Accepted Manuscript

Road traffic injuries: Cross-sectional cluster randomized countrywide population data from 4 low-income countries

Syed Nabeel Zafar, Joseph K. Canner, Neeraja Nagarajan, Adam L. Kushner, Shailvi Gupta, Joseph K. Canner, Tu M. Tran, Neeraja Nagarajan, Barclay T. Stewart, Thaim B. Kamara, Patrick Kyamanywa, Kapendra S. Amatya, Moses Galukande, Robin T. Petroze, Benedict C. Nwomeh, Emily R. Smith, Michael M. Haglund, Benedict Nwomeh, Reinou S. Groen, Adam L. Kushner

PII: S1743-9191(18)30564-8

DOI: 10.1016/j.ijsu.2018.02.034

Reference: IJSU 4453

To appear in: *International Journal of Surgery*

Received Date: 18 October 2017

Revised Date: 8 January 2018

Accepted Date: 13 February 2018

Please cite this article as: Zafar SN, Canner JK, Nagarajan N, Kushner AL, SOSAS4 Research Group, Gupta S, Canner JK, Tran TM, Nagarajan N, Stewart BT, Kamara TB, Kyamanywa P, Amatya KS, Galukande M, Petroze RT, Nwomeh BC, Smith ER, Haglund MM, Nwomeh B, Groen RS, Kushner AL, Road traffic injuries: Cross-sectional cluster randomized countrywide population data from 4 low-income countries, *International Journal of Surgery* (2018), doi: 10.1016/j.ijsu.2018.02.034.

Road Traffic Injuries: Cross-Sectional Cluster Randomized Countrywide Population Data from 4 Low-Income Countries

Authors:

Syed Nabeel Zafar MBBS MPH, Joseph K. Canner MHS, Neeraja Nagarajan MD MPH, Adam L Kushner MD MPH, and SOSAS4 Research Group

Affiliations:

SNZ: Department of Surgery, Howard University Hospital, Washington DC. zafar.nabeel@gmail.com
JKC: Johns Hopkins Surgery Center for Outcomes Research, Baltimore, MD jcanner1@jhmi.edu
NN: Johns Hopkins Surgery Center for Outcomes Research, Baltimore, MD; Department of Surgery, Brigham and Women's Hospital, Boston MA; drneerajanagarajan@gmail.com
ALK: Surgeons OverSeas, New York, NY. adamkushner@yahoo.com

SOSAS 4 research group members:
Shailvi Gupta, MD, MPH, Department of Surgery, UCSF-EB, Oakland, CA, USA shailvi.gupta@gmail.com
Joseph K Canner, MHS, Johns Hopkins Surgery Center for Outcomes Research, Baltimore, MD jcanner1@jhmi.edu
Tu M. Tran, Duke Global Neurosurgery and Neuroscience, Durham, NC, USA, tu.tran@duke.edu;
Neeraja Nagarajan MD, MPH, Department of Surgery, Brigham and Women's Hospital, Boston, MA. – Previously Johns Hopkins Surgery Center for Outcomes Research, Baltimore, MD; Department of Surgery drneerajanagarajan@gmail.com
Barclay T. Stewart, MD, MscPH, Department of Surgery, University of Washington, Seattle, WA, USA stewarb@uw.edu
Thaim B. Kamara, MD, Department of Surgery, Connaught Hospital, Freetown, Sierra Leone thaimyangbay@yahoo.co.uk
Patrick Kyamanywa, MD, College of Medicine and Health Sciences, University of Rwanda, Kigali, Rwanda pkyamanywa0@gmail.com
Kapendra S. Amatya, MBBS, MS, Nepal Cancer Hospital and Research Center, Lalitpur, Nepal
Moses Galukande, MBchB, M.Med, MSc: galukand@gmail.com; Makerere University College of Health Sciences, Kampala, Uganda
Robin T. Petroze, MD, MPH, Department of Surgery, University of Virginia, Charlottesville, VA, USA ksa712@yahoo.com
Benedict C. Nwomeh, MD, MPH, Department of Pediatric Surgery, Nationwide Children's Hospital, Columbus, OH, USA bnwomeh@gmail.com
Emily R. Smith, PhD, Duke Global Neurosurgery and Neuroscience, Durham, NC, USA. emily.smith1@duke.edu
Michael M. Haglund, MD, PhD: michael.haglund@duke.edu; Duke Global Neurosurgery and Neuroscience, Durham, NC, USA
Benedict Nwomeh: MD, Nationwide Children's Hospital, Columbus Ohio, bnwomeh@gmail.com

