Head Injuries & Helmet Use

Among The Patients Involved In Motorcycle Crashes In Kathmandu

NASA FOUNDATION
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NASA Foundation
Kathmandu, Nepal

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ACKNOWLEDGEMENT

How can we get rid of the terrible casualties and human loss of Motorcycle crashes and injuries?

What could be the main causes for casualties and human losses?

Why are there no actions being carried out from the civil society to prevent this unnatural death of Nepalese youth?

Could implementation of use of Safe helmets to pillion riders be a solution?

If use of helmet is the major solution, then where do we begin?

Yes. These are the pertinent questions that surrounds us right now. This study is the basis of the above-mentioned context. If our study answers even a few of the questions, we shall believe our study was successful. The findings of study will inform the debate for Road safety and Motorcycling Safety in Nepal.

There are about around 4 million vehicles registered in Nepal. Of which more than 3.2 million are Motorcycles and two wheelers. In today's world, where motorized two-wheelers have brought positive impact, its saddening that users of motorcycles are bound to deal and cope with negative effects rather than the benefits. Deaths and injuries occurring from motorcycles crashes should not be acceptable and the access to safety measures i.e. Helmets must be increased. Motorcycling safety is important make our journey and transportation safer. This study is the first step towards this.

We have been actively involved and working in the fields of road safety through the support of Global Alliance of NGOs, International Automobile Federation (FIA), Fédération Internationale de Motocyclisme (FIM) and other International agencies. Global Alliance of NGOs for Road Safety has been working on areas of Safe, Sustainable and affordable mobility, which has supported this study. Their financial support as well as administrative help from NASA foundation made this publication possible. Our activities also include two-wheeler safety policy dialogue involving stakeholders, initiatives and many related programs. We are also generating public pressure for safe and sustainable mobility and generating evidence to influence decision makers with the help of experts.

We would like to express my sincere gratitude to the research team of Dr. Puspa Raj Pant, Dr. Saman Aryal and Er. Suyog Khanal. Similarly, for the administrative support, we would like to thank Ishwor Ballav Upreti and Subas Bhattrai. Hospitals and injured patients and affected families for their invaluable information for this study. Furthermore, I would like to thank Dr. Pritha Adhikari, Dr. Sajiva Aryal, Dr. Neharika Shrestha, Dr. Asmita Ghimire and Dr. Dipansha Maroo for their support during the data collection phase.

We would also like to thank experts, Dr. Buland Thapa, Dr. Sameer Adhikari, and Ms. Bhagabati Sedain for their opinion and suggestions who have also vouched for the importance of Motorcycling Safety and Helmets use. We encourage everyone for making safer roads and sustainable transport in Nepal. Our cooperative effort and involvement will make Right to Mobility without Fear possible.

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Kathmandu

BACKGROUND

Road traffic injuries are the leading cause of death of children and young adults (aged 5-29 years) in the world according to the World Health Organization (WHO) report 2018. It is the cause of 1.35 million deaths each year and the 8th leading cause of death in people of all age group (WHO, 2018). Road traffic injuries also make up the cause of 50 million injuries each year (WHO, 2018). The burden of the deaths is unjustly over three times higher on the low-income countries compared to the high-income countries due to rapid increase in vehicles but lack of proportionate infrastructure (WHO, 2004). Road Traffic Injuries led to 26.7% of the total injury-related Disability Adjusted Life Years (DALYs) lost in 2019 (IHME, 2020). Thus, the United Nations Sustainable Development Goals and the UN decade of action on road safety initiatives target for 2021-2030 is to reduce the road traffic injuries and deaths by 50% (WHO, 2021).

Nepal has a high motor vehicle fatality rate compared to other Asian countries. There is significant mortality caused by Road traffic injuries in Nepal which is around 16 per 100,000 population in 2019 (WHO, 2020). Transportation injuries are 4.11% of total deaths in Nepal (Pant et al., 2020). It is estimated that the total cost of road traffic injuries is around USD 1.50 million and non-medical costs is around USD 91.57 million. The economic cost of road traffic injuries is around 1.52% of the 2017 Gross National Income of Nepal, which is a preventable financial burden (Banstola et al., 2020). Motorcycles are involved in 65% of total road traffic crashes (Nepal Police, 2022).

In Asia, especially in countries like Nepal, motorcycles and two-wheeled motorized vehicles form a major means of transportation. In absence of efficient public transportation, motorized two-wheelers are comparatively convenient and cheaper to run and maintain. The increase of registration of motorcycles in Asia confirms it. According to the Department of Transportation Management Nepal, annually around 300,000 motorbikes are registered in Nepal (DoTM, 2019). As of 2018/2019 fiscal year report, Nepal has 25,30,722 registered motorbikes in Nepal in a country of 2,85,06,712 population as per census of 2018 (DoTM, 2019). Motorbikes make up 75% of motorized vehicles in Nepal. Motorbike related Road traffic injuries are associated with occurrence of traumatic brain injury and other head injuries and the users of motorized two-wheelers are considered to the vulnerable road users (Newall et al., 2020; Atreya et al., 2022). A study done in Malaysia concluded that 55-88% of motorbike rider deaths were as a result of fatal head injuries (WHO, 2004). The

appropriate use of helmets plays a significant role in improving the outcome of head injuries and the overall mortality (WHO, 2006; WHO 2022)

A study conducted among the patients admitted to a super specialty neurosurgical hospital in Kathmandu found motorcycle crash-related brain injuries comprise 62.6% i.e. 62 out of 99 all road traffic injuries (Newall et al., 2020). Among the patients presenting Neurohospital for the treatment of Traumatic Brain Injuries (TBI), the percentage of motorcycle drivers was 61.3% whereas remaining 38.7% were the passengers. Interestingly, all of the patients not wearing a helmet at the time of injury were the passengers. Similarly, another study conducted among the 112 patients with a history of road traffic injuries presenting to the emergency department of a Teaching Hospital in Lumbini identified 38 patients involved in motorcycle crashes (Atreya et al., 2022) of which 25 (65.8%) were the drivers and 13 (34.2%) were the pillion riders.

Motorcycle uses in Nepal has been consistently increasing over the last several years. The number of 2 wheeled motorized vehicles has increased from 1,567,589 in 2015 to 3,160,623 in 2021 (Govt of Nepal, 2022), a 101.6% increase in 6 years. There were less than 60 thousand motorcycles in the country in FY 2049/50 when, the Vehicle and Transport Management Act (2049) was legislated.

