Implementation of a hospital-based trauma registry in India

Prachikumari Patel

Experimental Surgery, McGill University, Montreal

December 2018

A thesis submitted to McGill University in partial fulfillment of the requirements of the degree of Master of Science (Experimental surgery)

Table of Contents

List of Figures

List of Tables

List of Abbreviations

ALS	Advanced Life Support
ASCOT	American College of Surgeons Committee on Trauma
BLS	Basic Life Support
CHC	Community Health Center
DALY	Disability Adjusted Life Year
ED	Emergency Department
EMRI	Emergency Management and Research Institute
FYP	Five Year Plan
GCS	Glasgow Coma Scale
GNP	Gross National Product
GDP	Gross Domestic Product
HIC	High Income Countries
ISS	Injury Severity Score
IEC	Institutional Ethical Committee
IRB	Institutional Review Board
KTS	Kampala Trauma Score
LMIC	Low and Middle Income Countries
MTOS	Major Trauma Outcome Study
MVC	Motor Vehicle Collision
NTDB	National Trauma Data Bank
NISC	The National Injury Surveillance, Trauma Registry & Capacity Building Center
PPP	Public Private Partnership
RTS	Revised Trauma Score
RTI	Road Traffic Injuries
RTA	Road Traffic Accidents
SMIMER	Surat Municipal Institute of Medical Education and Research
TARN	Trauma Audit Research Network
TRISS	Trauma and Injury Severity Score
TR	Trauma Registry
WHO	World Health Organisation

Abstract

Background

The injury is responsible for a significantly high burden of disease globally, particularly in the low and middle income countries (LMICs). The epidemiological data of injury can help to identify risk factors for injury and target interventions to improve quality of care. Trauma registries (TR) have been recognized as an essential tool in decreasing death and disability rates from injuries. The importance of trauma registry has been widely recognized in the developing countries, but it is still underutilized due to lack of awareness, resources, and funding. The objective of the study was to explore the feasibility of the trauma registry by implementing it at a tertiary care hospital and estimate the epidemiology of the injury.

Method

The study was conducted at the casualty of the Surat Municipal Institute of Medical Education and Research (SMIMER) hospital, Surat, India during June 2018 to August 2018. Data were collected on the paper form of TR after taking consent from the patients presented to the casualty department with the sustained injury. TR was developed at the center of the global surgery, McGill University Health Centre, Montreal, Canada. Data about patient demographics, causal event, injury-related physiologic, anatomic data, and clinical outcomes were recorded. Data were entered in the electronic version of the TR and analysis was done.

Result

A total of 716 patients were included in the study. The mean age of the patient was 33 year, and 74.16% were male with maximum patients were in the age group of 20-25 and 30-35. Motor vehicle collision (34.64%) and Fall (29.89 %) were the most common causes of the injury followed by blunt trauma (13.41%). Students (28%) and unemployed (17%) were most frequently affected with majority of patients having primary and secondary education. 39.25 % were brought by the ambulance whereas 30.31% of patients arrived by private vehicle and 22.35% came by public transport. Cut/Open wound (46%) accounted for the majority of the injury followed by thoracic injury (22%) and head injury (19%). According to Kampala Trauma Score (KTS) calculation, 1.4% were severely injured compared to 91.8% mildly injured. Twenty patients died in the hospital, mainly injured due to fall and Motor Vehicle Collision.

Conclusion

Trauma registry was effective to capture injury-related information in a simple one-page proforma in the study which would be helpful to assess the trauma burden and evaluate the effectiveness of care given to the patients. The continuous use of the TR is imperative to ensure high quality data and adequate population coverage and a collaborative effort is needed in India for successful implementation.

Résumé

Contexte

À l'échelle mondiale mais particulièrement dans les pays à faible ou moyen revenu, les blessures sont responsables d'une charge de morbidité considérablement élevée. Une étude des données épidémiologiques des blessures peut permettre d'identifier leurs facteurs de risque et de cibler les interventions nécessaires pour améliorer la qualité des soins. Les registres de traumatisme ont été identifiés comme l'outil essentiel pour réduire les taux de décès et d'handicap dûs aux traumatismes. Leur importance est bien reconnu par les pays en développement mais ils sont encore sous-utilisés en raison d'un manque de sensibilisation, de ressources et de fonds. L'objectif de l'étude était d'explorer la faisabilité des registres de traumatisme en en mettant en place dans un hôpital de soins tertiaires, en Inde, et d'estimer l'épidémiologie des blessures.

Méthode

L'étude a été menée au sein des urgences de l'hôpital Institut municipal d'éducation et de recherche médicales de Surat (SMIMER)à Surat, en Inde, de juin à août 2018. En ayant l'accord des patients qui se sont présentés aux urgences avec une blessure, leurs données ont été collectées sous la forme papier du registre de traumatisme (TR). Le concept du registre de traumatisme a été développé au sein de la chirurgie globale, au centre universitaire de santé McGill, à Montréal, au Canada. Les informations sur les données démographiques des patients, les événements qui ont causés les blessures, la physiologie liée aux blessures, les données anatomiques et les résultats cliniques ont été enregistrées. Les données ont été entrées dans la version électronique du registre de traumatisme et une analyse a été effectuée.

Résultats

Un total de 716 patients ont participés à l'étude. L'âge moyen des patients était de 33 ans, mais la majorité avait un âge compris entre 20 et 25 ans ou entre 30 et 35 ans. 74,16% des patients étaient des hommes. Les accidents de la route (34,64%) et les chutes (29,89%) ont été les cause les plus fréquentes de blessures, suivis des traumatismes contondants (13,41%). Les étudiants (28%) et les chômeurs (17%) ont été les plus fréquemment blessés et une majorité des patients avaient une éducation primaire et secondaire. 39,25% des patients ont été transportés par ambulance, 30,31% sont arrivés en voiture personnelle et 22,35% en transport en commun. Les plaies ouvertes (46%)

représentaient la majorité des blessures, suivies des blessures thoraciques (22%) et de la tête (19%). Selon le calcul du score de traumatologie de Kampala (KTS), 1,4% avaient de graves blessures, contre 91,8% de blessures légères. Vingt patients sont décédés à l'hôpital, surtout à cause d'une blessure dûe à une chute ou à un collision de véhicule à moteur.

Conclusion

Le registre de traumatisme à été un outil très efficace pour la relève des informations liés aux blessures. En effet, toutes les informations utile pour évaluer le fardeau des traumatismes et l'efficacité des soins offerts aux patients se trouvaient dans un simple formulaire d'une page. L'utilisation continue de ce genre de registre est nécessaire afin d'assurer des donnés de haute qualité et de couvrir adéquatement la population. De plus, un effort de collaboration est requis en Inde pour une mise en œuvre réussie.

Acknowledgment

I am thankful for the continuous motivation and support provided by Dr. Dan Deckelbum, who is my supervisor for the thesis and a co-director of the Centre for Global Surgery, MUHC. I endeavor to meet his excellence and aspire to continue my work in the field of global Surgery.

I would also like to thank members of my Research advisory committee Dr. Fackson Mwale, Dr. Tarek Razek and Dr. Jeremy Gruskha. I am grateful for their guidance throughout that was necessary for the completion of my research. Moreover, I am thankful of Dr. Maulin Patel, whose support was crucial to accomplish my work in India. Lastly, I am grateful for the everlasting support of my family and friends.

Preface

The thesis consists of an introduction, literature review and a manuscript. The structure of the thesis is organized by the McGill University Graduate and Postdoctoral Studies regulations. The thesis is original, unpublished and I, am the candidate responsible for the literature review, data collection, analysis and preparation of the manuscript.

1 Introduction and literature review

1.1 Background

An injury is defined as "a bodily lesion at the organic level, resulting from acute exposure to energy (mechanical, thermal, electrical, chemical or radiant) in amounts that exceed the threshold of physiological tolerance. In some cases (e.g., drowning, strangulation, freezing), the injury results from an insufficiency of a vital element"[1]. The Injury can be divided into two forms – intentional and unintentional Injuries. Unintentional Injuries are subdivided into, Road traffic injuries (RTI), falls, poisoning, firearms, drowning and other unintentional injuries (e.g., exposure to mechanical force, electric current, radiation, extreme ambient temperature, and pressure plus exposure to poisonous plants and animals). Intentional injuries are subdivided into self-inflicted injuries (i.e., suicide), interpersonal violence (e.g., homicide), war-related injuries, and other intentional injuries (e.g., injuries due to legal intervention)[2].

1.1.1 Mortality and morbidity due to injuries

Mortality data is an important marker to measure the magnitude of a health problem, but the nonfatal outcomes are equally crucial to describe the burden of injuries accurately[2]. An internationally standardized form of the quality-adjusted life year has been developed, called the Disability Adjusted Life Year (DALY) for the global burden of disease. The DALY expresses years of life lost to premature death and years lived with a disability of specified severity and duration. One DALY is one lost year of healthy life[3].

It is estimated that in the year 1990, the injury was responsible for 8.8% of total global deaths, which increased to 9.6% of total mortality in the year 2010[4].In World Health Organisation (WHO) report "Injury and Violence: The Facts" stated that about 5.8 million people die each year as a result of injuries; every 5 seconds someone in the world dies as a result of it. This accounts for 10% of the world's deaths, 32% more than the number of fatalities that result from malaria, tuberculosis, and HIV/AIDS combined[5]. According to "WHO Global Status Report on Road Safety 2015" more than 1.2 million people die on the world's roads due to motor vehicle collision (MVC) every year and as many as 50 million incurred non-fatal injuries[6]. It is estimated that the injuries will be among the top 20 leading causes of death by 2030 and road traffic crashes are

predicted to become the fifth leading cause of death by 2030, with suicide and homicide rising to become the 12th and 18th leading causes of death respectively.

More than 90% of deaths that result from injury occur in low- and middle-income countries[5]. Injuries accounted for 10% of DALYs in 1990, which increased to 11.2% in the year 2010. In the year 2010, 75.5 million DALYs considered due to RTI; 27% of the total injury. The next most important injury was self-harm (1.5%) followed by falls (1.4%) and interpersonal violence (1.0%)[7]. It was mentioned in the WHO report "Global Burden of Disease 2004" that injuries accounted for 17% of the disease burden in adults aged 15–59 years in 2004. RTI was the third leading cause for the burden of disease with violence, and self-inflicted injuries were at sixth and eighth position respectively in the age group of 15-44 years. In LMICs of Americas, Europe, and Eastern Mediterranean region, more than 30% of the entire burden of disease was due to injuries in men aged 15-44 years[8]. A study for global burden of disease in the year 2013 showed that the main contributors for the injury DALYs were RTIs (29.3%), self-harm (14%) and falls (12%)[9]. It is estimated that RTIs would be in the third leading cause of the DALYs in 2030[8].

