avoid an obstacle or to stop. Additionally, higher speed increases instability and risk when approaching a curve and decreases the chances of the driver responding with an evasive action in an emergency situation in order to avoid colliding with another vehicle.[17] Speeding has an association with crash injury severity[18] and the US Department of Transportation has reported that speeding resulted in 9,500 deaths in 2019.[19] Males who drive at excessive speeds and in poor visibility have the highest risk of death.[20]

The day of the week has also been shown to be associated with car crashes. In 2019, fatal car crashes were more common on weekends, especially on Saturdays. The number of nonfatal crashes was greater on weekdays, with Friday having the highest number of crashes.[21] Pedestrians, bicyclists, and motorcyclists were the most common victims of road traffic injuries, with weekdays being more common than weekends.[22]

Driving in the dark has proved to be a risk factor for car crashes. According to a study conducted in Poland, fatalities when driving in the dark are around 2.5 times higher than fatalities from driving during the day. Several studies have been undertaken to identify the risk factors contributing to a higher risk of crashes in the dark.[23] According to a study conducted in the Netherlands, the probability of fatal crashes is four times more at night in comparison with the daytime.[24] According to a study conducted in Croatia, there is a high probability of death and road injuries in urban areas at night.[20] Several studies have found similar results, further strengthening the link between nighttime traffic crashes and fatalities.[23,25–27]

Driving under the influence of alcohol or a drug is one of the frequent reasons for car crashes.[4] Alcohol usage is one of the contributing factors to fatality in car crashes, according to a study conducted in the US between 1982 and 2001.[16] Several studies prove the association between the high rate of crashes and alcohol use.[27–31] According to a study

conducted in British Columbia, there is a high probability of damage, fatality, and morbidity among drunk drivers.[32] Several other studies further support this notion.[33,34]

Driver fatigue and sleepiness are major risk factors for motor vehicle crashes and deaths.[35] In the US 1-3% of all car crashes are due to sleepiness.[36] According to a study conducted in Vietnam, fatigue was found to be the cause of approximately 37% of all crashes reported by motorbike taxi drivers.[37] Another study in Australia showed a high number of crashes related to fatigue and night driving.[38] The most widely studied issues, fatigue and sleepiness, were consistently linked to an elevated risk of car crashes.[39,40]

Because of slick roads, poor visibility, and other unpleasant weather conditions, the weather plays a role in road traffic crashes.[41,42] Wet seasons can also be a reason for car crashes, according to a study conducted in California.[43] The results of a study conducted in Glasgow suggest that the frequency of car crashes is higher in winter than in summer, which may be due to visibility issues caused by the extended duration of winter darkness and ice surfaces.[44] When it comes to car crashes, snow has a greater impact than rain. As the intensity of the precipitation grows, so does the probability of a crash.[45]

Injuries that could have been fatal were avoided because of the use of airbags.[46] The authors found that using seat belts or airbags reduced the probability of both fatality and injury severity in crashes.[47] In conjunction with lap and shoulder safety belts, airbags are believed to protect the drivers.[48]

The literature shows that working hours, driver age, and driving license may all have an impact on the amount of taxi-related car crashes.[49–51] A study conducted in Hong Kong showed that drivers' gender, the car utility year, time of the crash, and street lighting are the major factors for non-taxi related car crashes.[52]

Several other factors are associated with motor vehicle crashes. The risk of death in car crashes is related to involved individuals' education levels. People with little or no

education are more likely to die in car crashes. Another study done in Iran showed that 52.6 % of the mortality rate of car crashes was due to drivers with low educational status.[53] Also, there is an association between the years of driving a car or having a driving license and being involved in a car crash. Inexperienced drivers are more prone to be engaged in car crashes. A research study in the US found that young, inexperienced drivers are also prone to be engaged in deadly incidents because they used to break the regulations and do not obey the safety guidelines.[54] Another factor that results in car crashes can be not being alone during driving. When drivers are not alone in the car, the passengers can be distracting, which can be the cause of a car crash. Some studies showed that young drivers are more likely to get involved in car crashes than old-aged drivers when driving with passengers.[55] The number of vehicles involved in car crashes might influence crash severity.[51,]This is because more factors worsen the severity of a crash when more cars are involved. Transportation mode is yet another risk factor that can result in car crashes. In comparison, taxis are involved in car crashes more frequently because taxi drivers spent more time on the road, especially in traffic jams and bad weather conditions, show more risky driving behavior, and are less responsible.[56]

The above-mentioned risk factors related to car crashes and getting more severe injuries due to car crashes were categorized into three groups by the Haddon matrix. The Haddon matrix is a framework that is used to categorize the factors related to human, environmental, and vehicle associated characteristics to evaluate the importance of factors and inform developing interventions.[57] Human factors include the rise in overall speed of the car, driving under the influence of alcohol and/or drugs, driver's age, sex, and educational status, length of time having a driving license, driver fatigue and sleepiness, and not using a seat belt. Environmental factors include unpleasant weather conditions, the day of the week,

the time of the day, not driving alone, and the number of vehicles involved in car crashes. Vehicle-related factors include wrong-hand vehicles and the absence of airbags.