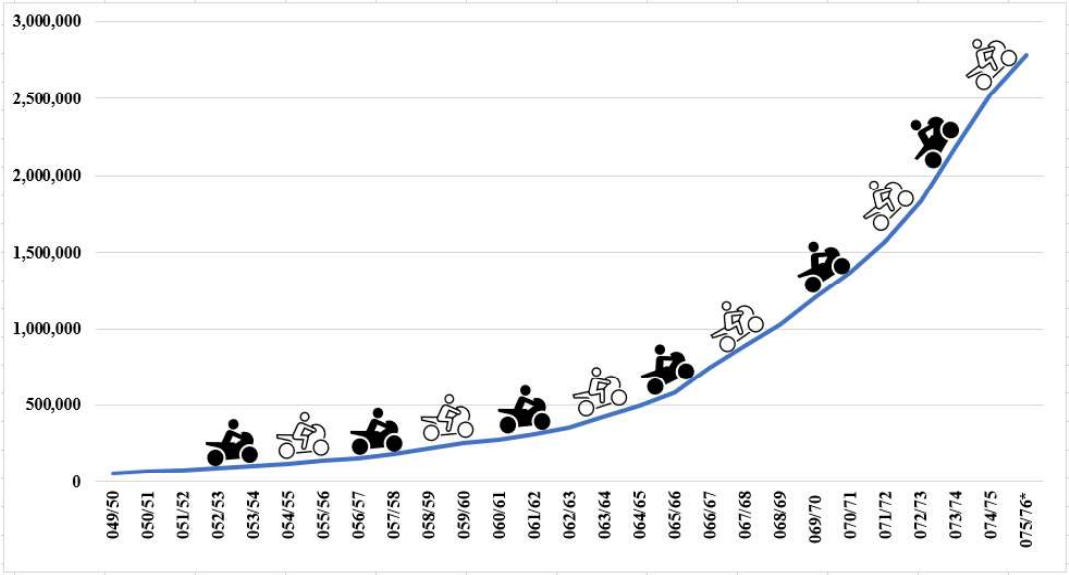


Figure 1. Cumulative number of two-wheeler vehicles registered at Department of Transport by year since the Vehicle and Transport Management Act was enforced in 2049BS.

This increase can be attributed to a number of factors, including the growing middle class, increased affordability of motorcycles, and the need for personal vehicle for commuting due to limited public transport options.

The use of safety helmets by motorcycle users in Nepal is not consistent i.e. nearly universal for the drivers and nearly null for the passengers and often blamed for poor enforcement of existing rules (Thygerson et al., 2019; Newall et al., 2020; Siebert et al., 2021). According to the Thygerson (2019), nearly 93% of all motorcycle drivers were males and 41.8% of the pillion riders were females; use of helmet among female pillion riders was lowest (0.4%) compared to males (1.2%).

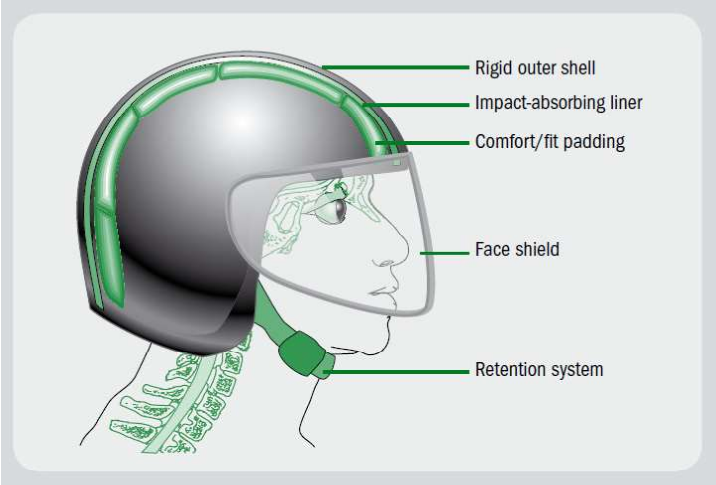


Figure 2. Elements of a Helmet and the protection mechanism (Source: WHO, 2006)

Helmets absorb impact, reducing the risk of serious head injuries and death. A standard helmet has a rigid outer shell, an impact-absorbing liner, and comfort/fit padding on the inside to make a cover for the skull, a face shield, and a retention system to hold other parts in place. The rigid outer shell serves as a mechanical barrier that prevents contact between the head and an impacting object. The impact-absorbing liner serves to reduce the rate of deceleration of the brain within the skull during an impact, thereby reducing the risk of resulting injury. This layer is lined by a comfort padding that helps the helmet fit snugly and keeps the user comfortable. The chin strap ensures that the helmet remains on the head prior to impact (Weze, 2019). Wearing a helmet is not only a personal responsibility but also a legal requirement in many regions, and it is important for riders to understand the importance of wearing a helmet for their own safety and the safety of others.

The study aims to summarize the actual prevalence of head injuries in selected tertiary hospitals in Kathmandu Nepal. This study will thus provide reference data for further studies.

METHODOLOGY

The study was conducted in Kathmandu during the month of April, May, June, and July in 2022. Kathmandu being the capital of country provides a large number of economic and educational opportunities, hence, large proportion of population migrate live here. Motorcycle being the cheapest and most convenient mode of transportation, it has become the transportation of choice for majority of people in Kathmandu.

We conducted a descriptive cross-sectional study in three hospitals, namely, Manmohan Memorial Hospital, National Trauma Center and Shahid Memorial Hospital. These hospitals were chosen because of their locations closer to the areas where higher number of motor vehicle injury cases were reported, and maximum number of cases get admitted or referrals. We began the study after we got the consent from IRB of each hospital to conduct the study. Our research assistants visited the hospital on the month of August to collect the information about the victims. We called the patient or their family members via number provided during hospital admission and took verbal consent to involve them in the study.

Data collection was organized in three stages: At first stage we collected answers from the patients involved in road traffic crashes to the following questions during hospital visits: gender, age, date of admission, type of vehicle involved in crash, details of two-wheeler bike, role of the patient (driver or pillion or other road user), body parts injured (head or spine or limbs or other body parts). Using this information, we only solicited additional information from those who reported head injury and the information regarding severity of head injury was obtained. As a next stage, we contacted the patient or their family members to get information on the following via phone calls, with their consent: status of helmet use (including whether it was worn properly), means of patient transportation to the hospital, time taken to arrive at hospital, Treatment provided to the patient, Time required/taken for the recovery, outcomes (recovered or referred or death) and treatment costs. Data collection was done on paper format and entered into the MS Excel Worksheet and exported to SPSS for further tabulation and cross-tabulation. Data is also presented using figures and graph. The advanced statistical analysis was not planned because of purposive sampling and the information of the patients who were injured / admitted in hospital for comparison was not available.

We also used expert opinion about the importance of helmet use to protect the motorcyclists and pillion riders from head injuries and traumatic brain injuries. The three experts represented trauma surgeon, road safety advocate, implementers and decision makers. The opinions were collected using questions including the situation of two-wheeler injuries in Nepal, measures for the prevention of head injuries, and importance of helmet use for the prevention of head/traumatic brain injury.

2.1 Description of the hospitals

Nepal Health Care Co-operative Limited (NEHCO)

Nepal Health Care Co-operative Limited (NEHCO) is founded and registered under cooperative act on 17 March 2006 under which a 100 bedded Manmohan Memorial Community Hospital (MMCH) and Manmohan Memorial Institute of Health Sciences (MMIHS) are established in the year 2006 and 2007 respectively. Both wings are established after the name of Former Prime Minister Late Manmohan Adhikari, a great patriot and legendary leader of Nepal and South Asia.

In line with national and international concept of Center of Excellence with purpose of providing quality medical education, health service delivery and health research, Manamohan Memorial Teaching Hospital (MMTH) is established under NEHCO. NEHCO is committed to invest it's all efforts to ensure the quality health care service delivery and to provide the practical as well as scientific education through the cooperative initiatives.

Sahid Memorial Hospital

With high evaluation of known and unknown martyrs who sacrificed their precious lives for the end of the feudal cultures and autocracy, practiced for ages and for democracy leading to republic and institutionalized sustainable peace, to shoe deep reverence for them and get inspired by them, "Martyr Memorial Public Health Cooperative Society Limited" has been founded in the campaign of cooperatives, with collections of small amounts of money from different individuals, aiming at extending affordable, reliable, modern technology-based quality health service to the Nepalese people, especially those who are poor and deprived, and under its investments and directions. "Martyr Memorial Hospital," located near Kalanki chowk, Kathmandu Metropolis ward number 14, a main gateway to the Kathmandu city.