1.1.2 Economic burden due to injuries

The injury is accountable for an extensive economic loss to the victims, their households, and to the country as a whole. It is estimated that the direct economic cost of road crash globally has been US$ 518 billion, with the costs in low-income countries – estimated at US$ 65 billion –which is more than the total annual amount received in development assistance[10]. The estimated annual costs (both direct and indirect) of road crash injury in European Union (EU) countries alone go beyond €180 billion (US$ 207 billion) which contributes to 5% of the global death[11,12]. In the year 2000, the human capital costs of MVC for the USA was estimated at US$ 230 billion[13]. The report in Canada estimated the total economic burden of injury was $26.8 billion in 2010. This estimate included direct costs of $15.9 billion arising from health care expenditures and indirect costs of $10.9 billion associated with reduced productivity from hospitalization, disability, and premature death[14]. The cost of RTI is estimated at roughly 1% of gross national product (GNP) in low-income countries, 1.5% in middle-income countries and 2% in high-income countries [10]. In LMICs, the total economic cost of the road crashes globally would be likely to overdo the current estimate of US$ 518 billion[15]. In Vietnam, the cost of injury to poor households was estimated as equivalent on average to 11 months' income. The risk of a poor household falling below the poverty line was 21% higher among those that had an injury than among those that had not[16]. In Ghana, a study

about the economic consequences of injury within the family found that in rural households, 28% of families reported a decline in food consumption following an injury[17]. In Kenya, more than 75% of road traffic casualties are among productive young adults[18] which directly affects the economic status of the country.

1.1.3 India – the burden of injuries

India is a lower middle-income country, with a population of 1.34 billion spread across 29 states and seven union territories. 18% of the world's population lives in India. Many of the states have populations of similar size of large countries; ten states had more than 60 million people in 2017[19]. There has been a heterogeneous economic growth over the past few decades in India, which could be contributed to the disparities in health and disease distribution in different parts of the country. The overall economic growth rate in India has been one the fastest in the world in the past decade[20].

Unintentional injuries (including RTI) were accountable for 13% of DALYs lost in India in 1990[21]. The number of DALYs due to injuries increased significantly from 1990 to 2016 for three leading causes of injury in India; RTI 65.1%, falls 41.3%, self-harm 29.8%[22]. As per the WHO report, India has the second highest reported mortality rate from RTI in the world which is 29.2 per 100,000 people[2]. The number of vehicles in India is rapidly increasing, with about 6 million new motor vehicles sold every year[23]. Adolescents (10–19 years old) comprise a fifth of the Indian population (253.2 million)[24]. From 1990 to 2013, deaths due to injuries increased in young girls and boys to 23% and 27% respectively. There was a noteworthy change in the leading cause of death in the young and adolescent girls over the two decades due to self-harm (87% and 92% respectively). For boys, the most significant change was the increase in deaths from interpersonal violence (increased by 52%)[25]. In 2016, there were 150,785 deaths occurred in 480,652 MVC. Further, RTI related deaths have increased by 43% over the last ten years[26]. It is estimated that unless new initiatives and intense efforts are made, the total number of road traffic deaths in India is likely to surpass 250,000 by 2025[27]. A study in Bangalore, India found that the burden from road crashes had pushed many households into poverty. In Bangalore, 71% of households in urban areas and 53% in rural areas were not poor before the crash[27]. The cost of RTIs in India is estimated to be more than 322 billion rupees (US$7.4 billion), 3.2% of the national Gross Domestic Product (GDP)[28.]

1.2 Injury surveillance and trauma registry

Public health surveillance is the ongoing, systematic collection, analysis, interpretation, and dissemination of data on health-related events for use in public health action to reduce morbidity and mortality and to improve health[28]. The evaluation of population, community, and societal needs are required to prevent injuries effectively. Trauma registry can serve as a tool for injury surveillance. Trauma registries are a "database designed to document the acute phase of hospital care delivered to victims of trauma." Trauma registries include information on patient demographics, the circumstances surrounding injury, pre-hospital care, and transport, emergency department, and in-hospital interventions received, anatomic injury description, physiological measurements, complications, outcomes and patient destinations[29].

1.2.1 Benefits of the trauma registry

Trauma registry provides information about the patient's clinical data which can be used to evaluate the efficiency of the trauma care, address the injury-related loopholes in the trauma system and many other aspects of trauma prevention. Information from the TR can be used at local, state and regional level by governing authorities and policymakers to identify the high-risk population, locations, infrastructure defects and guiding the policies for injury prevention[29,30]. The collected data is useful to quantify the effectiveness of implemented legislation in preventing mortality and morbidity overtime[31]. The registry data have been used suitably as a quality tool for comparison of the trauma system and measure performances overtime internally, between institutions with national and international standards[32,33]. Trauma Registry provides large sets of data for the researcher to develop and test the hypothesis. There have been many studies that used TR data significantly to broaden our knowledge of the trauma outcomes[34,35]. The WHO published guidelines for Trauma Quality Improvement Programmes to strengthen the quality of trauma care which emphasized the fact that improvement in trauma is optimal where there is access to a trauma registry collecting trauma-specific data[36].

1.2.2 Trauma registry in high-income countries (HICs)

The first computerized trauma database was established in 1969 at the Cook County Hospital, Chicago[37]. It led to Illinois state trauma registry in 1971 which started to collect data from 50 designated trauma centers across the state. In 1985, the first time they used microcomputers[38]. The American College of Surgeons Committee on Trauma (ASCOT) commissioned the Major Trauma

Outcome Study (MTOS) in 1982. It included 80,000 data observations collected from 139 North American hospitals. The MTOS ran from 1982 to 1989 and is still used as a standard by which trauma centers worldwide evaluate their performance using trauma and injury severity score (TRISS) methodology[39]. In the year 1993, ASCOT established National Trauma Data Bank (NTDB) which is the largest aggregation of trauma registry data ever assembled and contains approximately over one million records from 405 U.S. trauma centers. It is based on voluntary participation of hospitals treating injured patients along with other national trauma registries such as, Trauma Audit Research Network (TARN) in UK (1989)[40], German national trauma registry (1993)[41], National burn repository in U.S. (1994)[42], Israel national trauma registry (1995)[43], Canadian national trauma registry (1996)[44]. These registries were eventually implemented and integrated with the trauma systems. The studies in the HICs showed a decrease in the mortality after integration of trauma systems and indirectly owing to the trauma registries[45–49]. Many registries including Canadian national Trauma registry and Wisconsin trauma care registry, have been designed to provide information for injury prevention strategies[44,50]. Information from the registry regarding the use of safety devices (e.g., seat belts), drunk driving have been used to propose and guide changes in the legislation[44,51–53].

1.2.3 Trauma registry in low and middle income countries (LMICs)

Trauma registries in many LMICs are underutilized and poorly developed. The existence of the trauma registry in developing counties is debatable due to very limited published information[29,36,54]. In these countries, information about injuries is often based on the police data, mortality data, one time-health surveys, retrospective clinical case series[16,55–59]. There are several factors that affect implementation of the trauma registry in LMICs and hinders its potential improvement. The issues concerning the lack of resources such as limited funding, infrastructure, technology, human resources plus organizational/administrative concerns, data quality concern have been addressed multiple times in literature[60]. However, in many developing countries, the importance of the TR has been recognized with successful study outcomes.

In Uganda, a simplified system of hospital-based trauma registry was initiated with the minimal dataset in the Mulago and Kawolo hospital[61]. The study demonstrated effective implementation of a trauma registry in the urban and rural setting with limited resources and has been successfully extended to five large hospitals in Kampala[62]. In Pakistan, at a university trauma center in Karachi, data of the trauma patients were maintained using the emergency registry. The registry data has

been used in comparing outcomes between hospitals[63,64]. In Northern Thailand, trauma registry was set up in the mid-1990s at Khon Kaen hospital. After reviewing the cases, they found the problems in the system and took corrective action to improve trauma care without high-cost investment[65]. In northern Nigeria's teaching hospital, 10-point dataset registry was established for injured children which helped to re-organize the pediatric trauma care at the institution[66]. There are many compelling examples of the trauma registry data use in policy making for injury reduction such as in Columbia, the registry data showed a high number of deaths due to MVC in males which allowed policy makers to target interventions to a specific population[67]. In Thailand, data about the helmet use, alcohol, and speed on the road led to effective legislation into action[68].

1.2.4 Trauma registry in India

In India, most of the trauma-related data are gathered as mortality data from the National Crime Record Bureau. There has been non-existence of injury surveillance and active trauma registry with outcome-based data[69,70]. The National Injury Surveillance, Trauma Registry & Capacity Building Center (NISC) has been established at Dr. RML Hospital, New Delhi. The center is responsible for collecting, collating, analyzing and propagating Injury Surveillance activities throughout the country[71]. There is currently no hospital-based trauma registry in India. As per the proposed activity in 12th Five-year Plan (FYP), Trauma Registry pilot has been carried out at the JPN Apex Trauma Center and Dr. RML Hospital Trauma Center with an objective to establish the national trauma registry[71,72].

1.3 Rationale and Research Objective

There are many setbacks which restrict the use of trauma registry in the developing countries. Hospital-based trauma registry does not always represent population coverage because of the nonavailability of patient's data who obtain care outside of the participating hospital or who fails to receive treatment. The inconsistency in case criteria, missing values in data and limited health budget in developing countries question its worth as quality control, injury surveillance tool[30,62].

However, the benefits of the trauma registry outweigh the limitations. There have been many initiatives in the developing countries regarding the incorporation of the trauma registry and many countries like India are at the verge of implementing the trauma registry. The Successful efforts

from the developing countries as mentioned above show that trauma registry can be implemented in a limited-resource setting in a cost-effective manner. Therefore, the objective of our study is to explore the feasibility of the simplified trauma registry dataset by implementing it at the tertiary care hospital of India with the existing resources and estimate the epidemiology of injuries so that targeted interventions can be taken by addressing the injury-related gaps in trauma system.

1.4 References

1. Baker SP, O'Neill B, K. R. "The Injury Fact Book. Lexington Massachusetts" (1984).

2. World Health Organization. The injury chart book: A graphical overview of the global burden of injuries. Department of Injuries and Violence Prevention. World Health Organization. (2002).

3. Murray, C. J, Lopez, A. D, World Health Organisation. The global burden of disease: a comprehensive assessment of mortality and disability from diseases, injuries, and risk factors in 1990 and projected to 2020: summary.

4. Lozano R, Naghavi M, Foreman K, Lim S, Shibuya K, Aboyans V, Abraham J, Adair T, Aggarwal R, Ahn SY, AlMazroa MA. Global and regional mortality from 235 causes of death for 20 age groups in 1990 and 2010: a systematic analysis for the Global Burden of Disease Study 2010. The Lancet. 380, 2095–128 (2012).

5. World Health Organisation (WHO). Injuries and Violence*:* The Facts 2014. (2010).

6. World Health Organisation (WHO). Global status report on road safety 2015. (2015).

7. Murray, C. J. L. et al*.* Disability-adjusted life years (DALYs) for 291 diseases and injuries in 21 regions, 1990-2010: A systematic analysis for the Global Burden of Disease Study 2010. Lancet 380, 2197–223 (2012).