1.3 Situation in Armenia

From January 1, 2011, to April 1, 2021, a total of 34,992 car crashes were registered in Armenia, which injured 50,078 people and took 3,266 lives. During this period, almost half of the road crashes (14,965) occurred in Yerevan. In Yerevan only, 794 people died, and 19,301 were injured in car crashes.[58]

According to statistics from the road police of Armenia, the number of road crashes increased in 2019 compared to 2017. The police reported that 3,535 road crashes occurred in Armenia in 2017, resulting in 279 deaths and 5,179 injuries. In 2018, there were 4,111 road crashes, with 343 persons killed and 5,950 injured. From January 1, 2019, to December 26, 2019, 4,715 traffic crashes were reported, with 335 people killed and 6,678 injured.[59]

According to the road police of Armenia, 35,600 right-hand drive vehicles were registered in 2017. This represents around 7.5% of all cars on the road.[60] According to the traffic police of Armenia, in the first half of 2017, 84 fatal crashes were reported in the country. The incidents included 117 cars, and 102 people died as a result. Only six of the 117 vehicles were right-hand drive, while 111 were left-hand drive. In other words, right-hand drive vehicles accounted for 5.1 percent of fatal car crashes.[60]

In 2020, 4,016 road crashes were registered in the country, which is 783 less than in the same period of 2019. The most crashes in the last decade took place in 2019. In that year, the number of road crashes was 4,799. In the same year, the highest number of victims of road crashes was registered is 6,801. In 2020, the number of victims of road crashes was reduced to 5,846. The number of car crashes in 2020 may have decreased due to prevention measures such as lockdowns and working from home during the initial stages of the COVID-19 pandemic.[61,62]

In the first quarter of 2021, 1,028 road crashes were registered in Armenia, as a result of which 91 citizens died and 1547 people were injured. Moreover, almost half of the road crashes (433) occurred in Yerevan. Twenty-three people were killed, and 560 were injured in traffic crashes in the capital.

According to the Ministry of Transport and Information Technologies directory, 92,000 citizens have been licensed to drive taxis in recent years. This is because many citizens in Armenia carry out passenger transportation without a relevant license.[63] Numerous road crashes have occurred due to non-compliance with road sign requirements. As a result of non-compliance with road sign requirements, 101 crashes were registered in Armenia, 4 people died, and 150 were injured. Moreover, most violations (96) occurred in Yerevan.

According to the data retrieved from the Scientific-Practical Center of Forensic Medicine of the Republic of Armenia (SPCFM), 46 persons died from the car crashes, 73 people got life-threatening injuries, and 1,630 persons got another type of injury in 2021 in Yerevan, Armenia.

1.4 Study aim

The number of car crashes in Armenia is considerable, and they result in many injuries and fatalities, therefore, it is essential to identify the risk factors that influence car crashes involving life-threatening injuries or deaths as opposed to other injuries among drivers and passengers. This study will investigate the risk factors associated with sustaining fatal or life-threatening injuries compared to other injuries in motor vehicle crashes in Yerevan, Armenia in 2020-2021.

2. Methods

2.1 Study design

Given that the outcome (i.e., fatal and life-threatening injuries) of the study is rare, the appropriate design of the study will be case-control. The design will allow for the examination of multiple risk factors, offering improved feasibility and cost-effectiveness. [64]

2.2 Study settings

The data collection will be conducted using the printed and scanned reports of the Division of Investigation of Traffic Crimes (DITC) and the SPCFM. These centers were selected since in Armenia, all car crashes in which people get any type of injuries are registered in DITC. After the investigation of fatal and non-fatal injured cases, the reports are sent to SPCFM for injury type differentiation.

2.3 Study population

The study population for both groups (i.e., cases and controls) will be drivers and passengers who are 18 years old and above who were in the car during the car crash and got fatal or non-fatal injuries in Yerevan, Armenia from January 1, 2020, to December 31, 2021.

Definition of cases

Cases include either drivers or passengers who sustained fatal or life-threatening injuries as a result of the car crash. The life-threatening and fatal injuries are combined because Armenian laws and regulations consider them as an injury that can immediately cause death.[65]

Life-threatening injuries are divided into two groups: 1) injuries, which by their nature directly pose a threat to life and can lead to death, and 2) injuries that cause pathological conditions which are regularly accompanied by life-threatening conditions.[65]

The cases with fatal outcomes will be the drivers or passengers who died immediately due to a car crash or within 30 days after the crash.[66] Cases with life-threatening injuries will be those with at least one of six major blunt traumas such as head injuries, neck injuries, penetrating chest and abdominal injuries, and fracture of the skull with the following consequences, as well as severe brain injury, amputation and/or loss of movement and sensation in extremities.[67,68] The information on injury type will be retrieved from forensic reports, as life-threatening injuries are specifically differentiated in these reports.

Definition of controls

The drivers or passengers who did not meet the definition of fatal and life-threatening injuries but sustained other types of injuries will serve as the control group.