Reinou S. Groen, MD, MIH, PhD, Alaska Native Medical Center, Anchorage, AK, Affiliate Department of Gynecology and Obstetrics, Johns Hopkins Hospital, Baltimore, MD, USA
rsgroen@hotmail.com
Adam L. Kushner, MD, MPH, Surgeons OverSeas, New York, NY, USA
adamkushner@yahoo.com

Author for correspondence

Syed Nabeel Zafar MD MPH

Department of Surgery, Howard University Hospital

2041 Georgia Ave NW, Washington DC, USA

Ph: 202-865-4608

Fax: 202-865-6728

Email: zafar.nabeel@gmail.com

Current address

Department of Surgery, University of Maryland Medical Center
22 S Greene Street, Rm S8B03
Baltimore, Maryland 21201
Ph: 410-446-7225
Fax: 410-328-0401
Email: zafar.nabeel@gmail.com

Road Traffic Injuries: Cross-Sectional Cluster Randomized Countrywide Population Data from 4 Low-Income Countries

Abstract

Introduction: Road traffic injuries (RTI) are a leading cause of morbidity and mortality around the world. The burden is highest in low and middle-income countries (LMICs) and is increasing. We aimed to describe the epidemiology of RTIs in 4 low-income countries using nationally representative survey data.

Methods: The Surgeons Overseas Assessment of Surgical Needs (SOSAS) survey tool was administered in four countries: Sierra Leone, Rwanda, Nepal and Uganda. We performed nationally representative cross-sectional, cluster randomized surveys in each country. Information regarding demographics, injury characteristics, anatomic location of injury, healthcare seeking behavior, and disability from injury was collected. Data were reported with descriptive statistics and evaluated for differences between the four countries using statistical tests where appropriate.

Results: A total of 13,765 respondents from 7,115 households in the four countries were surveyed. RTIs occurred in 2.2% (2.0-2.5%) of the population and accounted for 12.9% (11.5-14.2%) of all injuries incurred. The mean age was 34 years (standard deviation ±1years);74% were male. Motorcycle crashes accounted for 44.7% of all RTIs. The body regions most affected included head/face/neck (36.5%) followed by extremity fractures (32.2%). Healthcare was sought by 78% road injured; 14.8% underwent a major procedure (requiring anesthesia). Major disability resulting in limitations of work or daily activity occurred in 38.5% (33.0-43.9%).

Conclusion: RTIs account for a significant proportion of disability from injury. Younger men are most affected, raising concerns for potential detrimental consequences to local economies. Prevention initiatives are urgently needed to stem this growing burden of disease; additionally,

improved access to timely emergency, trauma and surgical care may help alleviate the burden due to RTI in LMICs.

Keywords: Road Traffic Injury, Disability, Epidemiology, Global Surgery.

Introduction

Road traffic injury (RTI) accounts for about 1.24 million deaths annually. [1] It is the 8th leading cause of death globally and the number one cause of death in the youth (aged 15-29 years). [2] The global burden of RTIs has been growing over the past decades and it is estimated that it will become the fifth leading cause of mortality by 2030[3]. In addition, RTIs are the tenth leading cause of disability adjusted life years (DALYs).[4]

RTIs disproportionately affect low and middle income countries (LMICs) with the severest burden in middle income countries especially in Africa. [5] [6] About 91% of injury related deaths and 94% of injury related disability occurs in LMICs.[7,8] Despite the disproportionally high burden, epidemiologic data for RTIs in LMICs are poorly described. [5,9-11] Data aremost limited from low income countries where the case fatality rates are the highest and likely underestimates the true burden of disease. Additionally, the burden of non-fatal road injuries in low income countries is poorly reported. [10] Nationally representative survey data can help to fill these gaps.

Previously, four cluster randomized countrywide population surveys were performed in Nepal, Rwanda, Sierra Leone, and Uganda.[12-15] These surveys assessed the countries' surgical need and also collected information on death and disability related to road traffic injuries. Nepal, Rwanda, Sierra Leone, and Uganda are all low-income countries. A basic profile for each is provided in supplementary table 1 (data from USA is also provided for context). The purpose of

our study was to describe and compare the epidemiology of RTIs in four low income countries using data from these nationally representative surveys.