8. The World Health Organization (WHO). The Global Burden of disease 2004 Update. (2008).

9. Haagsma JA, Graetz N, Bolliger I, Naghavi M, Higashi H, Mullany EC, Abera SF, Abraham JP, Adofo K, Alsharif U, Ameh EA. The global burden of injury: incidence, mortality, disability-adjusted life years and time trends from the Global Burden of Disease study 2013. Injury prevention. 22(1):3–18 (2016).

10. Jacobs G, Aeron-Thomas A, Astrop A. Estimating global road fatalities. (2000).

11. Koornstra M, Evans A, Glansdorp C, Jørgensen NO, van Schagen I. Transport accident costs and the value of safety. (1997).

12. Koornstra M, Broughton J, Esberger R, Glansdorp C, Köppel W, Taylor F, Cauzard JP, Evans A, Hantula L, Piers M, Vanlaar W.Transport safety performance in the EU*:* a statistical overview. (2003).

13. Blincoe L, Seay A, Zaloshnja E, Miller T, Romano E, Luchter S, Spicer R. The economic impact of motor vehicle crashes. (2000).

14. The Cost of Injury in Canada. Available at: https://www.canada.ca/en/publichealth/services/injury-prevention/cost-injury-canada.html. (Accessed: 8th December 2018)

15. Peden M. World Health Organisation (WHO). World report on road traffic injury prevention. (2004).

16. Thanh NX, Hang HM, Chuc NT, Rudholm N, Emmelin A, Lindholm L. Does the injury poverty trap exist? A longitudinal study in Bavi, Vietnam. Health Policy. 78, 249–57 (2006).

17. Mock CN, Gloyd S, Adjei S, Acheampong F, Gish O. Economic consequences of injuries and resulting family coping strategies in Ghana. Accid. Anal. Prev. 81–90 (2003).

18. Odero W, Khayesi M, H. P. Road traffic injuries in Kenya: magnitude, cause, and status of intervention. Inj. Control Saf. Promot. 10, 53–61 (2003).

19. Population of India 2017. IndianOnlinePages. http://www.indiaonline pages.com/population/india-current-population.html. (Accessed: 11 November 2018)

20. International Monetary Fund. World economic outlook update, July 2017. Available at: http://www.imf.org/en/Publications/WEO/DIssues/2017/07/07/world-economicoutlook-update-july-2017. (Accessed: 9th November 2018)

21. Murray CJ, L. A. Global mortality, disability, and the contribution of risk factors: Global Burden of Disease Study. The Lancet. 349, 1436–42 (1997).

22. Dandona L, Dandona R, Kumar GA, Shukla DK, Paul VK, Balakrishnan K, Prabhakaran D, Tandon N, Salvi S, Dash AP, Nandakumar. Nations within a nation: variations in epidemiological transition across the states of India, 1990–2016 in the Global Burden of Disease Study. The Lancet. 390, 2437–60 (2017).

23. Society of Indian Automobile manufacturers. Available at: http://siamindia.com (Accessed: 9th September 2018)

24. Registrar General of India. Available at: http://censusindia.gov.in/2011(Accessed: 8th September 2018).

25. Joshi R, Alim M, Maulik PK, Norton R. A contemporary picture of the burden of death and disability in Indian adolescents: Data from the Global Burden of Disease Study. Int. J. Epidemiol. 46, 2036–43 (2017).

26. Ministry of Road Transport and Highways Government of India. Road Accidents in India – 2016. (2017). Available at: www.morth.nic.in. (Accessed: 8th November 2018)

27. Sing SK. Road traffic accidents in India: issues and challenges. Transp Res Procedia. 25, 4708–19 (2017).

28. German RR, Lee LM, Horan J, Milstein R, Pertowski C, Waller M. Updated guidelines for evaluating public health surveillance systems: MMWR Recomm Rep. 1–35 (2001).

29. Moore, L. & Clark, D. E. The value of trauma registries. Injury 1;39, 686–95 (2008).

30. Eastridge BJ, Wade CE, Spott MA, Costanzo G, Dunne J, F. S. & Holcomb JB, West S, Apodaca A, Blackbourne L, C. S. Utilizing a trauma systems approach to benchmark and improve combat casualty care. J Trauma 1;69(1), S5–9 (2010).

31. Mitchell R, Sherker S, Cavanagh M, Eager, D. F. from playground equipment: will the new Australian playground safety standard make a difference and how will we tell? Heal. Promot J Austr. 18, 98–104 (2007).

32. Mann NC, Mullins RJ, MacKenzie EJ, Jurkovich GJ, Mock CN. Systematic review of published evidence regarding trauma system effectiveness. J Trauma 1;47, S25–33 (1999).

33. Jurkovich GJ, Mock C. Systematic review of trauma system effectiveness based on registry comparisons. J Trauma 1;47: S46–55 (1999).

34. Wang HE, Peitzman AB, Cassidy LD, A. P. & DM, Y. Out-of-hospital endotracheal intubation and outcome after traumatic brain injury. Ann. Emerg. Med. 1;44(5), 439–50 (2004).

35. Hlaing T, Hollister L, A. M. Trauma registry data validation: essential for quality trauma care. J Trauma 61(6), 1400–7 (2006).

36. Mock C, Juillard C, Brundage S, Goosen J, J. M. Guidelines for trauma quality improvement programmes. Geneva: World Health Organization*;* 2009.

37. Boyd DR, Rappaport DM, Marbarger JP, Baker RJ, N. L. Computerized trauma registry: a new method for categorizing physical injuries. Aerosp Med 42(6), 607 (1971).

38. Cales RH, Bietz DS, H. R. J. The trauma registry: a method for providing regional system audit using the microcomputer. J Trauma 25(3), 181–186 (1985).

39. Champion HR, Copes WS, Sacco WJ, Lawnick MM, Keast SL, B. & LW Jr, Flanagan ME, F. C. The Major Trauma Outcome Study: establishing national norms for trauma care. J Trauma 30(11), 1356–1365 (1990).

40. Trauma Audit Research Network. Available at: https://www.tarn.ac.uk(Accessed :1st April 2018)

41. German Society of Trauma Surgery Trauma Registry; 2007. Available at: http://www.dguonline.de/de/index.jsp. (Accessed: 1st April 2018)

42. Latenser BA, Miller SF, Bessey PQ, et al. National burn repository 2006: a ten-year review. J Burn Care Res;28(5):635-58 (2007).

43. Aharonson-Daniel L, Avitzour M, Giveon A, P. K. A decade to the Israel national trauma registry. Isr Med Assoc J 9(5), 347–51 (2007).

44. National Trauma Registry. Available: https://www.cihi.ca/en/national-trauma-registrymetadata (Accessed: 3rd April 2018)

45. Pollock DA. Summary of discussion: trauma rgeistry data and TRISS evidence. J Trauma 47(3) S56-8 (1999).

46. EJ, Mackenzie, Rivara FP, J. G. A national evaaltuation of the effect of trauma-centre care on mortality. J Med 354(4), 366–78 (2006).

47. Sampalis JS, Lavoie A, Boukas S, et al. Trauma Center designation: initial impact on trauma -related mortality. J Trauma 39(2), 232–7 (1995).

48. Stewart TC, Lane PL, S. T. An evaluation of patient outcomes before and after trauma center designation using trauma and injury severity score analysis. J Trauma 39(6), 1036–40 (1995).

49. Mackenzie, E. J. Review of evidence regarding trauma system effectiveness resulting from panel studies. J Trauma 47(3), 34–41 (1999).

50. Wisconsin Trauma Care Registry. Available at: https://www.dhs.wisconsin.gov/trauma/registry.htm (Accessed:10thApril, 2018)

51. Javouhey E, Guerin AC, Gadegbeku B, et al. Are restrained children under 15 years of age in cars as effectively protected as adults? Arch Dis Child 91(4), 304–8 (2006).

52. Kerwin AJ, Griffen MM, Tepas III JJ, et al. The burden of noncompliance with seat belt use on a trauma center. J Trauma 60(3), 489–92 (2006).

53. Lerner EB, Jehle DV, Billittier AJ, et al. The influence of demographic factors on seatbelt use by adults injured in motor vehicle crashes. Accid. Anal. Prev. 33(5), 659–62 (2001).

54. Mock C, Lormand JD, Goosen J, Joshipura M, P. M. Guidelines for essential trauma care.World Health Organization; 2004.

55. Mock C, Acheampong F, Adjei S, K. T. The effect of recall on estimation of incidence rates for injury in Ghana. Int J Epidemiol 28(4), 750–755 (1999).

56. London J, Mock C, Abantanga FA, Quansah RE, B. K. Using mortuary statistics in the development of an injury surveillance system in Ghana. Bul. of the World Health Organ. 80(5), 357–64 (2000).

57. Razzak JA, L. L. Limitations of secondary data sets for road traffic injury epidemiology. Prehosp Emerg Care 9(3), 355–360 (2005).

58. Razzak JA, L. S. Estimating deaths and injuries due to road traffic accidents in Karachi, Pakistan, through the capture-recapture method. Int J Epidemiol 27(5), (1998).

59. Mock C, Nguyen S, Quansah R, Arreola-Risa C, Viradia R, J. M. Evaluation of trauma care capabilities in four countries using the WHO-IATSIC Guidelines for Essential Trauma Care. World J. Surg. 30(6),946-56 (2006).

60. Bommakanti, K., Feldhaus, I., Motwani, G., Dicker, R. A. & Juillard, C. Trauma registry implementation in low- and middle-income countries: challenges and opportunities. J. Surg. Res. 223, 72–86 (2018).

61. Kobusingye, O. C. & Lett, R. R. Hospital-based trauma registries in Uganda. J. Trauma Acute. Care Surg. 48(3), 498–502 (2000).

62. Kobusingye OC, Guwatudde D, Owor G, L. R. Citywide trauma experience in Kampala, Uganda: a call for intervention. Inj. Prev. 8(2), 133–136 (2002).

63. Jat AA, Khan MR, Zafar H, Raja AJ, Hoda Q, Rehmani R, L. & RH, B. S. Peer review audit of trauma deaths in a developing country. Asian J Surg 27(1), 58–64 (2004).

64. Zafar H, Rehmani R, Raja AJ, Ali A, A. M. Registry based trauma outcome: perspective of a developing country. Emerg. Med. J. 19(5), 391–394 (2002).

65. Chadbunchachai W, Sriwiwat S, Kulleab S, Saranrittichai S, Chumsri J, Jaikwang P. The comparative study for the quality of trauma treatment before and after the revision of trauma audit filter, Khon Kaen hospital 1998. J. Med. Assoc. Thail. 84(6), 782–790 (2001).

66. Nwomeh BC, Lowell W, Kable R, Haley K, Ameh EA. History and development of trauma registry: lessons from developed to developing countries. World J. Emerg. Surg. 1(1):32, (2006).