2.4 Sample size and sampling

2.4.1 Sample size calculation

The sample size was calculated using the formula for comparing two sample proportions. Gender was considered the primary exposure of interest. In this formula, P_1 represents the proportion of males with fatal and life-threatening injuries and P_2 represents the proportion of females with fatal and life-threatening injuries. *P-bar* is the mean of P_1 and P_2, and *n* is the sample size for each group.[69]

$$n = \frac{\{z_{1-\alpha/2}\sqrt{2\bar{P}(1-\bar{P})} + z_{1-\beta}\sqrt{(P_1(1-P_1) + P_2(1-P_2)}\}^2}{(P_1 - P_2)^2}$$

Based on the literature, the proportion of men among deaths and severely injured is 0.73 and 0.66 in the mildly injured group.[70] By using this information:

P_1 = (0.73+0.66)/2 = 0.695

The delta is considered 15%, hence:

P_2 = 0.695-0.15 = 0.545

P-bar = (0.695+0.545)/2 = 0.62

The sample size calculation is done along with an alpha of 0.05 and a power of 0.8.

$$n=\frac{(1.96\sqrt{2*0.62(1-0.62)}+0.842\sqrt{0.695(1-0.695)+0.545(1-0.545)})^2}{(0.695-0.545)^2}=164$$

The total sample size is 328 (164 per group).

Due to the potential of inclusion of more than one individual from each car, the assumption of independence of observations may be violated and thus resulting in a potential cluster effect.[71,72] Thus, the sample size was adjusted by a factor of 1.2 to account for the clustering effect. As a result, the total sample size will be 328*1.2=394 (197 per group).

2.4.2 Sampling strategy

Data collection will be performed using the reports from the DITC and the SPCFM. The data about car crashes that resulted in fatal and nonfatal injuries are regularly collected and are available in these two databases. In these centers, the information is kept with specific identification (ID) numbers that are assigned to each report, and the information cannot be traced back to the person in question. By using these two databases the cases and controls will be selected and then the data will be extracted.

The cases will be selected from the list of all fatal and life-threatening injury reports in Yerevan, Armenia for the duration of 2020-2021, using the simple random sampling strategy. For the fatal injury group, the data will be collected from the medicolegal reports of SPCFM, including the cause of death and the level of alcohol in their blood. The injury type for all groups will be collected from the reports of SPCFM. Other information for fatal and life-threatening injury groups will be collected from the DITC reports. These two databases are linked to each other with identical ID numbers.

The controls will be randomly selected from the list of reports of other types of injuries in Yerevan, Armenia for the duration of 2020-2021, using the simple random sampling strategy. This group's information will be collected from reports of SPCFM and DITC.

Thus, the study sample frame will include the entire list of drivers and passengers 18 years old and above who were engaged in car crashes from January 1, 2020, to December 31, 2021, and died or were injured because of the crash.

2.5 Data management

A self-generated participant ID will be allocated to each of the reports, in addition to the IDs which they already have as a part of the structure of the report. This will prohibit tracing the information back to the person in question. A separate document will be developed which will link the self-generated IDs with report IDs. In case any further information is needed from the reports, the research team will have the opportunity to refer back to them and collect the required data. First, the fatal, life-threatening, and other types of injury reports will be extracted, and a list of their ID numbers will be created. After this, the sampling will be performed. For the fatal injury group, the data will be collected from the medicolegal reports of SPCFM, including the cause of death and the level of alcohol in their blood. From SPCFM reports, the injury type will be obtained for all groups; the remaining information will be collected from DITC reports. Two data collectors will be trained on how to extract the data.

2.5.1 Data collection form

For the study, the data collection form was self-developed, based on similar studies' data collection forms.[73–75] With this form, the needed information will be collected from the reports. It contains 4 sections with 19 questions by which the risk factors will be explored (Appendix 1).

1. **General information** includes the ID number of the report, role in the car, injury type, and date of the crash.
2. **Driver characteristics** include driver's gender, age at the time of the crash, educational status, time (year/s) since getting a driving license, and the level of alcohol in the blood and exhaled air at the moment of a car crash.
3. **Vehicle associated characteristics** include using a seat belt at the time of the crash, speed of the car at the moment of the crash, where the was vehicle wrong-handed, the car type, the purpose of car use (taxi or private use), and if the airbag was deployed at the time of the crash.
4. **Environmental characteristics** include the time of the car crash, weather, not driving alone, and the number of cars involved in a car crash.

For collecting information about more than one case or control from the same car the ID numbers will be given to each car to be able to account for it in the analysis. In addition, the number of passengers in each car will be collected.

2.5.2 Study variables

The dependent (outcome) variables for this study are dichotomous. They are fatal/ life-threatening injuries and all other types of injuries getting due to car crashes.

The independent variables for this study are risk factors for a car crash. Driver characteristics are age, sex, educational status, the level of alcohol in the blood and exhaled air at the moment of a car crash, and time (year/s) since getting a driving license.

Vehicle associated characteristics are seat belt use at the time of car crash, speed of the car at the moment of a car crash, wrong-handed vehicle, the car type, the purpose of car use, and airbag use.

Environmental characteristics are the time of the crash (binary: daytime, nighttime), weather (categorical: sunny, snowy, rainy, dry), not driving alone (binary: yes/no), and the number of cars involved in a crash (nominal).