Methods

We performed secondary analysis on data collected from four nationally representative cluster randomized surveys. Household surveys were performed in Nepal and Uganda in 2014, Rwanda in 2011 and Sierra Leone in 2012. For the current analysis we chose these four countries as they represent diversity between LMICs and used the SOSAS survey methodology which enabled us to analyze data in aggregate.

Ethical considerations

Written informed consent was obtained from all survey respondents. Consent was obtained from parents where children were interviewed. Local approval and institutional review board approval was obtained for each of the surveys.[12-15]. This included approval for secondary analysis of collected data. The data analyzed for this study was deidentified prior to analysis.

Sampling and data collection

In each of the four countries households were sampled using two stage cluster sampling. First districts were randomly identified using the Population Proportion to Size method. Then within each district, households were randomly selected while accounting for rural/urban location. The number of households per district varied for each country depending upon the specific sample size calculations. At each household, the Surgeons OverSeas Assessment of Surgical need (SOSAS) survey tool was used to collect data in the local language. Data were collected by

trained personnel, which were health care professionals: medical students, nurses, or physicians in all countries except for Uganda – where non-medical but experienced researchers administered the survey. Response rates for the household surveys were between 97% and 99%. Details of training and implementation are described elsewhere[14,16].

Survey instrument

The SOSAS instrument was designed specifically to measure the burden of surgical conditions in LMICs.[16] It was developed using guidelines from the Demographic and Health Survey (DHS) and World Health Organization's (WHO) 'guidelines for conducting community surveys for injuries and violence'.[17] The survey instrument consisted of two parts. First a representative from each household was interviewed to provide basic demographics, a list of household members, information on accessibility of healthcare, and data on household deaths during the prior 12 months. For the second part two household members were randomly selected and underwent a complete head-to-toe verbal examination related to surgical conditions. Respondents were questioned about wounds, burns, masses, physical deformities, or prior operations on six anatomic regions: face/head/neck, chest/breast, back, abdomen, groin/genitalia, and extremities. For each condition the respondents were asked whether the condition was injury related and if so details of injury were asked. Timing of the injury - specifically if the injury took place within the last 12 months was also recorded. If a person was hit by a vehicle while not in a vehicle himself, this injury was classified as 'pedestrian struck'. Additionally, disability was assessed for each condition by a question with the following Likert-based response options: the condition is not disabling; I feel ashamed; I am not able to work like I used to; I need help with transportation; or I need help with daily living.

The SOSAS survey used ineach country was similar. Changes included an addition of a visual physical examination in the Nepal survey,[13] and minor changes to the structure of some

sections in the Uganda survey. These updates have previously been reported in detail. [12] The surveys were translated to local languages and pilot tested prior to use. Additional details of these surveys and their methodology have been described elsewhere[12-15].

Data analysis

For this study, data from all four individual surveys were aggregated and analyzed. We documented information on household and respondent demographics, injuries, injury characteristics, anatomic location of injuries, health seeking behavior, disability, and major disability from injuries. Descriptive analyses were performed and proportions with standard errors were calculated. Comparisons were made between each of the countries using the chi square test. Major disability was defined as the patient not being able to work, in need of help with transportation or in need of help with daily living as a result of the injury. We performed multivariable logistic regression analysis to determine independent risk factors for sustaining an RTI. A separate multivariable model was performed to test for associations with suffering a major disability after an RTI. Age, gender and rural/urban location were included as covariates in each model. The work has been reported in line with the STROCSS criteria.[18]

Results

Information from a total of 13,765 respondents from 7,115 households in four low-middle income countries was analyzed. Table 1 provides a breakdown of these numbers by country along with the proportions of people injured. A total of 17.2% (16.6 - 17.8) people suffered an injury. Road traffic injuries (RTIs) occurred in 305 [2.2% (1.95-2.45)] respondents. RTIs accounted for 12.9% (11.5-14.2) of all injuries overall. However, this proportion was as low as 7.2% in Rwanda and as high as 28.7% in Uganda. The incidence of RTI ranged from

190/100,000 population in Nepal to 740/100,000 population in Sierra Leone for the year of the survey (table 1).