67. Posada J, Ben-Michael E, Herman A, Kahan E, Richter E. Death and injury from motor vehicle crash in Colombia. Am. J. Public Health **7**, 88–91 (2000).

68. Nakahara S, C. W. et al. Temporal distribution of motorcyclist injuries and risk of fatalities in relation to age, helmet use, and riding while intoxicated in Khon Kaen, Thailand. Accid. Anal. Prev. 37(5), 833–842 (2005).

69. Gupta A, Kumar S, Sagar S, Singhal M, Mishra B, Misra MC (P1-88) Development of a First Hospital Based Trauma Registry at JPN Apex Trauma Center, India. Prehosp. Disaster Med. 26(S1),127 (2011).

70. O'Reilly, G. M., Cameron, P. A. & Joshipura, M. Global trauma registry mapping: A scoping review. Injury 43, 1148–1153 (2012).

71. Directorate General of Health Service, Ministry of Health and Family welfare. National Injury surveillance Trauma registry and Capacity Building centre. Available at: http://www.nisc.gov.in/trauma_building.aspx. (Accessed: 11th December 2018)

72. Planning Commission. Report of the Steering Committee on Health for the 12th Five-Year Plan (Incorporating Reports of Working Groups and deliberations in Steering Committee meetings) Health and Family Welfare Division Planning Commission. (2012).

2 Manuscript

2.1 Introduction

There has been a considerable shift in the causes of death in both developed and developing nations. Deaths from infectious diseases have decreased, whereas deaths from injury have increased to the point that it is one of the leading causes of death in many developing countries[1]. According to World Health Organisation (WHO) report, about 5.8 million people die each year as a result of injuries. Injury accounts for 10% of the world's deaths, 32% more than the number of fatalities that result from malaria, tuberculosis, and HIV/AIDS combined. It is estimated that Motor Vehicle Collision (MVC) would be the fifth leading cause of death by 2030, with suicide and homicide rising to become the 12th and 18th leading causes of death respectively. Many of the patients who survive injury are left with temporary or permanent disabilities. Trauma accounted for 16% of all disabilities globally[2]. More than 90% of deaths that result from injury occur in low and middle income countries (LMICs). Projections show that without necessary steps, deaths due to MVCs will increase by 65% worldwide and 80% in LMICs by 2020[3]. Road traffic injuries (RTIs) are predicted to become the third leading contributor to the global burden of disease globally and the second leading determinant of disability-adjusted life years (DALYs) in the developing countries by 2020[4].

India is a lower middle – income country with a 1.2 billion population and one of the fastest growing economies. India has one percent of total vehicle population in the world but 10 % of road accident-related deaths[5]. According to the National Crime Bureau Report, 53 cases of MVCs took place every one hour during 2015, wherein 17 people died[6]. Deaths due to MVCs have increased by 5.1% during 2015 and still increasing. Despite the growing burden of injuries in LMICs, there is limited primary epidemiologic data to guide health policy and health system development[7,8]. Most of the data in developing countries are gathered by the routine health surveys, surveillance reports, police data and the hospital-based case where information about the process, quality of trauma care or clinical outcome is lacking[9–11]. Mortality data reveal only the proverbial tip of the iceberg concerning the public health impact of a disease. They provide a limited measure of the availability, use, and effectiveness of health care services[12]. In India also, no credible data is available to ascertain the outcome of trauma victims. Trauma patients are often brought in by friends, relatives, witnesses or the police so, there is a lack of injury event data. RTIs represent

only a fraction of the trauma spectrum. But in India, most of the available literature regarding trauma epidemiology is pertaining to road traffic injuries[13], and there are hardly any studies done on the other causes of trauma.

Studies in the past indicated that people with life-threatening but treatable injuries are six-time likely to die in a country with no organized trauma system than with one[14]. Trauma registries (TR) are databases designed to document the acute phase of hospital care delivered to victims of trauma[15]. Trauma registries have been in existence for more than three decades in high-income countries (HICs); the data from the TR has been used for local, national and international comparisons and performance improvement[15–18]. Many LMICs have recognized the need for trauma system development and establishment of trauma registries to monitor these systems but the existence of TR in LMICs is still infrequent, and there has been a very limited published account of where trauma registries exist[15,19,20]. In our study, we aimed to explore the feasibility of a simplified trauma registry and estimate the epidemiology of the injury so that targeted interventions can be taken and address the injury-related gaps in trauma system.

2.2 Method

Study setting

The study was conducted at the emergency department of the Surat Municipal Institute of Medical Education and Research (SMIMER) hospital, Surat, India. Surat is a district in the state Gujarat with almost 4.5 million population. The health care system in Surat is divided into three district hospitals, two of which hold affiliations with medical schools and a minimal fee for service hospitals. There are 47 community health centers (CHCs), 201 primary health centers (PHCs),1362 sub-heath centers[21], private hospitals and dispensaries (data not available). SMIMER is a medical college and teaching hospital established in the year 2000 and has been affiliated to the Veer Narmad South Gujarat University. The hospital is a non-profit organisation, tertiary care center run by Surat Municipal Corporation. SMIMER has all the basic as well as speciality and super speciality health care amenities with 750 bed in the hospital out of which 90% are free of charge beds, and 10% are minimal charge beds in the special wards. Casualty Outpatient Department, wards and operating theatres are equipped for round-the-clock services. Bed strength in the casualty department is twenty, and there are two operation theatres in the section[22]. Expressed written approval from the Institutional Ethics Committee (IEC), SMIMER hospital, Surat, India and Institutional Review Board (IRB), McGill University, Montreal, Canada has been obtained. Data were collected during June 2018-August 2018.

Description of the trauma registry

The TR is a one-page, 19 items form developed at the Centre of the Global Surgery, McGill University Health Centre, Montreal, Canada. Figure 1 shows the Trauma Registry (Data collection form) used in the study. Trauma registry includes information of patient demographics (age, gender, education, occupation, origin of patient, identification number), mechanism of injury, injury-related physiologic (arterial pressure, respiratory rate, neurological status) and anatomic data, and clinical outcomes (Treated, admitted to ward or intensive care, taken to operating theatre died and referred to another hospital). The collected data was entered into the electronic version of the trauma registry with the help of Kobo Toolbox. It is a free and open source software developed by the Harvard Humanitarian Initiative In 2009. All data were de-identified and stored in a password-protected server. All collected data remains strictly confidential and only study investigators have access to the database. Descriptive statistics were calculated for baseline characteristics, injury parameters and clinical outcomes using appropriate statistical software and

methodology. Chi-square test was done to study the association between different types of injuries and demographic variables.

Kampala trauma score (KTS)

Kampala Trauma Score was developed in Kampala, Uganda as part of the injury surveillance registry for use in the resource-limited settings[23]. It is a simple injury scoring system calculated by adding the following coded variables: patient age, systolic blood pressure, respiratory rate, neurologic status and number of serious injuries. Initially, it was scored on a scale of 5–16. A severe injury consisted of a KTS less than 11, a moderate injury 11–13 and a mild injury 14–16.

The KTS was then modified in 2004 to a range of 0–10. Although the parameters were maintained, the scoring of all the parameters was given one score lower. Thus, mild injuries have a KTS of 9–10, moderate 7–8 and severe 6 or less[24]. The neurologic status components were converted from the Glasgow Coma Scale (GCS) in following manner[25]. Patient with a motor response score of 6 (obeys commands) and an eye response score of 4 (spontaneously opens eyes) was considered "alert." An eye response score of 3 (opens eyes to verbal commands) was considered "responds to verbal stimulus." A motor response from 2 to 5 (extension to painful stimulus =2, localized painful stimulus =5) or an eye response score of 2 (opens eyes in response to painful stimulus) was considered "responds to painful stimulus." Motor and eye responses of 1 (no motor or eye response to painful stimulus) were considered "unresponsive." The KTS has proven to be useful in poor resource health care settings to predict early trauma mortality and improve outcome[23,25–27]. It compares favourably with other trauma scoring systems such as the Revised Trauma Score (RTS) and Injury Severity Score (ISS)[26].

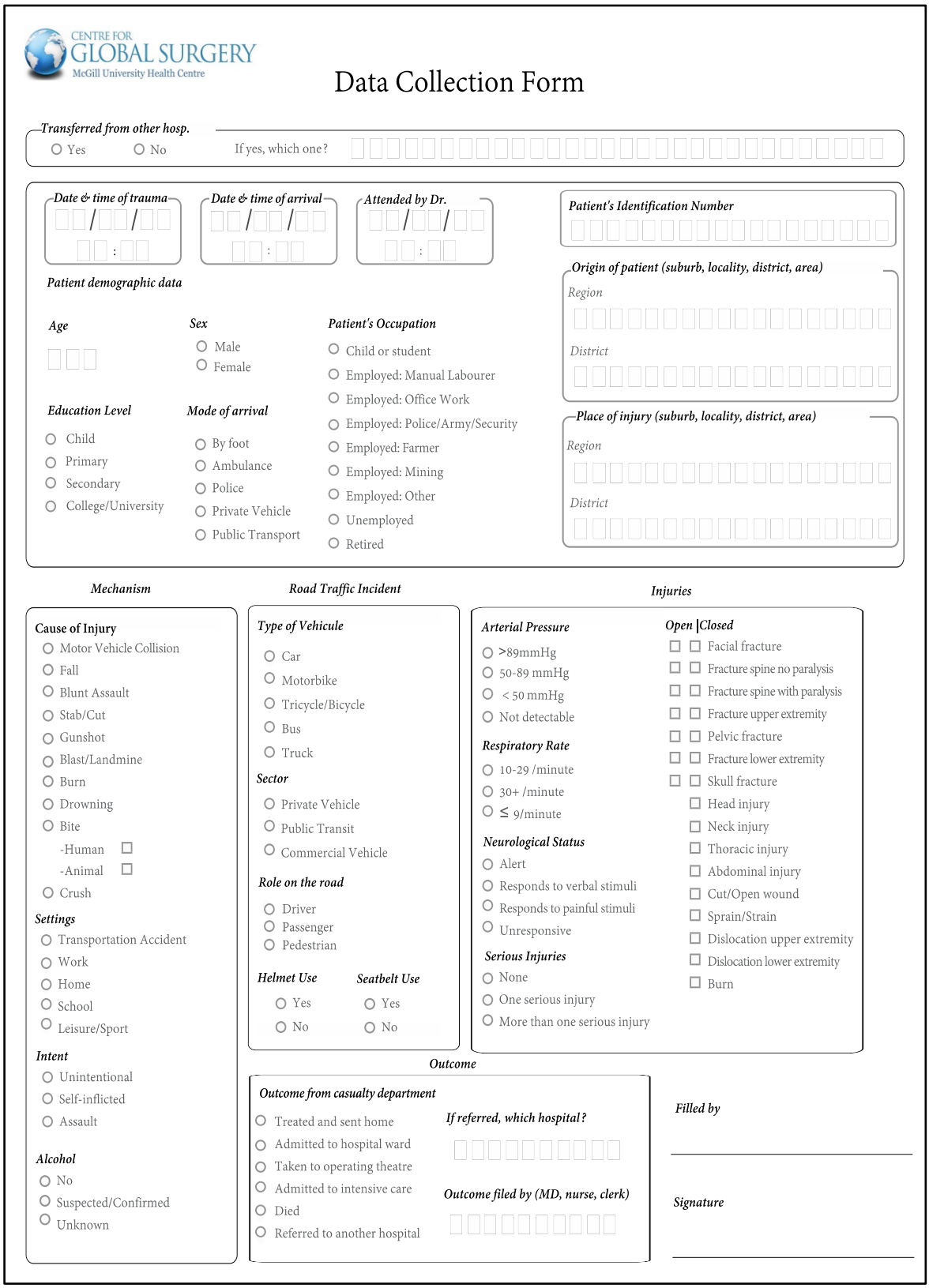

Figure 1. Trauma Registry (Data Collection) Form

Table 1. Components of the Kampala Trauma Score

Variables	Value
a. Age (years)	
5-55	1
<5 or >55	0
b. Number of serious injuries	
None	2
One	1
Two or more	0
c. Systolic blood pressure (mmHg)	
> 89 mmHg	2
50-89mmHg	1
≤ 49 mmHg	0
d. Respiratory rate (breaths/min)	
0-29/min	2
>30/min	1
≤ 9/min	0
e. Neurological status (AVPU system*)	
Alert	3
Responds to verbal stimuli	2
Responds to painful stimuli	1
Unresponsive	0