Whether the injured was the driver or passenger will also be taken into consideration. The study variables are presented in Table 1, and they were chosen based on availability in reports and literature reviews.

2.6 Statistical analyses

Missing values will be checked and the observations with 50% or more missing values will be excluded from the analyses. All statistical analyses will be performed using SPSS software. Double data entry followed by merging and cleaning of the data set will be done to avoid data entry mistakes.

Descriptive analysis will be conducted, and the characteristics of the study population (cases and controls) will be presented using frequencies and proportions for categorical variables, and means, ranges, and standard deviations for continuous variables. Logistic regression will be utilized to find the association, if any, between the potential risk factors and sustaining fatal and life-threatening injuries. Firstly, bivariate logistic regression will be done to examine the association between each risk factor and the outcome. Afterward, the statistically significant risk factors (p-value < 0.05) will be included in the final multivariable logistic model to determine the associations between risk factors and getting fatal and life-threatening injuries and odds ratios, confidence intervals, and p-values will be presented. Potential correlation among observations due to multiple individuals from the same vehicle will be addressed using random intercept models.

3. Ethical consideration

The study was approved by the Institutional Review Board (IRB) within the College of Health Sciences at the American University of Armenia before conducting the pilot study.

Furthermore, in addition to these ethical concerns, DITC and SPCFM were notified that all information will be used anonymously, that only researchers will have access to it, and that all data would be kept in password-protected files. Also, they were assured that the information gathered would only be utilized for scientific purposes and the outcomes will be presented with no personal identification. DITC provided written and SPCFM verbal approvals for access to the required reports. The collected data will be deleted within 6 months after finishing the study.

4. Pilot study

After obtaining IRB approval and approval from DITC, in April 2022, a pilot study was conducted to understand the feasibility of the project and to test the sampling and data collection tools proposed. The collected data include 6 cases and 6 controls. The descriptive results are shown in Table 2. The pilot study demonstrated the feasibility of the study. Moreover, during data collection for the pilot study, modifications were made to the data collection form based on the availability of variables in the reports. Additionally, data collection took more time than was anticipated, therefore the proposed duration of the data collection process was prolonged. Thus, the current proposal is based on the pilot study and the changes that were deemed necessary.

5. Logistic considerations

For this study, access is needed to police and investigators' reports about car crashes and the investigative reports of forensic experts in Yerevan, Armenia. Overall, five months will be used to conduct this study. One month was used for IRB and DITC approval and for the pilot study. The remaining four months will be used to complete the study in its entirety. Two months will be contributed for data collection and two months for data entry, cleaning, analysis, and write-up. Table 3 presents the timeline of activities.

6. Budget

Personnel, operational, and transportation-related costs are all factored into the study's budget. Two data collectors will be needed for data collection and entry. A statistician will be needed for data analysis, as well as a research coordinator for planning and implementation of the study. A monthly salary will be paid to the research personnel. Based on these costs, this study's overall budget was estimated to be around 2,030,000 Armenian drams (AMD). The budget is presented in Table 4.

Reference list:

1. About: Traffic collision. Accessed April 10, 2022. Available at: https://dbpedia.org/page/Traffic_collision
2. Motor Vehicle Crash Facts | NIOSH | CDC. Accessed January 16, 2022. Available at: https://www.cdc.gov/niosh/motorvehicle/resources/crashdata/facts.html
3. Road Safety Facts — Association for Safe International Road Travel. Accessed January 16, 2022. Available at: https://www.asirt.org/safe-travel/road-safety-facts/
4. Road traffic injuries. Accessed January 16, 2022. Available at: https://www.who.int/news-room/fact-sheets/detail/road-traffic-injuries
5. Road Traffic Accidents Increase Dramatically Worldwide | PRB. Accessed January 16, 2022. Available at: https://www.prb.org/resources/road-traffic-accidents-increase-dramatically-worldwide/
6. Roesel F. The causal effect of wrong-hand drive vehicles on road safety. Published online 2017. Available at: https://www.econstor.eu/bitstream/10419/170527/1/1001186524.pdf
7. This Day in History: Swedish Traffic Switches Sides - September 3, 1967 - Real Scandinavia. Accessed May 9, 2022. Available at: http://realscandinavia.com/this-day-in-history-swedish-traffic-switches-sides-september-3-1967/
8. Males and females. Accessed January 16, 2022. Available at: https://www.iihs.org/topics/fatality-statistics/detail/males-and-females#fn2
9. Jonah BA. Accident risk and risk-taking behaviour among young drivers. *Accident Analysis & Prevention*. 1986;18(4):255-271. doi:10.1016/0001-4575(86)90041-2
10. Williams AF. Nighttime driving and fatal crash involvement of teenagers. *Accid Anal Prev*. 1985;17(1):1-5. doi:10.1016/0001-4575(85)90002-8
11. Injury Vulnerability and Effectiveness of Occupant Protection Technologies for Older Occupants and Women. Accessed April 17, 2022. Available at: https://trid.trb.org/view/1252398
12. Febres JD, García-Herrero S, Herrera S, Gutiérrez JM, López-García JR, Mariscal MA. Influence of seat-belt use on the severity of injury in traffic accidents. *European Transport Research Review*. 2020;12(1):1-12. doi:10.1186/S12544-020-0401-5
13. Robertson LS. Reducing death on the road: The effects of minimum safety standards, publicized crash tests, seat belts, and alcohol. *American Journal of Public Health*. 1996;86(1):31-34. doi:10.2105/AJPH.86.1.31
14. Høye A. How would increasing seat belt use affect the number of killed or seriously injured light vehicle occupants? *Accident Analysis & Prevention*. 2016;88:175-186. doi:10.1016/J.AAP.2015.12.022