National Trauma Center

Recognizing the need for quality trauma care and trauma relief centers in Nepal, the National Trauma Center was established as the first and only trauma hospital in Nepal. It has provided its undivided attention and services to patients during the Great Earthquake of Nepal (2015). It is well prepared for the collective loss of trauma victims.

The National Trauma Center (NTC), a public hospital, is located in the center of the capital city, Kathmandu, Nepal. It is just opposite to the famous Mahankal Temple near New Road.

The hospital is easily recognizable by its red and beige ten-story building. The hospital has 12 departments, five major operation theaters and one emergency room. Departments include orthopedics, general surgery, neurosurgery, spine surgery, burn and plastic surgery, anesthesiology, radiology, pathology, otolaryngology, thoracic and vascular surgery, dental, and faciomaxillary departments. Compulsory posting of residents in surgery, neurosurgery, orthopedics, radiology and anesthesiology for trauma care has added strength to this hospital.

RESULTS

- A total of 419 traffic injury patients were identified in 3 hospitals, for the months of Baishakh, Jestha and Ashar 2079.

	Male	Female	Total
Trauma Center	204	54	258
Shahid Memorial	127	21	148
Manmohan Memorial	11	2	13
Total	**342**	**77**	**419**

Table 1. Distribution of study participants by study hospitals

- Among them 349 (83%) of the patients were involved in a motorcycle crash as a driver (232; 66%), pillion rider (73; 21%) or pedestrian (44; 13%). Among these categories, the percentages if males were 88% (drivers), 64% (pillion riders) and 73% (pedestrians) respectively.
- Among the 232 Motorcycle drivers only 14% were treated for head injuries and 55% for injuries to the limbs

Figure 3. Body parts injured in two-wheeler vehicle crash for the drivers (N=232)

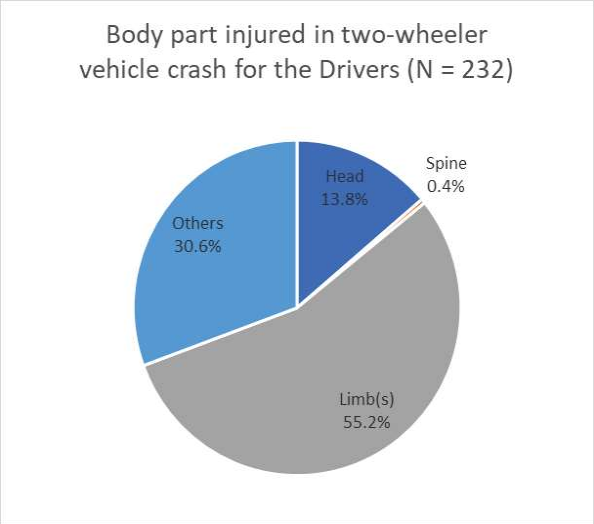
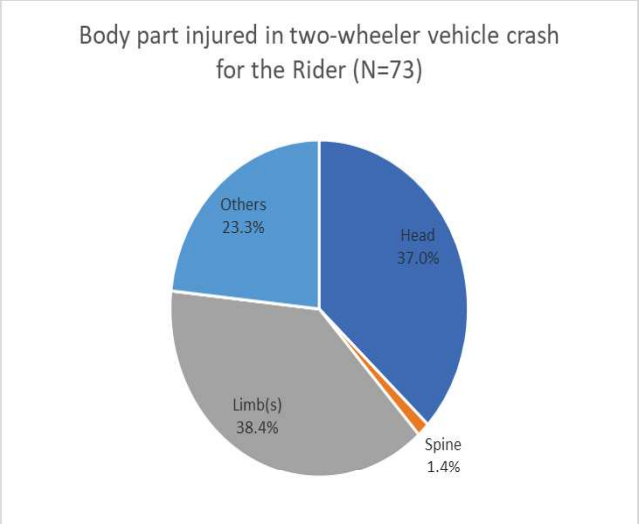


Figure 4. Body parts injured in two-wheeler vehicle crash for the passengers (N=73)



- Among the 73 pillion riders 37% were treated for head injuries, 38% for injuries to the limbs and 1% had spinal injuries.
- Among all 349 of the patients were involved in a motorcycle crash 283 (81%) were males and 66 (19%) were females.

- Nearly 20% of all patients involved in two-wheeler crashes suffered head injuries (67 out of 349). Among these 67 patients 58 had head injury only; 8 had injury to face and 3 had injuries to head and limbs.

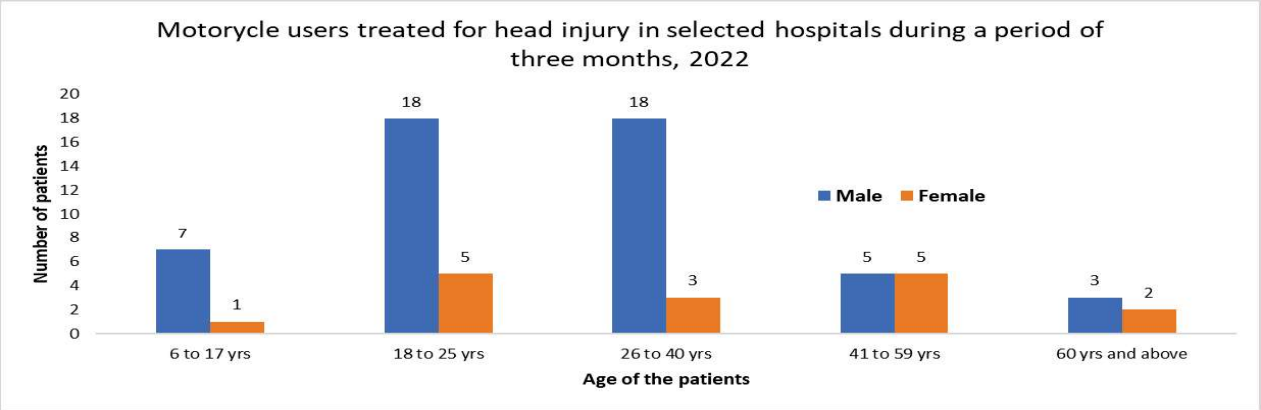


Figure 5. Motorcycle users treated for head injuries in selected hospitals during a period of 3 months in 20022

- Among the identified 67 Head injury patients, the biggest proportion (69%) was from the National Trauma Center followed by Sahid Memorial Hospital (24%) and only 7% were from Manmohan Memorial Hospital.

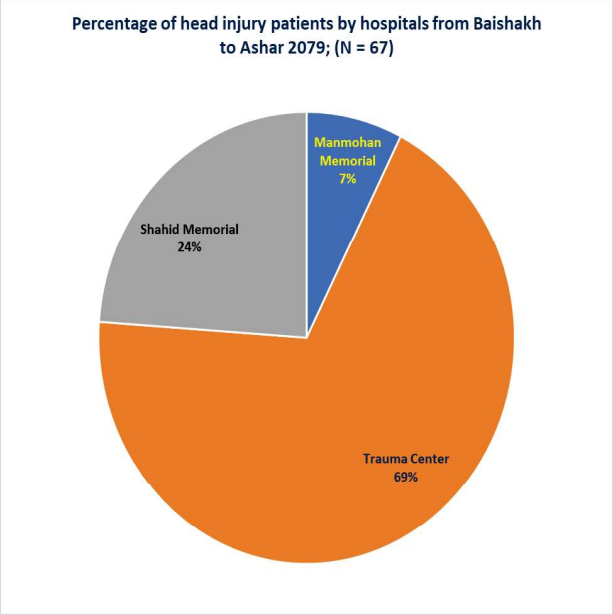


Figure 6. Percentage of head injury patients by hospitals from Baishakh to Ashar 2079 (N=67)

- Nearly 70% of the head injury patients sustained fracture of skull or brain haemorrhage or concussion.