*The AVPU system is a simplified version of the Glasgow coma scale.

KTS total = a+b+c+d+e

Mild: 9-10, Moderate: 7-8, Severe: <6

2.3 Results

A total of 716 patients were enrolled in the study during the period of three months who presented to the emergency department of the hospital.

Socio-demographic profile

Injured patient in the study had a mean age of 33 years (SD = 37.53) with maximum patients fall into the age group of 20-25 (104) followed by 30-35(88). More males (74.16%) presented to the emergency department with an injury than females which was 25.84%. Figure 2. Shows the age distribution of the injured patients and Figure 3. shows age-wise distribution of gender.

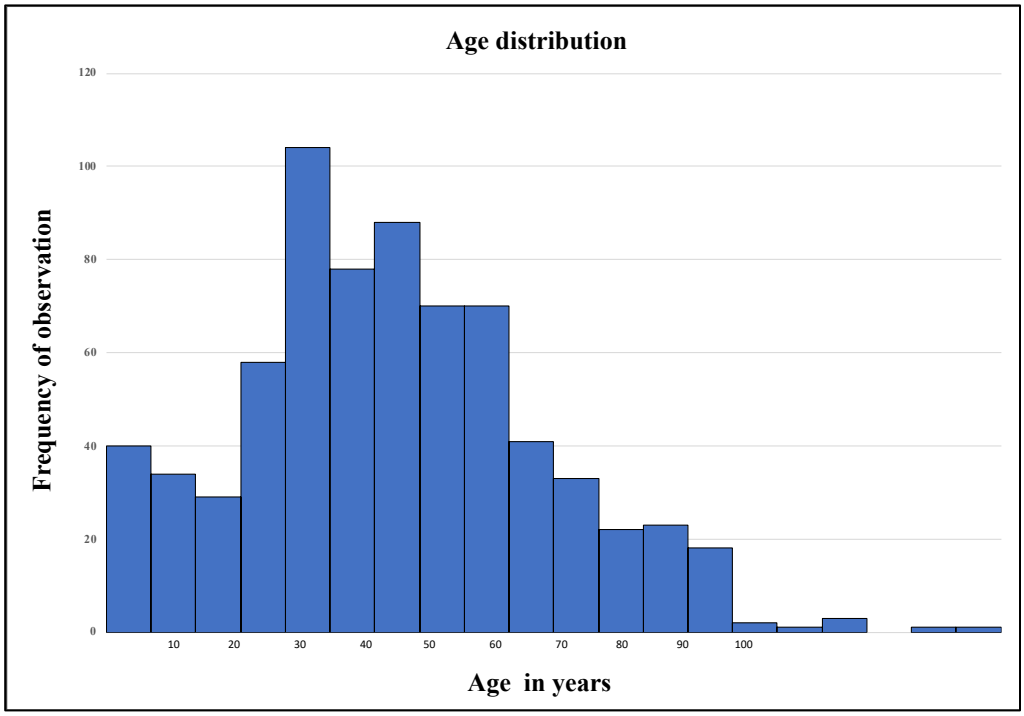

Figure 2. Age distribution of injured patients

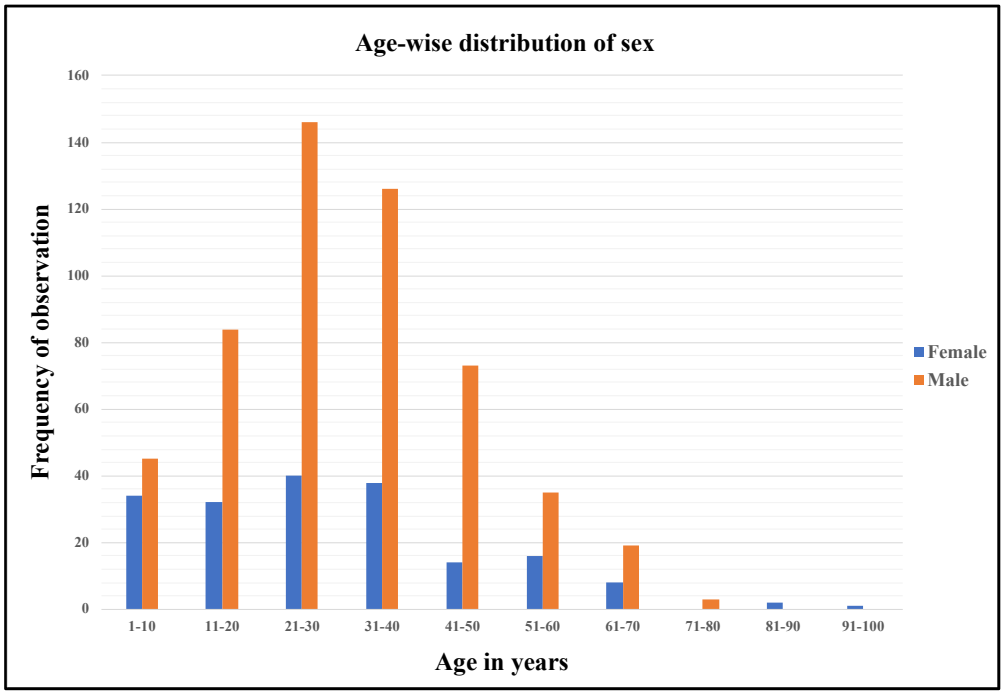

Figure 3. Age-wise distribution of sex

Students (28%) and unemployed (17%) were most frequently affected. 14% of patients were manual labourer followed by office worker (10%). Farmers, security(/police), retired patients were less than 5%. Majority of patients had a primary education (46%) followed by secondary education (25%) and university education (21%).

Place of injury and transportation used

97% of the people presented to the emergency hospital were from the Surat district. Out of 48 patients who transferred from another hospital, 50% were admitted to the hospital ward. 36% of trauma occurred on the road (transportation accident) followed by 29% happened at home. 18% of the injury occurred at the workplace 13% during leisure time/sports and 4% at the school. Patients from all age groups were injured on transportation accident except in less than 15 years and more than 75 years. 55 % of female patients were injured at home compared to 20% of male patients. ($p < 0.05$) From the patients in study arriving at the emergency department, 39.25 % were brought by the ambulance. 30.31% of patients arrived by private vehicle, and 22.35% came by public transport followed by police (5.03%) and foot (3.07%).

Causes of injury

Motor vehicle collision was the most common cause of the injury (34.64%) followed by fall (29.89%) and assault with blunt trauma (13.41%). Figure 4 shows the percentage of common causes of injuries in the patients presenting to the hospital.

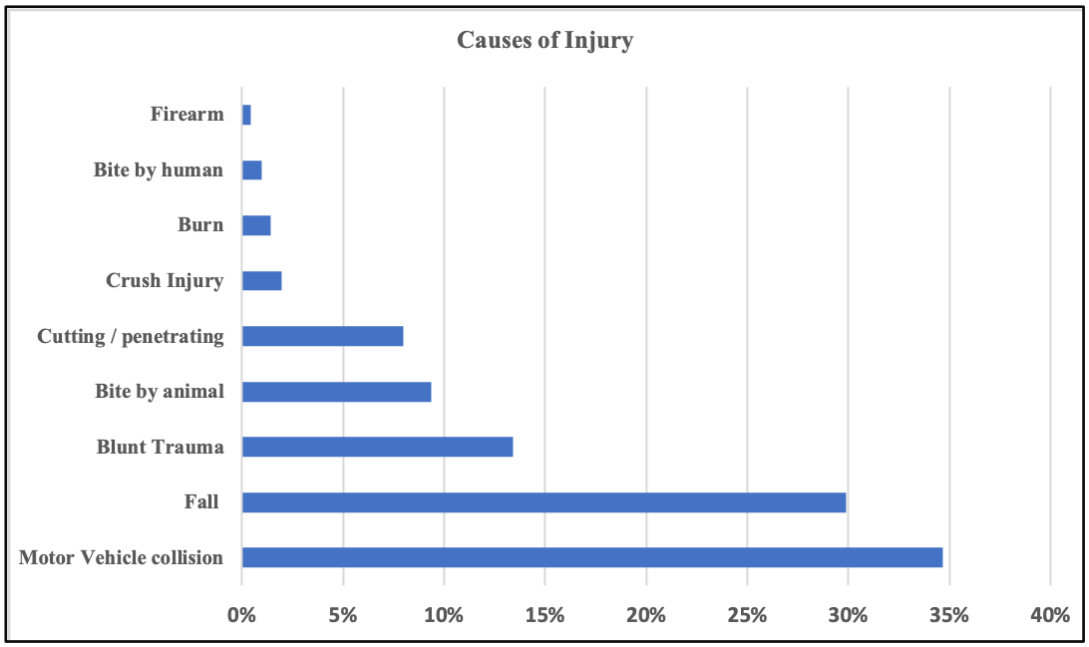

Figure 4. Common causes of injuries in patients sustained injuries.

Motor vehicle collision was common cause followed by fall and blunt assault in almost all age group except < 10 years and > 60 years. In the < 10 years of age group, fall was the most common cause followed by an animal bite. Figure 5 shows the frequency of three most common causes of injuries in different age groups. For all the type of injuries, the pattern was similar in both the gender except in motor vehicle collision, 38% of male injured compared to 25% female and 43% of female injured due to fall compared to 22% male ($p < 0.05$).