15. Bédard M, Guyatt GH, Stones MJ, Hirdes JP. The independent contribution of driver, crash, and vehicle characteristics to driver fatalities. *Accident Analysis & Prevention*. 2002;34(6):717-727. doi:10.1016/S0001-4575(01)00072-0

16. Cummings P, Rivara FP, Olson CM, Smith KM. Changes in traffic crash mortality rates attributed to use of alcohol, or lack of a seat belt, air bag, motorcycle helmet, or bicycle helmet, United States, 1982-2001. *Injury Prevention*. 2006;12(3):148-154. doi:10.1136/IP.2005.010975

17. SpeedRoadCrashes. Available at: https://www.paho.org/sites/default/files/2018-SpeedRoadCrashes_ENGLISH_FINAL.pdf

18. Ahmad N, Ahmed A, Wali B, Saeed TU. Exploring factors associated with crash severity on motorways in Pakistan. *Proceedings of the Institution of Civil Engineers: Transport*. Published online 2021. doi:10.1680/JTRAN.18.00032

19. Speeding | NHTSA. Accessed January 17, 2022. Available at: https://www.nhtsa.gov/risky-driving/speeding

20. Vorko-Jović A, Kern J, Biloglav Z. Risk factors in urban road traffic accidents. *Journal of Safety Research*. 2006;37(1):93-98. doi:10.1016/J.JSR.2005.08.009

21. Crashes by Time of Day and Day of Week - Injury Facts. Accessed January 17, 2022. Available at: https://injuryfacts.nsc.org/motor-vehicle/overview/crashes-by-time-of-day-and-day-of-week/

22. Sanyang E, Peek-Asa C, Bass P, Young TL, Daffeh B, Fuortes LJ. Risk Factors for Road Traffic Injuries among Different Road Users in the Gambia. *Journal of Environmental and Public Health*. 2017;2017. doi:10.1155/2017/8612953

23. Gaca S, Kiec M. Risk of accidents during darkness on roads with different technical standarts. Published online 2013:15-17. Available at: http://www.diva-portal.org/smash/get/diva2:758685/FULLTEXT01.pdf

24. Noordzu Pc. Cycling in the dark: an analysis of fatal bicycle accidents in the Netherlands. *Journal of Safety Research*. 1976;8(2). Available at: https://trid.trb.org/view/53003

25. Sullivan JM, Flannagan MJ. The role of ambient light level in fatal crashes: Inferences from daylight saving time transitions. *Accident Analysis and Prevention*. 2002;34(4):487-498. doi:10.1016/S0001-4575(01)00046-X

26. Al-Bdairi NSS, Hernandez S, Anderson J. Contributing Factors to Run-Off-Road Crashes Involving Large Trucks under Lighted and Dark Conditions. *Journal of Transportation Engineering, Part A: Systems*. 2017;144(1):04017066. doi:10.1061/JTEPBS.0000104

27. Twisk DAM, Reurings M. An epidemiological study of the risk of cycling in the dark: The role of visual perception, conspicuity and alcohol use. *Accident Analysis and Prevention*. 2013;60:134-140. doi:10.1016/J.AAP.2013.08.015

28. Dozois A, Nkondora P, Noste E, Mfinanga JA, Sawe HR, Runyon MS. Drug and alcohol use in Tanzanian road traffic collision drivers. *African Journal of Emergency Medicine*. 2021;11(4):390-395. doi:10.1016/J.AFJEM.2021.06.004

29. Millo T, Sharma RK, Murty OP, Bhardwaj DN, Murmu LR, Aggarwal P. Study of Incidence of Alcohol Use in Road Traffic Accidents in South Delhi in Fatal Cases. *Indian Journal of Forensic Medicine & Toxicology*. 2008;2(1):29-32.