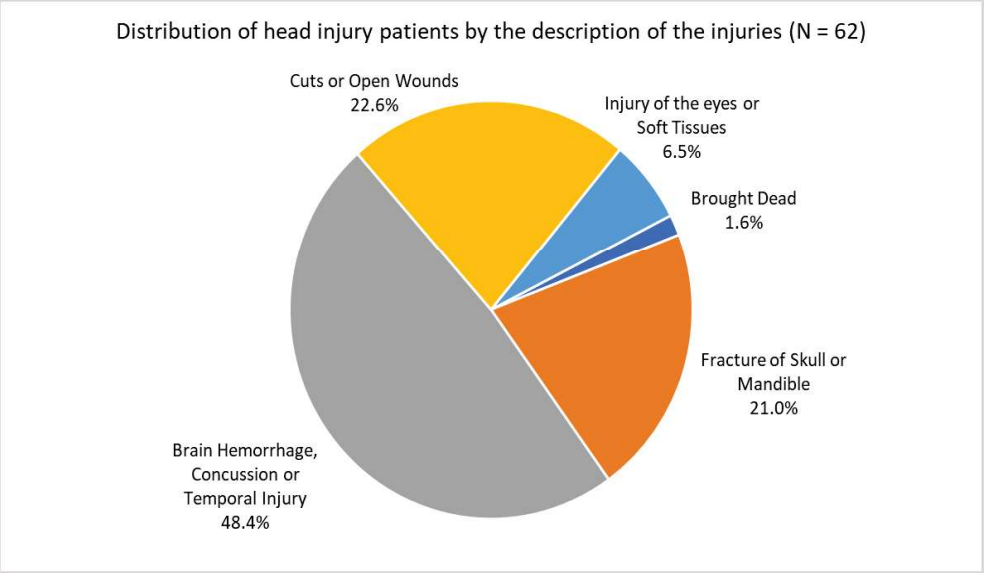


Figure 7. Distribution of head injury patients by description of their injuries (N=62)

- Among the 62 identified head injury patients: one was brought dead; one went in comma; two were permanently disabled; three were under treatment during this study and 55 were recovered.
- All kinds of injuries were higher among males.

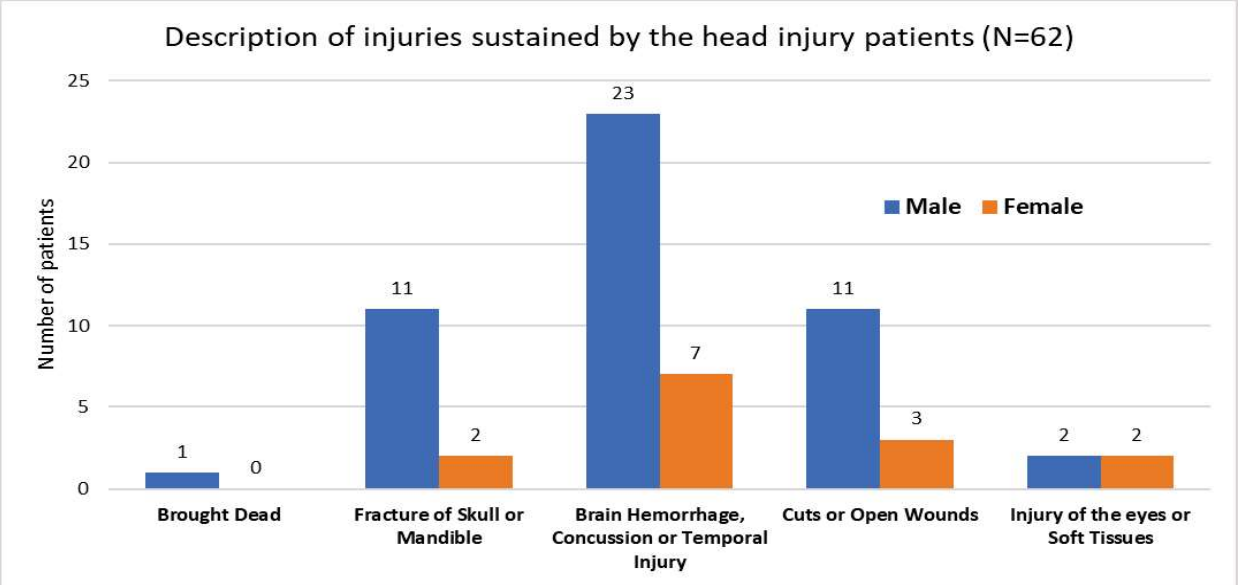


Figure 8. Description of injuries sustained by the head injury patients (n=62)

- Among the 62 identified head injury patients: one was brought dead; one went in comma; two were permanently disabled; three were still undergoing treatment during this study and 55 were recovered.

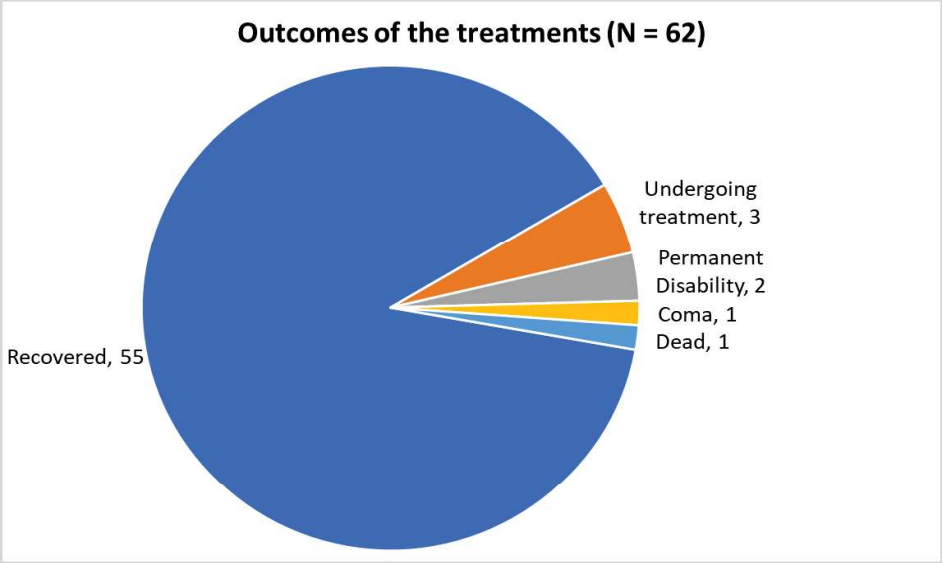


Figure 9. Outcomes of the treatment provided to the head injury patients (n=62)

3.1 Use of Helmets

- Among the 67 head injury patients; 59 were motorcycle users (32 drivers or 27 pillion riders). Therefore, the analysis of Helmet related findings will use 59 as denominator.
- Among all the drivers sustained head injuries 94% were wearing a helmet (of any standard) whereas only 7% pillion riders (i.e. 2 out of 27 sustaining head injuries) reported of wearing a helmet while involved in a motorcycle crash.