The mean age of those affected by an RTI was 33.8 years (± 1.02) and 74% were males (table 2). The mechanism of injury varied among the four countries (Figure 1) with motorcycle injuries being the leading type of RTI in Nepal (50%), Sierra Leone (45%), and Uganda (53%), while pedestrian struck injuries were the most common in Rwanda ($p<0.001$). The most commonly injured body regions were the head/face/neck (36.5%) followed by extremity fractures (32.2%) (Table 2). Upon multivariable analysis respondents between the ages of 15 and 45 years were 2.3 times more likely to sustain an RTI than other age groups (OR= 2.33, 95% CI = 1.76 -2.83). Males were also, independently, 3.4 times more likely to suffer an RTI than females (OR=3.41 95% CI = 2.63-4.43). Rural/urban location was not an independent risk factor (OR= 1.13, 95% CI = 0.88-.1.46)

A majority of respondents sought healthcare (78%) after the RTI, and 14.8% underwent a major procedure (Table 2). Health seeking behavior was highest in Nepal (90%) and Uganda (85%). For those that did not seek healthcare, the top reasons were “no money for healthcare” (62.2%) and “no money for transportation (35.2%). Unfortunately, disability was high following RTIs (Table 2). Major disability which included not able to work, needing help with transport and needing help with daily living occurred in a total of 38.5% (33.0-43.9) of people (Figure 2). Upon multivariable analysis respondents at extremes of ages (<15 years and >45 years) were more likely to suffer a major disability after an RTI than those between the ages of 15 and 45 years (OR = 3.70, 95% CI = 2.23-6.01). Gender and urban/location were not significantly associated with an increased likelihood of major disability (gender OR=0.85, 95% CI= 0.49-1.48; urban/rural OR=0.63, 95% CI= 0.36-1.10)

Discussion

Among the four low income countries, an RTI was reported by 1.8% to 2.6% of the population. These accounted for about 12.9% of all injuries. Disability was high, and 38.5% of those suffering an RTI reported a major disability as a result of the injury. Patterns of injury varied between countries, however, head and extremity injuries remained the most common.

The incidence of RTIs is not well documented in the literature. Most epidemiologic data concerning RTIs pertains to fatalities after motor crashes.[5,9] It is estimated that for every road traffic fatality there are at least 20 non-fatal injuries.[19] Collecting data on non-fatal road injuries is extremely challenging especially in LMICs. Registry based estimates from Africa demonstrate a wide range of road traffic injury rates, from 2.9 per 100,000 population to 717 per 100,000 population.[20] Data are often collected from police records, however, these records under-report the true burden. An emergency room based surveillance in a large metropolis in Pakistan demonstrated that only 2-3% of non-fatal injuries are reported in police records .[21] More accurate estimates can be collected from national surveillance systems or survey data which are often resource intensive [22]. Only 46% of middle and 24% of low income countries have a national injury surveillance system in place. [5] The SOSAS surveys used local personnel and organizational support to perform nationally representative surveys at very low costs in these low-income countries. Such surveys should be repeated in other countries to provide more accurate estimates of the true burden of RTIs.

Data from high and LMICs consistently report a predominance of males and the younger population being affected by RTIs. [1,23,24] Not surprisingly, our study demonstrated similar findings. The mean age was 34 years and 74% of the population who had suffered a RTI was male. This disparity was consistent across all four low income countries. The economic consequences of the loss of productivity of young males is immense and the estimated cost

burden of RTIs and its consequences in LMICs are over $10 billion a year. [25] RTIs in low income countries account for a 1-3% loss of GDP. [5] There are also rippling economic losses for the victims' families and communities that are often not measured nor reported.[10]

In this study between one fifth and one half of patients suffering an RTI reported major disability. The most common being an inability to work - compounding the economic consequences of RTIs. In comparison in a longitudinal study in the United States work limiting long term disability occurred in 6.9% of crash victims.[26] Injuries after a motor vehicle crash (MVC) can range from minor cuts and bruises to those severe enough to cause permanent disability. Some can be treated immediately and with basic medical care, while others require intensive care or even longitudinal care with treatment and rehabilitation spanning several months and multiple procedures. In the present study injuries were most commonly to the extremities and the head/face region. These injuries are more likely to be serious and more likely to cause disability if not promptly treated.[27] Adequate and immediate post injury care can not only save lives but also prevent disability.[28] In our study between 65% and 90% of people sought some kind of healthcare, and a major procedure was performed in only 15% of patients. A survey on RTIs in Ghana demonstrated only 31% of fatal and 58% of non-fatally injured patients received formal healthcare.[29] While only 27% of injured patients used hospital services,barriers to obtaining surgical healthcare in LMICs are multifactorial and include financial as well as cultural and structural difficulties. [30,31] In our study the most common reason was lack of money for transportation and for medical care highlighting both affordability and accessibility as major issues.