Accessed January 18, 2022. Available at: http://ischolar.info/index.php/ijfmt/article/view/45744

30. Khanjani N, Mousavi M, Dehghanian A, Jahani Y, Souri H. The role of drug and alcohol use and the risk of motor vehicle crashes in Shiraz, Iran, 2014: A case–crossover study. 2017;18(6):573-576. doi:10.1080/15389588.2017.1279736

31. Traynor TL. The impact of driver alcohol use on crash severity: A crash specific analysis. *Transportation Research Part E: Logistics and Transportation Review*. 2005;41(5 SPEC. ISS.):421-437. doi:10.1016/J.TRE.2005.03.005

32. Desapriya E, Pike I, Raina P. Severity of alcohol-related motor vehicle crashes in British Columbia: case – control study. 2006;13(2):89-94. doi:10.1080/17457300500172685

33. Shyhalla K. Alcohol Involvement and Other Risky Driver Behaviors: Effects on Crash Initiation and Crash Severity. *Traffic Injury Prevention*. 2014;15(4):325-334. doi:10.1080/15389588.2013.822491

34. Híjar M, Flores M, López M v., Rosovsky H. Alcohol intake and severity of injuries on highways in Mexico: a comparative analysis. *Addiction*. 1998;93(10):1543-1551. doi:10.1046/J.1360-0443.1998.9310154311.X

35. Bener A, Yildirim E, Özkan T, Lajunen T. Driver sleepiness, fatigue, careless behavior and risk of motor vehicle crash and injury: Population based case and control study. *Journal of Traffic and Transportation Engineering (English Edition)*. 2017;4(5):496-502. doi:10.1016/J.JTTE.2017.07.005

36. Lyznicki JM, Doege TC, Davis RM, Williams MA, Bresolin LB. Sleepiness, driving, and motor vehicle crashes. *J Am Med Assoc*. 1998;279(23):1908-1913. doi:10.1001/JAMA.279.23.1908

37. Truong LT, Nguyen HTT, Tay R. A random parameter logistic model of fatigue-related motorcycle crash involvement in Hanoi, Vietnam. *Accident Analysis & Prevention*. 2020;144:105627. doi:10.1016/J.AAP.2020.105627

38. Fell DL, Black B. Driver fatigue in the city. *Accident Analysis and Prevention*. 1997;29(4 SPEC. ISS.):463-469. doi:10.1016/S0001-4575(97)00025-0

39. Robb G, Sultana S, Ameratunga S, Jackson R. A systematic review of epidemiological studies investigating risk factors for work-related road traffic crashes and injuries. *Injury Prevention*. 1966;14:51-58. doi:10.1136/ip.2007.016766

40. Philip P, Vervialle F, le Breton P, Taillard J, Horne JA. Fatigue, alcohol, and serious road crashes in France: factorial study of national data. *BMJ*. 2001;322(7290):829-830. doi:10.1136/BMJ.322.7290.829

41. Nofal FH, Saeed AAW. Seasonal variation and weather effects on road traffic accidents in Riyadh City. *Public Health*. 1997;111(1):51-55. doi:10.1038/SJ.PH.1900297

42. Qiu L, Nixon WA. Effects of adverse weather on traffic crashes: Systematic review and meta-analysis. *Transportation Research Record*. 2008;(2055):139-146. doi:10.3141/2055-16

43. Satterthwaite SP. An assessment of seasonal and weather effects on the frequency of road accidents in California. *Accident Analysis & Prevention*. 1976;8(2):87-96. doi:10.1016/0001-4575(76)90002-6

44. Smith K. How seasonal and weather conditions influence road accidents in Glasgow. *Scottish Geographical Magazine*. 1982;98(2):103-114. doi:10.1080/00369228208736523

45. Saha S, Schramm P, Nolan A, Hess J. Adverse weather conditions and fatal motor vehicle crashes in the United States, 1994-2012. *Environmental Health: A Global Access Science Source*. 2016;15(1):1-9. doi:10.1186/S12940-016-0189

46. Antosia RE, Partridge RA, Virk AS. Air Bag Safety. *Annals of Emergency Medicine*. 1995;25(6):794-798. doi:10.1016/S0196-0644(95)70210-5

47. Cummins JS, Koval KJ, Cantu R v, Spratt KF. An Original Study Do Seat Belts and Air Bags Reduce Mortality and Injury Severity After Car Accidents? Accessed January 22, 2022. Available at: www.amjorthopedics.com

48. Segui-Gomez M. Driver air bag effectiveness by severity of the crash. *American Journal of Public Health*. 2000;90(10):1575-1581. doi:10.2105/AJPH.90.10.1575

49. La QN, Lee AH, Meuleners LB, van Duong D. Prevalence and factors associated with road traffic crash among taxi drivers in Hanoi, Vietnam. *Accident Analysis and Prevention*. 2013;50:451-455. doi:10.1016/J.AAP.2012.05.022

50. Dalziel JR, Job RFS. Motor vehicle accidents, fatigue and optimism bias in taxi drivers. *Accident Analysis & Prevention*. 1997;29(4):489-494. doi:10.1016/S0001-4575(97)00028-6

51. Peltzer K, Renner W. Superstition, risk-taking and risk perception of accidents among South African taxi drivers. *Accident Analysis & Prevention*. 2003;35(4):619-623. doi:10.1016/S0001-4575(02)00035-0

52. Yau KKW. Risk factors affecting the severity of single vehicle traffic accidents in Hong Kong. *Accident Analysis & Prevention*. 2004;36(3):333-340. doi:10.1016/S0001-4575(03)00012-5

53. Sami A, Najafi A, Yamini N, et al. Educational level and age as contributing factors to road traffic accidents. *Chinese Journal of Traumatology*. 2013;16(5):281-285. doi:10.3760/CMA.J.ISSN.1008-1275.2013.05.005