	Drivers		Pillion riders	
Age groups	**Total**	**Wearing Helmet**	**Total**	**Wearing Helmet**
6 to 17 yrs	2	2 (100%)	5	0 (0%)
18 to 25 yrs	14	11 (91.7%)	8	0 (0%)
26 to 40 yrs	14	13 (92.9%)	6	1 (16.7%)
41 to 59 yrs	3	3 (100%)	5	1 (20%)
60 yrs and above	1	1 (100%)	3	0 (0%)
All ages	**32**	**30 (93.8%)**	**27**	**2 (7.4%)**

Table 2. Distribution of patients with head injuries by age group and helmet wearing status.

- Among all the drivers sustained head injuries 94% were wearing a helmet (of any standard) whereas only 7% pillion riders (i.e. 2 out of 27 sustaining head injuries) reported of wearing a helmet while involved in a motorcycle crash.
- The following figure is showing the head injuries sustained by non-helmet wearing pillion riders.

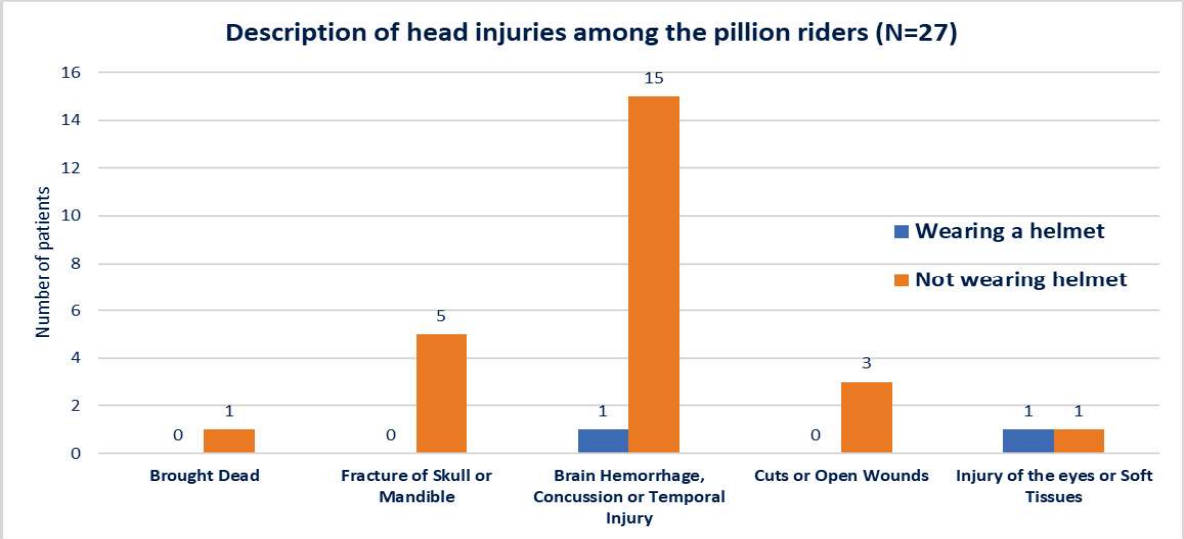


Figure 10. Description of head injuries among the pillion riders (n=27)

- Among the 27 identified pillion riders with head injuries: one was brought dead; one went in comma; two were permanently disabled; and 22 were recovered.

Treatment provided	Pillion riders (n=27)	Drivers (n=32)
Conservative treatment and CT scan	19 (70.4%)	14 (43.8%)
ICU Admission	3 (11.1%)	4 (12.5%)
Surgery	1 (3.7%)	1 (3.1%)
Symptomatic Management	2 (7.4%)	1 (3.1%)
X-Ray and/or Suture	1 (3.7%)	12 (37.5%)
Brought dead	1 (3.7%)	0 (0%)

Table 3. Treatments regimes received by pillion riders and drivers.

- Although a large proportion of helmet wearing drivers were treated for head injuries (table) only 10% of those were still undergoing treatment (most of them had minor injuries and discharged).
- Total expenditures amounted NRs 6,431,000 for all 57 head injury patients. The treatment costs ranged from a minimum of NRs 3,000 (~25 USD) to a maximum of NRs 1,800,000 (~13,900 USD). The mean of the amount was NRs 112,825.
- In addition to the amount in terms of money, the duration of hospital stay for the 57 head injury patients was 1,300 days (in the past 3 months only). On an average one head injury patient stay 23 days in hospital.

3.2 Three experts: three opinions

i. Dr Buland Thapa, Former Chairperson, Nepal Orthopedic Association & Alliance member, Safe and Sustainable Mobility

1. Two-wheeler crashes in Nepal are a major cause of grave & serious injuries with high mortality / morbidity especially among young patients between 20-40 years of age. Therefore, the

population of productive age are largely affected. Many of them sustain head injuries which need urgent medical services and there is increased chances of death at the scene or if the treatment is delayed.

2. To reduce these causalities, we have to limit speed, maintain lane discipline, restrict inappropriate overtaking, implement licensing rules strictly, zero tolerance on driving under the influence of alcohol and find ways to detect the use of drugs by the riders; restrict or ban mobile use while driving.
3. Enforcing mandatory helmet rules for both the rider and pillion riders is a proven measure to protect motorcycle users. The use of Certified Standard helmets and proper gear (protectinve dress for motorcyclists) is necessary not only to the drivers but also to pillions and children because children are highly vulnerable to sustain severe head injury in case they are involved in a crash.

ii. Dr Sameer Adhikari, Chief, National Health Emergency Operation Center (HEOC) & Joint Spokesperson (Ministry of Health and Population, Government of Nepal

1. Injuries caused by motorcycle crashes is a very serious issue in Nepal. Most of the road traffic crashes are related with motorcycles so we have to rethink to make them safer. On another hand, cyclists are also highly vulnerable to road crashes as they require high of energy to operate and positive health outcome, we have to create conducive environment to promote cycling. But neither motorcycles nor cycles are safe in current situation.
2. Prompt action for rescue, response, hospitalization and follow up of the persons injured after they are involved in motorcycle crashes is very essential. For the prevention, we have to create different lanes for two-wheeler, mandatory helmets—both for riders and passengers, increase taxes on risky vehicles, through education for drivers before issuing them a license. Similarly, the probation period for two-wheeler license needs to be about 5 years.
3. Helmets are vital to prevent mortality and morbidity from crashes.

iii. Bhagabati Sedain, Coordinator, NASA Foundation

1. Motorcycles are an important means of transport and rapidly growing in Nepal. It is a family vehicle and is increasingly popular among young people. Unfortunately, motorcycles are dangerous riskier means of transportation, and motorcycle users are categorized as vulnerable road users. Head and neck injuries are the most common causes of death and severe injury among motorcyclists. Motorcyclists who do not wear helmets are at a much higher risk of sustaining head injuries which can be open (skull fracture and penetrating injuries) or closed (concussion, brain contusions or brain haemorrhages) type and it

exponentially increases the risk of death from these injuries. Wearing a helmet is the single most effective way of reducing head injuries and fatalities resulting from motorcycle crashes. Quality and correct use of helmet can lead to 42% decrease in the risk of fatal injuries and a 69% reduction in risk of head injuries. A more recent systematic review from LMICs in African region has concluded that helmet use reduces up to 88% of head. Therefore, helmet use has become a recommended intervention in the World Health Organization (WHO) and United Nations (UN) Global plan: decade of action for road safety 2021–2030.