The disability rate in the study population is high also in part due to the high proportion of pedestrian and motorcyclists injured. These populations are at the highest risk for disability[2,32]. Literature on RTIs in low income countries often shows a disproportionately higher rate of pedestrians and motorcyclists[5,33]. In a systematic review of pedestrians accounted for up to 75%

of all road fatalities[23]. Since most of the road users in low income countries are composed of pedestrians, cyclists and motorcyclists, targeted policy and safety legislation must be performed. There were slight variations in the composition of RTIs by road user group, for example the disproportionately higher number of pedestrian stuck injuries in Rwanda. This highlights the need to collect and rely on locally generated data to derive policy and road traffic safety.

Urgent intervention is required to address this high incidence of RTIs and the resultant disability. In an effort to curtail this enormous burden in March 2010 the Wordl Health Organization proclaimed 2011 to 2020 the “Decade of Action for Road Safety” with intentions to focus research and intervention towards decreasing RTIs. The issue is multifactorial and safer vehicles, safer roads, and targeted policy and legislation are required to prevent the growing burden of RTIs. [10] Infrastructure to provide post injury care must also be developed. Better ambulance systems, trained personnel and access to urgent medical facilities are required. Between 2007 and 2010 several countries were able to decrease the number of road traffic deaths, however most of these were high income countries. Unfortunately, in a substantial proportion of LMICs the burden of RTIs is still increasing[5] While research from LMICs on cost effective interventions to reduce RTI is limited, successful interventions include increasing awareness and legislation pertaining to the use of helmets and seat belts as well traffic calming strategies such as speed bumps, road deviations and rumble strips[34-36]. Simple speed reducing strategies on a main highway in Ghana decreased crashed by 35% and fatalities by 55%.[37] Ministries of health in coordination with injury prevention and road safety programs should identify high crash sites and employ these low cost interventions. Health policy researchers should use data such as presented here to help inform national policy.

There are important limitations to this study that should be taken into consideration. The SOSAS tool by design is meant to be self-reported and hence the accuracy of responses cannot be

guaranteed without validation by physical examination, diagnostics or medical record checks. Such validation would have proven costly and not feasible in most circumstances. Another limitation is that of recall bias. All other injury related questions used in this study pertained to presence of the condition at the time of the survey and hence are likely not affected by recall bias. However, questions pertaining to health seeking relied on recall and may not be accurate. We also did not measure nor calculate case fatality rates, as we do not have accurate death data or a denominator value for the number of road traffic events that occurred. We are also limited in our ability to identify risk factors for suffering an RTI or a major disability. Variables such as daily commute, road conditions, severity of injury, household income etcetera were not available however, determining all risk factors was the aim of this study. Additionally, inaccuracies in translation may have occurred. Even though the instrument was translated and piloted, many dialects are spoken in different regions of the country and some information error may have occurred. We did try to limit these errors by having interviewers from the local population wherever possible.

Conclusions

Disabilities resulting from road traffic injuries pose a significant burden in LMICs and disproportionately affect younger men and hence threaten economic productivity. The epidemiology of RTIs vary between LMICs, highlighting the need for local data. Using nationally representative survey data we report the rate of RTIs in four low income countries and a measure of the resultant disability. Prevention initiatives are urgently needed to stem this growing burden of disease. Additionally, access to timely emergency, trauma and surgical care may help alleviate the burden for RTI in LICs.