54. Gonzales MM, Dickinson LM, DiGuiseppi C, Lowenstein SR. Student drivers: A study of fatal motor vehicle crashes involving 16-year-old drivers. *Annals of Emergency Medicine*. 2005;45(2):140-146. doi:10.1016/J.ANNEMERGMED.2004.08.039

55. Orsi C, Marchetti P, Montomoli C, Morandi A. Car crashes: The effect of passenger presence and other factors on driver outcome. *Safety Science*. 2013;57:35-43. doi:10.1016/J.SSCI.2013.01.017

56. Polytech Transp Eng Zhao PY, Zhang J, He X, Zhao Y, Zhang J, He X. Risk Factors Contributing to Taxi Involved Crashes: A Case Study in Xi'an, China. doi:10.3311/PPtr.7742

57. Haddon W. A logical framework for categorizing highway safety phenomena and activity. *Journal of Trauma - Injury, Infection and Critical Care*. 1972;12(3):193-207. doi:10.1097/00005373-197203000-00002

58. Գլխավոր – Հայաստանի Հանրապետության Ոստիկանություն. Accessed April 10, 2022. Available at: https://www.police.am/

59. ՃՏՊ-ների թիվը 2019-ին աճել է նախորդ 2 տարվա համեմատ. Accessed January 19, 2022. Available at: https://www.police.am/

60. Աջ ղեկերի արգելման փաստերի հերքումն ու հակափաստարկները | Իրազեկ քաղաքացիների միավորում. Accessed January 19, 2022. Available at: https://uic.am/4073

61. Yasin YJ, Grivna M, Abu-Zidan FM. Global impact of COVID-19 pandemic on road traffic collisions. *World Journal of Emergency Surgery*. 2021;16(1):1-14. doi:10.1186/S13017-021-00395-8/TABLES/2

62. Barnes SR, Beland LP, Huh J, Kim D. COVID-19 lockdown and traffic accidents: Lessons from the pandemic. *Contemporary Economic Policy*. 2022;40(2):349-368. doi:10.1111/COEP.12562

63. Կառավարություն - Կառուցվածք - Հայաստանի Հանրապետության Կառավարություն. Accessed January 22, 2022. Available at: https://www.gov.am/am/structure/277/

64. Armenian H. The Case-Control Method: Design and Applications. *The Case-Control Method: Design and Applications*. Published online May 14, 2009:1-238. doi:10.1093/ACPROF:OSO/9780195187113.001.0001

65. Իրտեկ - Իրավական տեղեկատվական կենտրոն. Available at: *http://www.irtek.am*.

66. Global status report on road safety 2015. Accessed January 29, 2022. Available at: www.who.int/violence_injury_prevention/road_traffic/en/

67. Identifying Life-Threatening Injuries Following a Car Accident | Chiropractors in Mesa, AZ. Accessed February 2, 2022. Available at: https://www.advancespine.com/identifying-life-threatening-injuries-following-a-car-accident/

68. Definition of severe injury - TAC - Transport Accident Commission. Accessed February 2, 2022. Available at: https://www.tac.vic.gov.au/clients/how-we-can-help/treatments-and-services/policies/supporting/definition-of-severe-injury

69. Ann L, Llewellyn A, Foreword JC, Cohen SB. Designing and conducting health surveys A Comprehensive Guide third edition. Available at: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.476.5561&rep=rep1&type=pdf

70. Vorko-Jović A, Kern J, Biloglav Z. Risk factors in urban road traffic accidents. *J Safety Res*. 2006;37(1):93-98. doi:10.1016/J.JSR.2005.08.009

71. Oltean H, Gagnier JJ. Use of clustering analysis in randomized controlled trials in orthopaedic surgery. *BMC Medical Research Methodology*. 2015;15(1):1-8. doi:10.1186/S12874-015-0006-1

72. Eldridge SM, Ashby D, Kerry S. Advance Access publication. *International Epidemiological Association International Journal of Epidemiology*. 2006;35:1292-1300. doi:10.1093/ije/dyl129

73. Valent F, Schiava F, Savonitto C, Gallo T, Brusaferro S, Barbone F. Risk factors for fatal road traffic accidents in Udine, Italy. *Accid Anal Prev*. 2002;34(1):71-84. doi:10.1016/S0001-4575(00)00104-4

74. Smink BE, Ruiter B, Lusthof KJ, de Gier JJ, Uges DRA, Egberts ACG. Drug use and the severity of a traffic accident. *Accid Anal Prev*. 2005;37(3):427-433. doi:10.1016/J.AAP.2004.12.003

75. Batool I, Hussain G, Kanwal N, Abid M. Identifying the factors behind fatal and non-fatal road crashes: a case study of Lahore, Pakistan. 2018;25(4):401-407. doi:10.1080/17457300.2018.1456466