2. Current practices of ride-share showed that two-wheelers are also popular public transport in urban areas. Among total road crashes, more than half were motorcycle crashes and comprised about one-third of Nepal's road traffic deaths and injuries. Thus, two-wheeler safety is challenging, and the high probability of two-wheeler crash deaths and injuries in the coming days.
3. The best effective way to prevent untimely deaths of people, numerous injuries and disabilities is strengthen the public transport system. Besides, public transport system strengthen following initiatives can save preventable deaths, injuries and disabilities:
    - Government should prioritize to import up to 200cc motorcycle for common use and more for the riders only.
    - Government should strictly make provision to import quality helmet.
    - Strictly enforce helmet use rules to the riders and the pillion riders
    - Strict speed limit regulations for two-wheeler users
    - Two-wheeler users (rider and pillion rider) need to wear helmet.
    - Maintain two-wheelers timely.
    - Maintain distance between the vehicles front and beside while riding.
    - Wear possible safety gear.
    - Follow the road safety rules and regulations.
    - Do not use mobile phone while riding.
    - Do not drink drive.

DISCUSSION

This study highlights the epidemiology of head injuries and helmet use among motorcycle crash victims. The study revealed how low prevalence of helmet use is related to high occurrence of head injuries. Given the rapid increase of motorcycles on Nepali roads without stringent law enforcement to ensure safety of the motorcycle users, there is an urgency to ensure sustained efforts at reducing the risk of injuries and their consequences among the drivers and pillion riders.

According to Motorcycle Data statistics1, in Nepal 78% of circulating vehicles are two wheelers. In the year 2020, the domestic market of motorcycle was 28th largest in the world, with over 193,000 new 2- and 3- wheelers registered. Projecting the data 10 years ahead, it is estimated that the country will be a half million market, potentially one of the top 15 in the world. Increasing motorcycle and motorcycle users will further increase the chances of injuries among the motorcyclists if the enforcement of laws do not get adequate attention. At the same time shortening the response time for post-crash and pre-hospital care services to the casualties resulted from motorcycle crashes is equally important.

Helmet use

In one study done among active-duty US Army personnels in the United States it showed significant increase in the rate of non-fatal motorcycle traffic crashes. Alcohol use and not wearing a helmet increased the odds of fatality, given that a crash occurred, and additional modifiable risk factors were identified. Percentage of population not wearing helmet in the study was 31.9% who had undergone various crash injuries (Rappole et al., 2019). Similarly, in our study only 7.4% pillion riders were wearing helmet and 94% riders wore helmets. Among the riders who wore helmets and still experienced head injuries many other behavioral factors like alcohol use and fatigue or lack of sleep before riding could have been the cause. However, among the pillion riders there was a case that was brought dead, one that went into coma and two cases that became permanently disabled. Which implies the higher severity among the pillion riders who were not wearing a helmet at the time of the crash. The remaining patients had to go through various treatment procedures and fully recovered. The average amount (expenditure) per head injury patient surmounted to NRs 112,825 (850 USD), as per our study. So, we can infer that wearing a helmet is safe in every aspect whether

1 Nepal 2022. Motorcycles Industry Struggles Hit By Government Ban To 150cc+ Import *https://www.motorcyclesdata.com/2022/12/04/nepal-motorcycles-industry/*

be it health or economic. Mandatory helmet use for pillion riders and driver is beneficial to save from premature deaths due to severe head injuries.

Another study by Siebert and colleagues conducted in all 7 provinces of Nepal, found that overall driver helmet use was 98.7% and passenger helmet use was only 0.8%; we also observed a similar difference in our study where 94% of riders used a helmet and only 7.4% passengers used a helmet. The study recommended effective changes in helmet use regulation. According to the study, there is high adherence to the penalized mandatory helmet-use law for drivers which paves the way for the potential of more comprehensive regulation for fines for the passengers too (Siebert et al., 2021). In a similar study conducted in India, among pillion riders using helmets, it was found that pillion riders who were men were fined if not wearing helmets whereas female pillion riders had no obligations. All these studies, conducted in different parts of the world provide insight into factors associated with the non-use of helmets among pillion riders and especially females. The results of these different studies and our study can be used as an evidence base for the potential of legislative improvements in traffic laws concerning mandatory helmet use among pillion riders. Also, strategies like awareness campaigns in the media, prominent women creating examples, and women starting to use helmets as first steps, strict law enforcement in form of fines can be undertaken in all seriousness.

Sex difference in 2-wheeler injuries

It was found that women pillion riders faced more head injuries compared to their male counterparts because of such regulations (Swaroop et al., 2014). Different studies conducted in countries like Vietnam and Taiwan have shown that helmet laws implemented with adequate enforcement, punitive fines, and a strong public awareness campaign have shown positive effects of increased rates of helmet use in these countries (Tsai & Hemenway 1999; Passmore et al., 2010).

Similarly, in country like Pakistan, it was found that female pillion riders lacked both knowledge and awareness of helmet law for pillion riders and other factors like gazes and stares of people and the sitting position of women in bikes with both legs on one side (saddle-sided sitting) led to more serious injuries among them (Uzma et al., 2012). In our study most of the road traffic injuries were found among males 342 than females 77; the ratio being 4.4:1, which is similar to Tanzania (Chalya et al., 2014) but slightly lower to the study done at Lagos University where the ratio of males: females involved in road traffic injuries is 6:1 (Faduyile et al., 2017).

Also, the studies conducted in Kenya and other low- and middle-income countries show similar results (Sisimwo et al., 2018). This could possibly be due to the greater exposure to traffic of the males compared to females as drivers or riders and as frequent travelers in motor vehicles for work-related activities as suggested by these studies.

Age group involved in 2-wheeler injuries

Our study found that the age group most commonly involved in 2-wheeler crashes were the people aged 21-35 years. This finding is similar to another metanalysis done in African countries which showed that majority of population of 16-45 years were involved in such fatalities (WHO, 2022). Majority of youth population of this age group are either breadwinners for their families or productive and therefore, predisposing them to risk of being involved in road traffic crashes compared to other age groups. These individuals were found to be major or even sole source of income for their families as per interventions taken via phone calls in our study. These findings suggest how any severe injury or casualty may damage not only an individual's health but also the economic structure of whole family and push them into poverty.

Body parts commonly injured during 2-wheeler crashes

Our study showed 37% of population involved in 2-wheeler crashes sustained head injuries and 38% of population sustained limb injuries which is in fact a very negligible difference and was found to be similar to the study done at Bugando Medical Center in Northwestern Tanzania (Chalya et al., 2014). Similarly, in a study done on Kenya regarding the factors associated with road traffic injuries, it was found that among 2- wheeler injuries most common region of the body injured among the victims was the head and neck followed by the lower extremities (Osoro et al., 2011). Similar findings were seen in New Delhi where the most common pattern of injury was head (18.9%) followed by fracture of lower limbs (17.8%) (Malhotra et al., 2005). Furthermore, in our study, it was found that 70% of head injury patients sustained fractures of the skull or brain hemorrhage or concussion which is similar to a study done in Tehran which was conducted in 6 hospitals (McKee and Dhaneshvar, 2015).