None of the authors have any conflicts of interest

No funding was received for this study

References

1. Lozano R, Naghavi M, Foreman K, et al. 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. *Lancet.* Dec 15 2012;380(9859):2095-2128.
2. Global status report on road safety 2015. Geneva: World Health Organization; 2015. http://www.who.int/healthinfo/global_burden_disease/en/. Accessed Dec 20, 2017.
3. Mathers CD, Loncar D. *Updated projections of global mortality and burden of disease, 2002-2030: data sources, methods and results.* 2005.
4. Murray CJ, Vos T, Lozano R, 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.* Dec 15 2012;380(9859):2197-2223.
5. *World Health Organization. Violence and Injury Prevention. Global status report on road safety 2013: supporting a decade of action.* Geneva, 2013.
6. Nantulya VM, Reich MR. The neglected epidemic: road traffic injuries in developing countries. *Bmj.* May 11 2002;324(7346):1139-1141.
7. WHO. *World Health Organization, World Report on Disability.* Geneva2011.
8. WHO. *World Health Organization, Injuries and Violence: The Facts.* Geneva2010.
9. Borse NN, Hyder AA. Call for more research on injury from the developing world: results of a bibliometric analysis. *The Indian journal of medical research.* Mar 2009;129(3):321-326.
10. Ameratunga S, Hijar M, Norton R. Road-traffic injuries: confronting disparities to address a global-health problem. *Lancet.* May 06 2006;367(9521):1533-1540.
11. Evaniew N, Godin K, Schemitsch EH, Bhandari M. Evidence gaps in the global decade of road traffic safety. *Journal of orthopaedic trauma.* 2014;28 Suppl 1:S15-17.

12. Fuller AT, Butler EK, Tran TM, et al. Surgeons OverSeas Assessment of Surgical Need (SOSAS) Uganda: Update for Household Survey. *World journal of surgery.* Dec 2015;39(12):2900-2907.

13. Gupta S, Shrestha S, Ranjit A, et al. Conditions, preventable deaths, procedures and validation of a countrywide survey of surgical care in Nepal. *The British journal of surgery.* May 2015;102(6):700-707.

14. Groen RS, Samai M, Stewart KA, et al. Untreated surgical conditions in Sierra Leone: a cluster randomised, cross-sectional, countrywide survey. *Lancet.* Sep 22 2012;380(9847):1082-1087.

15. Petroze RT, Groen RS, Niyonkuru F, et al. Estimating operative disease prevalence in a low-income country: results of a nationwide population survey in Rwanda. *Surgery.* Apr 2013;153(4):457-464.

16. Groen RS, Samai M, Petroze RT, et al. Pilot testing of a population-based surgical survey tool in Sierra Leone. *World journal of surgery.* Apr 2012;36(4):771-774.

17. McGee K, Sethi D, Peden M, Habibula S. Guidelines for conducting community surveys on injuries and violence. *Injury control and safety promotion.* Dec 2004;11(4):303-306.

18. Agha RA, Borrelli MR, Vella-Baldacchino M, Thavayogan R, Orgill DP, Group S. The STROCSS statement: Strengthening the Reporting of Cohort Studies in Surgery. *International journal of surgery.* Oct 2017;46:198-202.

19. WHO. *World report on road traffic injury prevention.* Geneva2004.

20. Adeloye D, Thompson JY, Akanbi MA, et al. The burden of road traffic crashes, injuries and deaths in Africa: a systematic review and meta-analysis. *Bulletin of the World Health Organization.* Jul 1 2016;94(7):510-521A.

21. Razzak JA, Shamim MS, Mehmood A, Hussain SA, Ali MS, Jooma R. A successful model of Road Traffic Injury surveillance in a developing country: process and lessons learnt. *BMC public health.* May 16 2012;12:357.

22. Kipsaina C, Ozanne-Smith J, Routley V. The WHO injury surveillance guidelines: a systematic review of the non-fatal guidelines' utilization, efficacy and effectiveness. *Public health.* Oct 2015;129(10):1406-1428.

23. Odero W, Garner P, Zwi A. Road traffic injuries in developing countries: a comprehensive review of epidemiological studies. *Tropical medicine & international health : TM & IH.* May 1997;2(5):445-460.

24. Nantulya VM, Reich MR. Equity dimensions of road traffic injuries in low- and middle-income countries. *Injury control and safety promotion.* Mar-Jun 2003;10(1-2):13-20.

25. Dalal K, Lin Z, Gifford M, Svanstrom L. Economics of global burden of road traffic injuries and their relationship with health system variables. *International journal of preventive medicine.* Dec 2013;4(12):1442-1450.

26. Waller JA, Skelly JM, Davis JH, Herreid TW. Characteristics, hospital charges, and effects of road transportation injuries in Vermont. *Accident; analysis and prevention.* Oct 1994;26(5):635-645.