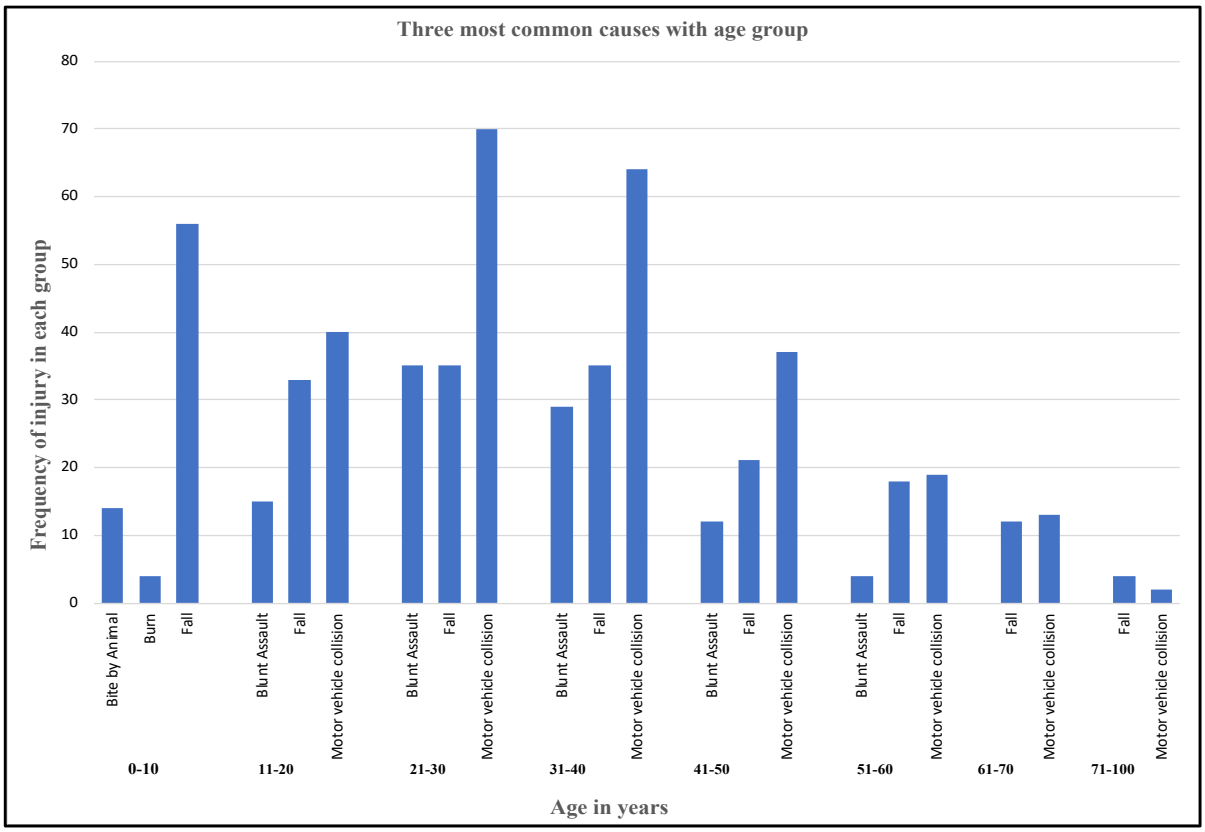

Figure 5. Three most common causes of injuries in different age groups

Type of vehicles and role on the road

In motor vehicle collision, more drivers (47.58%) were involved than passengers (28.63%) and pedestrians (23.79%). Amongst the RTIs , motorbikes were the most common type of vehicle (45.97), and 84% did not use helmets. Cars were the second most common vehicle (20.56%) in which 91% of patients did not use seatbelts. Figure 6 shows the number of patients of MVCs presenting to the hospital by type of vehicles used and role on the road.

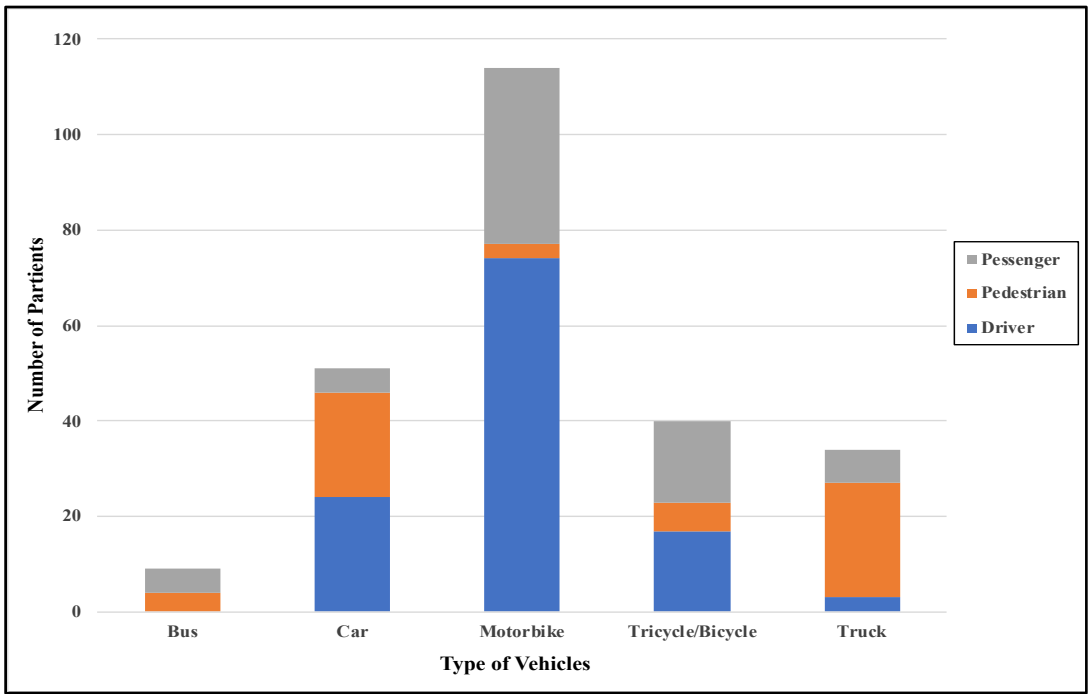

Figure 6. Number of patients involved in Motor vehicle collision with the type of vehicles

Intent and nature of injuries

Majority of injuries were unintentional (79%) followed by assault (15%) and self-inflicted injuries (6%). Cut/Open wound (46%) accounted for the majority of the intentional and unintentional injuries with similar incidents in both sexes. Thoracic injury (22%) was the second most common in patients with assault. Head injury (19%) was the third most common in patients presenting to the hospital with unintentional injury and assault.

Injury severity and outcome

From the patients arrived at the hospital and enrolled in the study, 1.4% were severely injured compared to 91.8% who were mildly injured. Table 3. shows the injury severity of patients with Kampala trauma score who presented at the emergency department.

Table 2. Injury Severity of patients with KTS

Category	KTS Score	Percentage (no.)
Severe	< 6	1.4% (10)
Moderate	7-8	6.8% (49)
Mild	9-10	91.8% (657)

55% of patients were treated and sent home. Patients admitted to the hospital ward (37%) were majorly suffered from MVCs (40%), fall (29%) and blunt assault (12%). 4% (26) patient admitted to the intensive care unit with cutting/penetrating injury (31%) and traffic injuries (27%). Among the patients who died (20) in the hospital, the most common cause was fall (55%). MVCs and blunt assault were the second most common cause (20%). Patients who died in the hospital, 75% had head injury, and 20% had neck injury. Ten patients were taken to the operating theatre, in which half of the patients had MVCs . Five patients transferred to another hospital.

2.4 Discussion

Our study is one of the first prospective studies in India which examined the epidemiology of injury presented to the emergency department of a tertiary care hospital with the use of a trauma registry. The findings from the study show that it is feasible to implement the trauma registry in this health care setting. There are the numerous significant findings in the study which requires attention. Majority of injured patients were the younger population in the age group of 20-25 followed by 30-35. The result is consistent with the other studies[28,29] as well which show that injury affects productive youth of the country. In the study, more males were involved than females with a ratio of 2.8:1. The gender distribution was heavily skewed towards male similar to other studies[30–32]. In India, the reason for the disparity could be the fact that still in majority of population, men are more likely to participate in high-risk behavior. Students were most commonly affected followed by people who were unemployed and manual labourers. From the patients presenting to the hospital with an injury, maximum had primary/secondary education. Many studies have presented a strong inverse association between the education level, mortality, and life expectancy. The results from these studies proved that educational attainment and income were significant predictors of health outcomes[33–35]. It would be vital to analyze the association between the socioeconomic status and effect on an injury[34–36].

Motor vehicle collision was the most common cause of the injury amongst all patients presenting to the hospital. It affected patients in the age group of 21-30, and 31-40 where males outnumbered females. Other studies in different parts of India which examined the epidemiology of the MVCs suggested similar results[37–40]. Amongst the traffic injuries, motorbikes were the most common type of vehicle followed by cars involving more drivers in the accident than passenger and pedestrians. In contrast to this result, many other studies showed that pedestrians are at high risk of being involved. They have demonstrated the high effect on vulnerable road users such as pedestrians and motorbike drivers[41–44]. Further study is needed to understand the responsible risk factors and possible solutions to avoid more extent. Multiple randomized controlled trials have shown that safety education can change behavior and lifestyle in high- income countries, although the effects on injury rates are not known. Pedestrian training in combination with the other interventions should be considered to address the injury problem[45–47]. In motorbike users, 81 % did not use the helmet, and in car users, 91% did not use the seat belt. The results from the study show that the patients who did not use helmet have 87% of head injury followed by neck and face injury. The

result is similar to the other studies[48–52]. in the past, studies have indicated that the helmet use results in an improved outcome for patients involved in accidents[53–55]. In India, the Motor Vehicles Act has mandatory helmet legislation, but the notification and implementation of the law is the responsibility of individual states. There is a need for proper implementation of road traffic regulations and awareness generation among the drivers and passengers about the helmet and seat belt use. In Taiwan and Vietnam, helmet laws were implemented concurrent with adequate enforcement, punitive fines, and a robust public awareness campaign, resulted in helmet use rising substantially[56,57].

Fall was the most common cause of the injury in the age group 1-10 and > 60 years in which the majority of injuries occurred at home. According to previous studies, fall was the most common cause of admission to the emergency department (ED) during childhood and are the fourth leading cause of trauma deaths[58–61]. Majority of childhood injuries occur at home which also mirrors in our study; further study requires to understand the responsible factors associated with it. As mentioned in the literature, fall from the windows, balconies, staircase, bed, terrace are the common causes of injury at home[62–66]. Child supervision is recognized as vital to protecting children from harm. Some estimates suggest that 90% of injuries to young children occur in or around their home when they are supposedly being supervised by a caregiver[67]. 25% (54) injury occur due to fall at the workplace, involving manual labourer (24) the most. It requires attention regarding the safety of workers and thorough safety education at the workplace. Old age patients (>60 year) who were injured due to fall at home, 82% of patients were admitted to the hospital ward. Upper, lower extremity and pelvic fractures were the most common nature of the injuries. The result from the study was consistent with other studies as well[68–70]. Fall causes a significant amount of morbidity and mortality in elderly patients. The event of fall and their consequences are preventable so, it is essential to study the detailed information regarding risk factors, casual event, and management to design multidisciplinary prevention programs and interventions.