In a similar study done at Annapurna Neurological Institute and Allied Sciences, Kathmandu, Nepal it was found that among 167 patients presenting to the hospital with traumatic brain injury, 59% of the cases were due to road traffic injuries, and among them, 38% were due to 2- wheeler crashes (Newall et al., 2020). Among them, skull fractures were the most common diagnosis which deviates from our study that had concluded brain hemorrhages, concussion, or temporal injury as the most common (48.4%) and skull fracture to be the second most common diagnosis (21%). In a metanalysis done in lower and middle-income countries in Africa, if motorcycle helmets reduce road traffic injuries, hospitalizations, and mortalities, it was found that wearing a helmet at the time of the crash was protective against head injuries (Abdi et al., 2022). The study also found that helmet use reduced mortality in developed and developing countries. Studies from Kenya found risk reduction in head injuries by 69% and mortality by 42% from using helmets (Liu et al., 2009; Bachani et al., 2017). In Vietnam, it was found that after the implementation of helmet laws in Cu Chi City, head injuries were reduced by 65% and mortality by 31% (Ha et al., 2018). Looking at examples from countries with similar socio-economic backgrounds, it would be safe to conclude that helmet use not only reduces the likelihood of significant injuries but also saves the healthcare system in treatment and rehabilitation costs.

Role of ambulances

Among the head injury patients of our study, most were taken to the hospital by vehicles other than ambulances, which shows the lack of emergency response service in case of road traffic injuries in the capital city. It could also because the patients were rushed to the hospital without looking for appropriate pre-hospital arrangements. The prompt and safe evacuation of road crash victims to a healthcare facility is critical in the management of injuries. The evacuation of crash victims from the crash scene as seen in our study was mostly by vehicles other than Ambulances (52%), which is similar to findings in Uganda and Kenya (Andrews et al., 1999; Hazen and Ehiri, 2006). This could be due to no organized pre-hospital emergency medical service in the country, especially on the highways. Ambulances come into the scene only when the patient has been taken to primary health care centers and are being referred to tertiary centers for further/ serious management. However, inside Kathmandu valley and city areas where availability of hospitals and ambulances is easier, the victims seem to have arrived to the hospital via ambulances.

Helmet Standard

In our study it was also found that 51% of riders did not have any knowledge regarding UN standard helmet or ISO certified helmets. They did not know if the helmets they were using were safe enough to protect them from head injuries. The other 49% could not provide us the answer to our query. From this we felt that due to lack of public awareness regarding standard helmet use many riders and pillion riders did not feel the importance of helmet and could be sending the wrong message among them that "helmets have no protective effect in head injuries". It feels like the people have never thought about wearing a helmet as a pillion rider, and hence no further knowledge about its quality. According to United Nations Economic Commission for Europe, motorcyclists are required to wear helmets that comply with a safety standard that prescribe rigorous testing (UNECE, no date). Such standards are adopted to ensure that helmets available on the market protect the head adequately in case of a crash. One or more of the following standards govern the performance of motorcycle helmets internationally.

Country/Region	Standards
Australia/ New Zealand	**AS/NZS 1698** Protective helmets for vehicle users
China	**GB811:2022** Helmets for motorcycle and electric bicycle riders
Europe	**UN/ECE 22.05** Uniform provisions concerning the approval of protective helmets and of their visors for drivers and passengers of motorcycles and mopeds. **ECE 22.06** to be enforced after 1st January 2024.
Great Britain	**BS 6658:1985** Specification for protective helmets for vehicle users
India	**IS:4151** standard for motorcycle helmets; effective since 15th January 2019
Japan	**JIS T 8133** Protective helmets for motor vehicle users
Nepal*	**NS 550:2075** Protective helmets for motorcycle riders –specification

USA	**Snell M2010:** Standard for protective headgear for use with motorcycles and other motorized vehicles
	Snell 2005: Standard for protective headgear for use with motorcycles and other motorized vehicles
	DOT 571.218 or Standard No. 218; Motorcycle helmets

**Nepal Standards for motorcycle helmets is awaiting to be endorsed by the government.*

Table 4. Common Motorcycle Helmet Standards

UN Regulation No. 22 - also known as ECE 22 - is the most widely respected and used regulation in the world, endorsed by more than 50 countries. To identify the approved helmet, the helmet and visor must carry the type approval mark. A helmet approve under ECE 22 shall display a capital E in a circle followed by a number that represents the country whose certified authority granted its approval. This is followed by a series of numbers and letters representing the specifics of type approval, approval number, and production serial number.

E = ECE 22-05 Certified by 2 = French Authority;

051018 = ECE 22-05 + Approval No. 1018 issued in France;

P = "Protective", i.e., chin bar tested and approved as a protective full-face helmet;

J – although not visible in this example, would for instance signify "Jet" style open-face approval;

320678 = Batch Test control number – identifies the production batch for which test results are available.

The ECE 22 has a regulation for manufacturing of these helmets so as to produce durable and effective helmets that protect the users from sustaining head injury during a motorcycle crash.

Nepal standards

Few years ago, the Nepal Helmet Standards "NS 550: 2075" was released as "the Protective Helmets for Motorcycle Rider-Specification" by Nepal Bureau of Standards and Metrology in the initiation of NASA Nepal.

Nepal Helmet Standard lays down the requirements regarding materials, construction, workmanship, finish, mass and performance for protective helmets for everyday use by motorcycle user. The helmets covered by this standard, however are not intended for high speed competitive events.

The materials used in the manufacture of helmets as per NS 550: 2075 should not undergo appreciable alteration under the influence of ageing, or of the circumstances of use to which the helmet is normally subjected, such as exposure to sun, extremes of temperature and rain. For

performance testing various tests of Impact Absorption, Resistance to penetration, Rigidity and Retention system will be performed.

Nepal Helmet Standards prescribes all the requirements regarding protective helmets for everyday use by motorcycle riders. This technical regulation needs more efforts in the direction of its formal endorsement, recognition and implementation.

CONCLUSION

Motorcycles being cheaper, convenient and easily accessible are the most widely used dangerous type of motorized vehicles to drive but contribute a majority of crashes leading to fatalities and disabilities to riders, pillion riders, and pedestrians. Helmets have been shown to offer a substantial protection to head and reduction in the risk of head injury in case of a crash. Our study supports that the helmet wearers had considerably less severe head injuries as evidenced by minor injuries and early recovery of their treatment. However, considering the pillion riders who did not wear helmets had more severe forms of head injuries resulting brain hemorrhage and concussion which are considered to be dangerous signs and may result in deaths. Nevertheless, there were cases where severe head injuries occurred despite wearing helmets which could relate to several factors such as emergency response and care provided to the victims of road traffic crashes.

SUGGESTIONS AND RECOMMENDATIONS

Based on the findings of our study and the fact that Nepal is a developing country where the usage of motorcycles is still rising, the following suggestions are recommended:

i. Collaborative efforts are required to develop appropriate helmet laws, policies and strategy ranging from manufacturer to proper usage in order to improve road safety.

ii. Coordinate with government agencies to enforce Helmet Standards for the promotion of Standard Helmet import, manufacturing and sales.

iii. Develop and implements measures to minimize the duration of highway emergency response and care so as to decrease the time required to get to the treatment facility after a road traffic crashes.

iv. Improve and expand the availability of quality trauma care at dedicated hospitals for quick response to road traffic injuries.

v. Improve availability of appropriate counseling to patient and patient parties regarding emergency situations and decision-making for better treatment outcomes.

6.1 Suggestions for Policy and implementation

- Mandatory use of Safe helmets for both Rider as well as Pillion Rider
- Enforcement of minimum standard on the import of Helmet
- Emergency care units should be established in health facilities focusing head injuries.
- Follow up, rehabilitation of injured.
- Coordination with stakeholders including World Health Organisation and NGOs in order to promote further research and practice related to mandatory Helmet use.
- In case of casualties despite wearing helmets, helmets companies, importer or distributor should be held accountable.