27. Mishra B, Sinha Mishra ND, Sukhla S, Sinha A. Epidemiological study of road traffic accident cases from Western Nepal. *Indian journal of community medicine : official publication of Indian Association of Preventive & Social Medicine.* Jan 2010;35(1):115-121.

28. Sasser S VM, Kellermann A, Lormand JD. *Prehospital trauma care systems.* Geneva2005.

29. Mock CN, nii-Amon-Kotei D, Maier RV. Low utilization of formal medical services by injured persons in a developing nation: health service data underestimate the importance of trauma. *The Journal of trauma.* Mar 1997;42(3):504-511; discussion 511-503.

30. Grimes CE, Bowman KG, Dodgion CM, Lavy CB. Systematic review of barriers to surgical care in low-income and middle-income countries. *World journal of surgery.* May 2011;35(5):941-950.

31. Forrester JD, Forrester JA, Kamara TB, et al. Self-reported Determinants of Access to Surgical Care in 3 Developing Countries. *JAMA surgery.* Mar 2016;151(3):257-263.

32. Mayou R, Bryant B. Consequences of road traffic accidents for different types of road user. *Injury.* Mar 2003;34(3):197-202.

33. Naci H, Chisholm D, Baker TD. Distribution of road traffic deaths by road user group: a global comparison. *Injury prevention : journal of the International Society for Child and Adolescent Injury Prevention.* Feb 2009;15(1):55-59.

34. Banstola A, Mytton J. Cost-effectiveness of interventions to prevent road traffic injuries in low- and middle-income countries: A literature review. *Traffic injury prevention.* May 19 2017;18(4):357-362.

35. Staton C, Vissoci J, Gong E, et al. Road Traffic Injury Prevention Initiatives: A Systematic Review and Metasummary of Effectiveness in Low and Middle Income Countries. *PloS one.* 2016;11(1):e0144971.

36. Waters HR, Hyder AA, Phillips TL. Economic evaluation of interventions to reduce road traffic injuries--a review of the literature with applications to low and middle-income countries. *Asia-Pacific journal of public health.* 2004;16(1):23-31.

37. Afukaar FK. Speed control in developing countries: issues, challenges and opportunities in reducing road traffic injuries. *Injury control and safety promotion.* Mar-Jun 2003;10(1-2):77-81.

Tables and figures

Table 1: Proportion of non-fatal road traffic injuries at each of the 4 countries

	TOTAL	NEPAL	RWANDA	SIERRA LEONE	UGANDA
Number of households surveyed	7,115	1,350	1,620	1,842	2,303
Number of respondents	13,765	2,695	3,177	3,646	4,248
Injuries N(%)	2,368 (17.2)	343 (12.7)	809 (25.5)	867 (23.8)	349 (8.2)
Road traffic injuries (RTI) N(%)	305 (2.2)	71 (2.6)	58 (1.8)	75 (2.1)	100 (2.4)
RTI as % of total injuries	12.9%	20.7%	7.2%	8.7%	28.7%
Prevalence of RTI (PER 100,000 POPULATION)	2200	2600	1800	2100	2400
Incidence of RTI (PER 100,000 POPULATION/YR)	480	190	440	740	470