Injury from an animal bite was the second most cause in the age group of 1-10 year with only minor injuries. A study in New Delhi estimated the rate of rabies from animal bites at 80 per 10,0000 population, and significantly higher for 5-14 years old, with bites from stray dogs accounting for 90% of cases[71]. In India, about 15 million people are bitten by animals every year[72]. Injury by animal bite has not gained much focus and epidemiological studies particularly children

are still charted, but minor injuries from the animal bite can lead to serious complications or death if not given proper care.

In the study, majority of injuries were unintentional (79%) followed by assault (15%) and self-inflicted injuries (6%). In the female patients, all the intentional injury (assault, self-inflicted) occurred at home. The numbers of female patients with intentional injuries were small but evident enough to require the attention. According to WHO report, globally 35.6% of females have experienced either intimate partner violence and/or non-partner sexual violence. Nearly one-third of ever-partnered women (30.0%) have experienced physical and/or sexual violence by an intimate partner, and 7.2% of adult women have experienced sexual violence by a non-partner[73]. Many women, regardless of health systems in their country, do not seek health care for injuries[74] or are reluctant to disclose the actual source of the injury. Studies have shown the association between injuries from the sexual violence and depression/anxiety[75–78] which can lead to suicidal activity. The findings from all over the world underpin the need for the health sector to take intimate partner violence and sexual violence against women more seriously[73].

The patients presenting to the hospital, 39.25% were brought by the ambulance whereas 30.31% patients arrived by private vehicle, 22.35% came by public transport, 5.03% came with police (5.03%) and foot (3.07%). Patients who came by the public/private vehicles, the majority were injured due to fall (139) and MVCs(106), 44% needed hospitalization and two patients died. Though a considerable number of patients brought by the ambulance; the number of patients who needed emergency services and did not get or use were striking. In India,1-0-8 is a free ambulance service. It is a public-private partnership (PPP) model for emergency services being managed and operationalized by Emergency Management and Research Institute (EMRI) in many states. In Gujarat, the service has been launched with a fleet of 61 including 20 Advanced Life Support (ALS) and 41 Basic Life Support (BLS) ambulances across 42 towns (in 9 districts) of the state. EMRI was responsible for handling medical, police and fire emergencies through the 1-0-8 emergency services. In the subsequent years, the operations were extended to the entire state with 402 ambulances and 100% population coverage. EMRI has tie-ups with 2050 private hospitals in Gujarat, apart from 1381 government hospitals that can handle emergencies[79].

Here are some studies from different regions in India which highlighted cases with the low number of ambulance usage and delayed presentation to the hospital suggesting inadequacy of the

emergency medical service[40,42,80–84]. It is crucial to raise public awareness and accessibility of the service for the effective implementation of the pre-hospital emergency care.

Another significant finding in the study was that the majority of the patient presented with the minimally severe injuries. It could be attributed to the fact that there are many other private hospitals and clinics in the city with better facilities, resources, and 24-hour coverage. The study was done at a single tertiary care hospital, which might not reflect the condition of all the public health centers, private hospitals, and dispensaries. It would be imperative to do a multi-center study. It was only a three-month study so, the data from the study will likely under-represent the scale of the problem. The study was conducted in June, July, and August so, it is plausible to miss the seasonal variation in the pattern of the injury. The study did not incorporate two-week follow-ups data of the patients and might fail to evaluate the effect of hospital-based care on the outcome of the patients. We only included patients that presented to the emergency department of the hospital. So, the patients who did not seek medical care from the hospital are missing from the data and causes selection bias in the study. Another limitation of the study is the lack of ability to explore the association between socio-economic status of the patient and the preference of the people about utilization of the pre-hospital and in-hospital health care services. The association of socio-economic class and use of the private facility over the public health service might be a factor to look for in the future. However, there is another possibility to contemplate that the patients with severe injuries probably succumbed to their injuries in the prior to arriving at the hospital and fail to access the health care service. It highlights the need to further expand the pre-hospital system. Community-based surveys, police-data, mortuary data are also required to supplement the hospital surveillance and cover all the injury events and deaths in a population[85].

2.5 Conclusion

Trauma registry was able to capture injury-related information in a simple one-page proforma which could be administered easily without hampering the routine schedule of the emergency department medical staff. It is possible to implement a simplified dataset of the trauma registry and establish sustainable data collection system with the existing resources at the district hospital level. It is essential to identify gaps in the population safety, collect information about injury occurrences, characteristics, outcomes and hospital-related care for effective prevention strategies, policy making, and legislation. There is a need for the incorporation of the trauma registry in the health care facility along with continuous use to ensure high-data quality and adequate population coverage. More research needs to be done to further explore the effective interventions, but attention should be given on the raised issue from the study as it could be the foundation for the bigger objective. A concrete effort from the public and private sector, health care professionals as well society is needed to improve and strengthen the trauma care in India. We hope to see recognition of the trauma registry and establishment of the nationwide data collection system that will generate relevant and timely data on trauma patients in the future.

2.6 References

1. Mathers C, Stevens G, Mascarenhas M. World Health Organisation (WHO). Global Health Risks. Mortality and burden of disease attributable to selected major risks. (2009).

2. World Health Organisation (WHO). Injuries and Violence: The Facts. (2014).

3. Peden M. World report on road traffic injury prevention. (2004).

4. Murray CJ & Lopez AD. Alternative projections of mortality and disability by cause 1990 - 2020: Global Burden of Disease Study. The Lancet 349, 1498-504 (1997).

5. The Supreme court of India- Civil Original Jurisdiction - Written Petition (CIVIL) no.494 (2012). Available at: https://www.sci.gov.in/supremecourt/2012/35071/35071_2012_Judgement_24Aug-2017.pdf (Accessed: 11th December,2018).

6. Mohit Sharma,Ethan S. Brandler,. Emergency Medical Services in India: The Present and Future. Prehospital disaster Med. 29(3);307-10 (2014).

7. Lagarde, E. Road Traffic Injury Is an Escalating Burden in Africa and Deserves Proportionate Research Efforts. PLoS Med. 4, 170 (2007).

8. Hofman, K., Primack, A., Keusch, G. & Hrynkow, S. Addressing the growing burden of trauma and injury in low- and middle-income countries. Am. J. Public Health 95, 13–17 (2005).

9. Williams, J. M., Furbee, P. M., Prescott, J. E. & Paulson, D. J. The Emergency Department Log as a Simple Injury-Surveillance Tool. Ann. Emerg. Med. 25, 686–691 (1995).

10. Mock C, Nguyen S, Quansah R, Arreola-Risa C, Viradia R, J. M. Evaluation of Trauma Care capabilities in four countries using the WHO- IATSIC Guidelines for Essential Trauma Care. Wld j. of Surg.30(6):946-56, (2006).

11. Cinnamon, J. & Schuurman, N. Injury surveillance in low-resource settings using Geospatial and Social Web technologies. Int. J. Health Geogr. 9, (2010).

12. Pollock, D. A. Trauma registries and public health surveillance of injuries. Proc Int Collab Effort Inj. Stat. 1, 1–6 (1995).

13. Dandona, R. Making road safety a public health concern for policy-makers in India. Natl. Med. J. India 19, 126–133 (2006).

14. Mock, C. World Health Organisation (WHO): Strengthening care for the injured: success stories and lessons learned from around the world. (2010).

15. Moore, L. & Clark, D. E. The value of trauma registries. Injury 39, 686–695 (2008).

16. Victorian State Trauma Outcomes Registry (VSTORM). Available at: https://www.monash.edu/medicine/sphpm/epidemiology. (Accessed: 3rd December 2018)

17. Trauma Audit and Research Network. Available at: https://www.tarn.ac.uk/home.aspx?ReturnUrl=%2FLogin.aspx. (Accessed: 3rd December 2018)

18. American College of Surgeons. National Trauma Data Ban. Available at: https://www.facs.org/quality-programs/trauma/tqp/center-programs/ntdb. (Accessed: 3rd December 2018)

19. Mock C. World Health Organisation (WHO). Guidelines for essential trauma care. (2004).

20. Mock C. WHO releases Guidelines for Trauma Quality Improvement Programmes.

21. Health and Family Welfare Department, Govt. of Gujarat | India. Available at: https://gujhealth.gujarat.gov.in/. (Accessed: 3rd December 2018)

22. SMIMER - Hospital. Available at: http://smimer.suratmunicipal.gov.in/Hospital. (Accessed: 3rd December 2018)

23. Kobusingye, O. C. & Lett, R. R. Hospital-based trauma registries in Uganda. *J.* Trauma - Acute Care Surg. 48(3), 498–502 (2000).

24. Demyttenaere, S. V, Nansamba, C. & Razek, T. Injury in Kampala, Uganda: 6 years later. Canadian J of Surg. 52(5), E146 (2009).

25. Weeks, S. R. et al. A modified Kampala trauma score (KTS) effectively predicts mortality in trauma patients. Injury 47, 125–129 (2016).

26. MacLeod, J. B. A. et al. A Comparison of the Kampala Trauma Score (KTS) with the Revised Trauma Score (RTS), Injury Severity Score (ISS) and the TRISS Method in a Ugandan Trauma Registry: Is Equal Performance Achieved with Fewer Resources? Eur. J. Trauma 29, 392–398 (2003).

27. Weeks, S. R. et al. Is the Kampala Trauma Score, an effective predictor of mortality in lowresource settings? A comparison of multiple trauma severity scores. World J. Surg. 38, 1905–1911 (2014).

28. Duan, L. et al. The National Injury Surveillance System in China: A six-year review. Injury 46, 572–579 (2015).

29. Reihani H, Pirazghandi H, Bolvardi E, Ebrahimi M, Pishbin E, Ahmadi K, Safdarian M, Saadat S, Rahimi-Movaghar V. Assessment of mechanism, type and severity of injury in multiple trauma patients: A cross sectional study of a trauma center in Iran. Chinese J. Traumatol. 20(2), 75–80 (2017).

30. Yamuragiye, A., Ibambasi, A., Mutuyimana, A., Mutuyemariya, O. & Nsereko, E. Short communication Injury Profile in an Emergency Department at a Referral Hospital in Kigali, Rwanda. Rwanda j. Heal. sci. 2, 61–62 (2013).

31. Stoica, B., Paun, S., Tanase, I., Negoi, I. & Beuran, M. Trauma pattern in a level I eastEuropean trauma center. J. Acute Dis. 4, 322–326 (2015).