LIMITATIONS OF THE STUDY

- Our study was conducted in the months of Baishakh, Jestha, and Ashar 2079. These months coincide with the monsoon season and increase the risk of Motor vehicle injuries, leading to less generalizability of our study to other seasons. As our study only observed cases from April to July, data from other months' RTAs was not included.
- The hospitals included in our study were large tertiary care hospitals, with one being located near the highways, which get high patient influx with RTA injuries. This could have led to an ascertainment bias in our study. Most patients in the nearby areas were also referred to these hospitals, increasing the number of cases observed.
- The patients involved in motorcycle crash were interviewed after their discharge three to four months later which could give rise to recall bias regarding whether they were wearing the helmet properly or not.
- Also, as the company and type of helmet- such as full-face, modular, and open-face helmets- were not interviewed due to a lack of knowledge in the common public regarding the same, the distinction between whether standardized helmets were worn by the drivers and passengers could not be deciphered.
- Other factors which could have influenced the safety of drivers and passengers included the lack of impact-resistant material in helmets, chin strap defects leading to failure to properly secure the helmet during riding, helmet falling off during a collision, helmet fastener defects resulting in helmets moving out of position on the bike riders head and other requirements not fulfilled by an unstandardized helmet such as retention requirements, etc.
- Many patients were also unwilling to give a response as they could have been driving under the alcohol influence and were worried about getting fined and thus, were reluctant in giving their answers.
- With our study being cross-sectional, we could not determine causality and were only able to observe the association between exposure and outcome variables at one point in the given time period.

COLLABORATORS

a. Fédération Internationale de l'Automobile (FIA)

The FIA is the governing body for world motor sport and the federation of the world's leading motoring organisations. Founded in 1904, with headquarters in Paris, the Fédération Internationale de l'Automobile (FIA) is a non-profit making association.

b. Global Alliance of NGOs for Road Safety

The Global Alliance of NGOs for Road Safety (the Alliance) is a collection of nongovernmental organizations (NGOs) that implement programs and lobby for road safety initiatives around the world. Our member NGOs are often set up by everyday citizens responding to needs they see around them. NGOs can fill government gaps by providing immediate solutions, or they can influence decision making through advocacy and education. They play a vital role in the growing worldwide movement to reduce the devastating effects of traffic injuries. With interventions based on evidence for what works, our NGOs help save lives.

The Alliance was established in 2011 by NGO members of the United Nations Road Safety Collaboration (UNRSC) and currently represents more than 300 member NGOs working in road safety from more than 100 countries around the world.

The Alliance was established in response to demand from NGOs worldwide for a forum where they can share knowledge and collectively advocate for road safety and the rights of victims of road traffic crashes. The Alliance provides services to its members in three key areas: networking and sharing, advocacy and capacity building.

c. FIA Foundation

The FIA Foundation is an international charity, working closely with grant partners to shape projects and advocate to secure change in policy and practice. The objective of FIA Foundation is safe and healthy journeys for all, whether it is the daily walk to school or the final lap of a Grand Prix. Through

partners with global reach. FIA Foundation is supporting safer vehicles and highways, clean air and electric cars, safe motor sport and low speed streets.

Established as an independent UK-registered charity in 2001 by the Fédération Internationale de l'Automobile (FIA), the FIA Foundation has worked closely with international agencies, expert technical partners, civil society organisations and our member FIA clubs to develop a strong track record of results. Our Strategy 2030 firmly establishes our focus on helping to achieve the ambitious targets of the United Nations' Global Goals, in the areas of road traffic injury, air quality, climate action and youth empowerment. We support our partners at the FIA to work towards their 'vision zero' for no death or serious injury in motor sport.

d. National Alliance

National Alliance for Safe and Sustainable Mobility is a national network of professional organizations, charity organizations, non-governmental organizations, civil society organizations, academic institutions, and private organizations working in the fields of road safety, related to data, policies, and practices to ensure the safety of human life on the roads across Nepal. It is also umbrella organization of over two dozen Organizations who are involved in safe, sustainable, affordable, and accessible mobility for all.

The Major Objectives of the Alliance are:

i) To advocate safe, sustainable, smart and environmentally friendly infrastructure related to transportation and mobility.

ii) To promote an accessible mobility for vulnerable road users ensuring right to mobility without fear, and

iii) To contribute to national development and economic growth by promoting safer transportation and cross-border connectivity based on international best practices.

e. NASA Foundation

NASA Foundation is a non -profitable, non-governmental Charitable organization working for Road& Transport, Life Saving, Environment, Smart Cities, Consumer Right and Society in Nepal since 2015. It was established on 2015 in proud presence of Michelle Yeoh, Road Safety Global Ambassador. NASA Foundation is also member of

International Road Federation Geneva, Belt and Road International Transport Alliance (BRITA), International Road Victims' Partnership (IRVP) and International Association for Sports and Leisure Facilities (IAKS).

8.1 NASA Initiatives for motorcycle safety in Nepal

- List of activities Done in Nepal Regarding Motorcycle Helmet
- Motorcycling Conference- FIM under We the Riders Campaigns
- Safety Riding Initiatives – FIM Supported
- workshop with experts on helmets use – FIA Supported
- Child helmet campaign with metropolitan city
- Helmets for Life- FIA Safe Helmet Campaign
- Motorcycling Safety Year (Demand Letter, Suggestion letter, Social Media Campaigns)
- Leaflet and Brochure (Information on Safe Helmets and Motorcycling Safety) – FIA Supported
- WHO Safety Helmet Guideline has been followed and Implemented.
- Slow Bike Riding Competition (Nepal Jaycees and NASA Nepal)
- Presented on TRB – Transport Research Board
- Oath taking Campaign (To parents for use of helmets)
- Ban use of mobile during ride
- Ban Driving under influence (Drink and Drive)
- Orientation to Riders – (to NASA Affiliated Clubs)
- Media Orientation on Road Safety - MOPIT

8.2 Study team

Dr. Puspa Raj Pant is an injury prevention and road safety researcher and a member of NASA Foundation Nepal. Dr Pant holds PhD degree in Injury Prevention from United Kingdom. He has published numerous research articles and his research interests include Injury Prevention, Road Safety, Global Health, and others.

Dr. Saman Aryal is MBBS graduate from Kathmandu Medical College in 2018. She has worked medical officer at Om Hospital and Research Center and Kantipur Dental College and Hospital. Dr Aryal has served as the Community Service Director at multiple health camps. She is also a member BOD at National Youth Movement Nepal, a club that relentlessly helped and reached out to ones suffering during Covid-19.

Er. Suyog Khanal is a graduate of Automobile Engineering from IOE Thapathali Campus. Mr. Khanal has served as Supervisor at automobile companies. He has given presentations on Safety Riding been part of Nationwide Campaigns of Helmets for Life, Safe Road and Sustainable Transport and Star Rating for Schools. He is currently working as National Coordinator at F1 in Schools Nepal.

Mr. Subas Bhattarai is an Executive Officer at Nepal Automobiles' Association (NASA). He completed Master's Degree in Business Studies and has led different road safety campaigns of NASA Nepal focusing on mass awareness, youth & student mobilization, media engagement on road safety, safer helmet campaign, safer vehicle campaign and star rating of schools. As a project manager he has actively worked on the planning, execution and reporting of various road safety projects supported by the FIA to Nepal.

Mr. Ishwor Ballav Upreti is a graduated Masters in Sociology and Anthropology from Ratna Rajya Campus. Mr. Upreti has been actively involved in media service as well as Road Safety activities, as a coordinator he has been conducting Kathmandu Road Safety Film Festival in a series. He is currently working in NASA as event manager.

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