Tables

Table 1. Variables

Variable	**Type**	**Options**
Injury type	Dichotomous	Fatal/Life-threatening Other types
Role in the car	Binary	Driver Passenger
Driver characteristics		
Age (years)	Continuous	
Sex	Binary	Male Female
Educational status	Categorical	No education School Professional-technical education Institute/university or higher
The level of alcohol in the blood, and exhaled air at the moment of car crash	Continuous	
Time (year/s) since getting a driving license	Continuous	
Vehicle associated characteristics		
Seat belt use art e time of the crash	Binary	Yes No
Speed of the car at the moment of car crash	Continuous	
Wrong handed vehicle	Binary	Yes No
The car type	Categorical	Sedan SUV Minivan Other
The purpose of car use	Binary	Taxi

		Private
Airbag use	Binary	Yes No
Environmental characteristics		
Driving in darkness	Binary	Yes No
Weather	Categorical	Sunny Snowy Rainy Dry
Not driving alone	Binary	Yes No
The number of cars involved in a crash	Nominal	

Table 2. Results of Pilot Study

	Cases (N=6) n (%)	**Controls (N=6) n (%)**
Role in the car		
Driver	5 (83)	4 (67)
Passenger	1 (17)	2 (33)
Injury type		
Fatal	4 (67)	-
Life-threatening	2 (33)	-
Other	-	6 (100)
Gender		
Male	5 (83)	6 (100)
Female	1 (17)	
Age (in years), mean (sd)	30 (23-43)	29 (21-37)
Educational status		
School (10 years or less)	1 (33)	6 (100)
Institute/University or higher	2 (67)	
Time (in years) since getting a driving license, mean (sd)	5.3 (3-7)	5.1 (0.08-6)
Seat belt use		
Yes	1(25)	3 (75)
No	3(75)	1 (25)
Speed (km/hr), mean (sd)	130 (50-210)	60 (50-90)
Wrong handed vehicle		
Yes	-	2 (33)
No	6 (100)	4 (67)
Car type		
Sedan	4 (67)	6 (100)
SUV	2 (33)	-
Purpose of car use		
Taxi	-	2 (25)
Private	6 (100)	4 (67)
Airbag use		
Yes	3 (75)	2 (50)
No	1 (25)	2 (50)
Time of crash		
Daytime	2 (33)	3 (50)
Nighttime	4 (67)	3 (50)
Weather		
Sunny	2 (33)	1 (16.7)
Snowy	-	3 (50)
Rainy	-	1 (16.7)
Dry	4 (67)	1 (16.7)
Not driving alone		
Yes	4 (67)	2 (67)
No	2 (33)	4 (33)
Number of the cars involved in crash		
One car	2 (33)	1 (17)
More than one car	4 (67)	5 (83)

Table 3. Timeline

Activity	**M1***	**M2**	**M3**	**M4**	**M5**
IRB approval, approval from DITC	X				
Pilot study	X				
Data collection	X	X	X		
Data management	X	X	X	X	X
Data analysis and interpretation				X	X

* Month

Table 4. Budget

Budget item	**Appointment type**	**Number of required units**	**Number of units**	**Total**
Data collector 1	Monthly	2	150,000 AMD*	300,000 AMD
Data collector 2	Monthly	2	150,000 AMD	300,000 AMD
Research coordinator	Monthly	4	200,000 AMD	800,000 AMD
Statistician	Monthly	2	200,000 AMD	400,000 AMD
Transportation	Monthly	3	60,000 AMD	180,000 AMD
Other costs	-	1	50,000 AMD	50,000 AMD
Total				2,030,000 AMD

*Armenian Dram

Appendix 1

Risk factors associated with fatal and life-threatening road traffic injuries in Yerevan, Armenia, 2020-2021 **Data Collection Form**		
General information		
1.	Self-generated participant ID _____	
2.	Number of the cars involved in a car crash _____	
3.	Role in the car	1. ☐ Driver 2. ☐ Passenger
4.	Injury type	1. ☐ Fatal 2. ☐ Life-threatening 3. ☐ Other
5.	Date of car crash ___/___/___ (mm/dd/yy)	
Driver associated characteristics		
6.	Gender	1. ☐ Male 2. ☐ Female
7.	Age at the car crash _____ (Years)	
8.	Educational status	1. ☐ No education 2. ☐ School (10 years or less) 3. ☐ Professional technical education 4. ☐ Institute/University or higher
9.	Time (year/s) since getting a driving license _____ (Years) _____ (Months)	
10.	The level of alcohol in the blood or in exhaled air _____ (Per-mille, ‰)	

Vehicle associated characteristics		
21.	Passengers number in the car during the car crash _____	
11.	Seat belt use at the time of car crash	1. ☐ Yes 2. ☐ No
12.	Speed of the car at the moment of the crash _____ (km/hr)	
13.	Wrong handed vehicle	1. ☐ Yes 2. ☐ No
14.	The car type	1. ☐ Sedan 2. ☐ SUV 3. ☐ Minivan 4. ☐ Other (Specify)
15.	The purpose of car use	1. ☐ Taxi 2. ☐ Private
16.	Airbag use	1. ☐ Yes 2. ☐ No
Environmental characteristics		
17.	Time of the car crash ___/___ (hh:mm)	
18.	Weather	1. ☐ Sunny 2. ☐ Snowy 3. ☐ Rainy 4. ☐ Dry
19.	Not driving alone	1. ☐ Yes 2. ☐ No
20.	Number of the cars involved in a car crash_____	