32. Fararoei, M., Sadat, S. J. & Zoladl, M. Epidemiology of trauma in patients admitted to an emergencyward in Yasuj. Trauma Mon. 22, 1–5 (2017).

33. Cubbin, C., LeClere, F. B. & Smith, G. S. Socioeconomic status and the occurrence of fatal and nonfatal injury in the United States. Am. J. Public Health 90, 70–77 (2000).

34. Cubbin, C. & Smith, G. S. Socioeconomic Inequalities in Injury: Critical Issues in Design and Analysis. Annu. Rev. Public Health 23, 349–375 (2002).

35. Yadollahi, M., Ghaem, A. & Paydar, S. The association between socioeconomic status and injury in patients referring to expert accident hospital, Shiraz, Iran. Int. J. Curr. Microbiol. App.Sci. 4(4), 240–247 (2015).

36. Chen, H., Du, W., Li, N., Chen, G. & Zheng, X. The socioeconomic inequality in trafficrelated disability among Chinese adults: The application of concentration index. Accid.
Anal. Prev. 55, 101–106 (2013).

37. Hsiao M, Malhotra A, Thakur JS, Sheth JK, Nathens AB, Dhingra N, Jha P, Million Death Study Collaborators. Road traffic injury mortality and its mechanisms in India: Nationally representative mortality survey of 1.1 million homes. BMJ Open 3(8): e002621, (2013).

38. Mehta, R.K, Rai, S.&Mehta, R. An epidemiological study of road traffic accident cases attending a tertiary care hospital, Tirupati. IOSR J. Dent. Med. Sci. Ver. III 14, 2279–861 (2015).

39. Singh, R., Singh, H., Gupta, S. & Kumar, Y. Pattern, severity, and circumtances of injuries sustained in road traffic accidents: A tertiary care hospital-based study. Indian J. Community Med. 39, 30 (2014).

40. Misra P, Majumdar A, Misra MC, Kant S, Gupta SK, Gupta A, Kumar S.Epidemiological study of patients of road traffic injuries attending the emergency department of a trauma center in New Delhi. Indian J. Crit. Care Med. 21(10), 678 (2017).

41. Matheka, D. M., Kitonyi, M. N. & Alkizim, F. O. Three-month pattern of road traffic injuries at a Kenyan level 4 hospital. Pan Afr. Med. J. 20, (2015).

42. Farooqui, J. M. *et al.* Pattern of injury in fatal road traffic accidents in a rural area of western Maharashtra, India. Australas. Med. J. 6, 476–482 (2013).

43. Shruthi, P. *et al.* Analysis of fatal road traffic accidents in a metropolitan city of South India. J. Indian Acad. Forensic Med. 35, 317–320 (2013).

44. Uthkarsh, P. S. *et al.* Profile of injury cases admitted to a tertiary level hospital in South India. Int. J. Inj. Contr. Saf. Promot. 19, 47–51 (2012).

45. Rodriguez JM, Hijar Medina M, Campuzano JC, Bangdiwala SSI, V. A. Methodological proposal for implementing an intervention to prevent pedestrain injuries, a multidisciplinary approach: the case of Cuernavaca, Morelos, Mexico. Inj. Prev.20(1): e1, (2014).

46. Duperrex O, Roberts I, Bunn F. Safety education of pedestrians for injury prevention. Cochrane Database of Systematic Reviews. 2002(2).

47. Sandt, L. S. *et al.* Effect of a community-based pedestrian injury prevention program on driver yielding behavior at marked crosswalks. Accid. Anal. Prev. 93, 169–178 (2016).

48. Bener, A., Rahman, Y. S. A. & Mitra, B. Incidence and severity of head and neck injuries in victims of road traffic crashes: In an economically developed country. Int. Emerg. Nurs. 17, 52–59 (2009).

49. Kumar, A., Lalwani, S., Agrawal, D., Rautji, R. & Dogra, T. Fatal road traffic accidents and their relationship with head injuries: An epidemiological survey of five years. Indian J. Neurotrauma 5, 63–67 (2008).

50. Hemanth Kumar, R. G. & Chandrakant, V. A. Pattern and distribution of injuries among road traffic accident victims in North Karnataka. Indian J. Forensic Med. Toxicol. 10, 35– 37 (2016).

51. Tripathi M, Tewari MK, Mukherjee kk, M. S. Profile of patients with head injury among vehicular accidents: a n experience from a tertiary care centre of India. Neurol. India 62, 610–7 (2014).

52. Venkateswarrao, S. & Bhaskar, K. A study of cranial injuries in road traffic accidents in Tirupati region. Indian J. Forensic Med. Toxicol. 10, 58–63 (2016).

53. Ouellet, J. V. & Kasantikul, V. Motorcycle helmet effect on a per-crash basis in Thailand and the United States. Traffic Inj. Prev. 7, 49–54 (2006).

54. Yadukul, S., Devadass, P. & Gururaj, G. Role of Helmet in Preventing Head Injury among Two-Wheeler Occupants in Fatal Road Traffic Injuries. Indian J. Forensic Med. Toxicol. 10, 6 (2016).

55. Bhoi S, Singh A, Sinha TP, Pal R, Galwankar S, Baluja A, Ali S, Sharma V, Agrawal A. Magnitude and spectrum of injuries sustained in road traffic accidents among two-wheeler riders and correlation with helmet use. J. Emergencies, Trauma Shock. 11(3),160 (2018).

56. Passmore, J. W., Nguyen, L. H., Nguyen, N. P. & Olivé, J. M. The formulation and implementation of a national helmet law: a case study from Viet Nam. Bull. World Health Organ. 88, 783–787 (2010).

57. Tsai, M. & Hemenway, D. Effect of the mandatory helmet law in Taiwan. Inj Prev. 5(4):2901 (1999).

58. Hall, J. Mortality of Childhood Falls. J Trauma 29, 1273–5 (1989).

59. Lallier, M., Bouchard, S., St-Vil, D., Dupont, J. & Tucci, M. Falls from heights among children: A retrospective review. J. Pediatr. Surg. 34, 1060–1063 (1999).

60. Stone KE, Lanphear BP, Pomerantz WJ, Khoury J. Childhood injuries and deaths due to falls from windows. J. Urban Health. 77(1):26-33 (2000).

61. Beale, J. P., Wyatt, J. P., Beard, D., Busuttil, A. & Graham, C. A. A five-year study of high falls in Edinburgh. Injury. 31, 503–508 (2000).

62. Istre GR, McCoy MA, Stowe M, Davies K, Zane D, Anderson RJ, Wiebe R. Childhood injuries due to falls from apartment balconies and windows. Inj. Prev. 9(4), 349–52 (2003).

63. American Academy of Pediatrics. Committee on Injury and Poison Prevention. Falls from heights: windows, roofs and balconies. Pediatrics.;107(5):1188-91. (2001).

64. Sharma M, Lahoti BK, Khandelwal G, Mathur RK, Sharma SS, Laddha A. Epidemiological trends of pediatric trauma: A single-center study of 791 patients. J. Indian Assoc. Pediatr. Surg. 16(3):88 (2011).

65. Bulut, M., Koksal, O., Korkmaz, A., Turan, M. & Ozguc, H. Childhood falls Characteristics, outcome, and comparison of the injury severity score and new injury severity score. Emerg. Med. J. 23, 540–545 (2006).

66. Ong, M. E. H., Ooi, S. B. S. & Manning, P. G. A review of 2,517 childhood injuries seen in a Singapore Emergency Department in 1999 - Mechanisms and injury prevention suggestions. Singapore Med. J. 44, 12–19 (2003).

67. Peden, M. World report on child injury prevention appeals to "Keep kids safe". Inj Prev. 14(6):413-4 (2008).

68. Tripathy, N. K., Jagnoor, J., Patro, B. K., Dhillon, M. S. & Kumar, R. Epidemiology of falls among older adults: A cross sectional study from Chandigarh, India. Injury. 46: 1801–1805 (2015).

69. Dandona R, Kumar GA, Ivers R, Joshi R, Neal B, Dandona L. Characteristics of non-fatal fall injuries in rural India. Inj. Prev. 16(3), 166–71 (2010).

70. Joshi, K., Kumar, R. & Avasthi, A. Morbidity profile and its relationship with disability and pyschological distress among elderly people in Northern India. Int. J. Epidemiol. 32, 978–987 (2003).

71. Singh J, Jain DC, Bhatia R, Ichhpujani RL, Harit AK, Panda RC, Tewari KN, Sokhey J. Epidemiological characteristics of rabies in delhi and surrounding areas, 1998. Indian Pediatr. 38(12):1354–60 (2001).

72. Martin, E. Rabies in India. J. Comp. Pathol. Ther. 8, 207–212 (1895).

73. Patricia Tjaden, N. T. Extent, Nature, and Consequences of Intimate Partner Violence. (2000).

74. World Health Organisation (WHO). Global and regional estimates of violence against women: prevalence and health effects of intimate partner violence and non-partner sexual violence: executive summary (2013).

75. Nicolaidis, C., Curry, M. A., McFarland, B. & Gerrity, M. Violence, mental health, and physical symptoms in an academic internal medicine practice. J. Gen. Intern. Med. 19: 819–827 (2004).

76. Kohout, F. J., Berkman, L. F., Evans, D. A. & Cornoni-Huntley, J. Two Shorter Forms of the CES-D Depression Symptoms Index. J. Aging Health. 5:179–193 (1993).

77. Plichta, S. B. & Falik, M. Prevalence of violence and its implications for women's health. Women's Heal. Issues. 11: 244–258 (2001).

78. Kimerling, R., Gima, K., Smith, M. W., Street, A. & Frayne, S. The Veterans Health Administration and military sexual trauma. Am. J. Public Health. 97: 2160–66 (2007).

79. National Health Systems Resource Centre;Ministry of Health and Family Welfare, Gov. Of India. Study of Emergency Response Service - EMRI model. (2009).

80. Fitzgerald, M., Dewan, Y. & O'Reilly, G. India and the management of road crashes: Towards a national trauma system. Indian J. Surg. 68:226–232 (2006).

81. Mehta, R.K, Rai, S.&Mehta, R. An epidemiological study of road traffic accident cases attending a tertiary care hospital, Tirupati. IOSR J. Dent. Med. Sci. Ver. III 14:2279–861 (2015).

82. DeepakSharma, Uday Shankar Singh2, S. M. A study on road traffic accidents in AnandGujarat. Heal. Line 2:2–5 (2011).

83. Radjou, A., Pal, R., Balliga, D. & Mahajan, P. Injury-related mortality audit in a regional trauma center at Puducherry, India. J. Emerg. Trauma. Shock 5:42 (2012).

84. Ramanujam, P. & Aschkenasy, M. Identifying the need for pre-hospital and emergency care in the developing world: A case study in Chennai, India. J. Assoc. Physicians India 55:491–495 (2007).

85. McGee K, Sethi D, Peden M, Habibula S. Guidelines for conducting community surveys on injuries and violence. Injury control and safety promotion.11(4):303-6 (2004).