Table 2: Characteristics of road traffic injuries

	TOTAL (n=304)	**NEPAL** (n=71)	**RWANDA** (n=58)	**SIERRA LEONE** (n=75)	**UGANDA** (n=100)	P value
Age in years mean (SD)	33.8 (1.02)	32.97 (1.9)	32.24 (2.24)	35.71 (2.08)	33.98 (1.97)	<0.001
Male gender n (%)	226 (74.3)	56 (78.9%)	44 (75.9%)	55 (73.3%)	71 (71.0%)	0.692
Rural residence	217 (71.4)	44 (62.0)	52 (89.7)	38 (50.7)	83 (83)	<0.001
Body region affected						
Face/Head/Neck	111 (36.5)	16 (22.5)	20 (34.4)	31 (41.3)	44 (44.0)	<0.001
Chest	30 (9.9)	2 (2.8)	5 (8.6)	7 (9.3)	16 (16.0)	<0.001
Back	29 (9.5)	4 (5.6)	8 (13.8)	11 (14.7)	6 (6.0)	<0.001
Abdomen	35 (11.5)	2 (2.8)	10 (17.2)	17 (22.7)	6 (6.0)	<0.001
Groin/Buttocks	25 (8.2)	3 (4.2)	3 (5.2)	10 (13.3)	9 (9.0)	<0.001
Extremity fracture	98 (32.2)	37 (52.1)	9 (15.5)	30 (40.0)	22 (22.0)	<0.001
Health seeking behavior						
Healthcare Sought	237 (78.0)	64 (90.14%)	38 (65.52%)	49 (65.33%)	86 (85.0%)	<0.001
Minor procedure done	150 (49.3)	23 (32.4%)	27 (46.6%)	29 (37.3%)	72 (72%)	<0.001
Major procedure done	45 (14.8)	15 (21.13%)	6 (10.3%)	15(20.0%)	9(9.0%)	0.059
Disability						<0.001
Not disabling	164 (53.9)	53 (74.7)	37 (63.8)	29 (38.7)	45 (45)	
Feel ashamed	13 (4.3)	1 (1.4)	2 (3.5)	7 (9.3)	3 (3)	
Not able to work	99 (32.6)	11 (15.5)	16 (27.6)	33 (44.0)	39 (39)	
Need help with transport	5 (1.6)	1 (1.4)	2 (3.5)	0 (0)	2 (2)	
Need help with daily living	13 (4.3)	3 (4.2)	1 (1.7)	4 (5.3)	5 (5)	
Not answered	10 (3.3)	2 (2.8)	0 (0)	2 (2.7)	6 (6)	

Figure legends

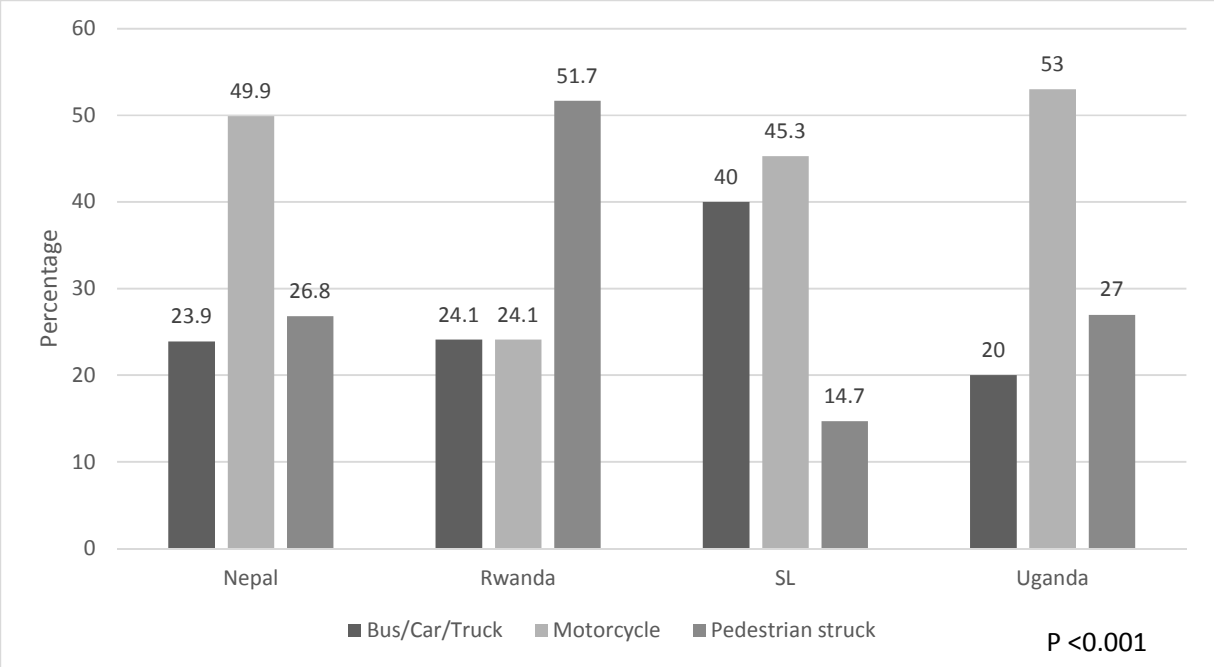
Figure 1: Type of non-fatal road traffic injury in each of the four countries, as a proportion of all road traffic injuries.

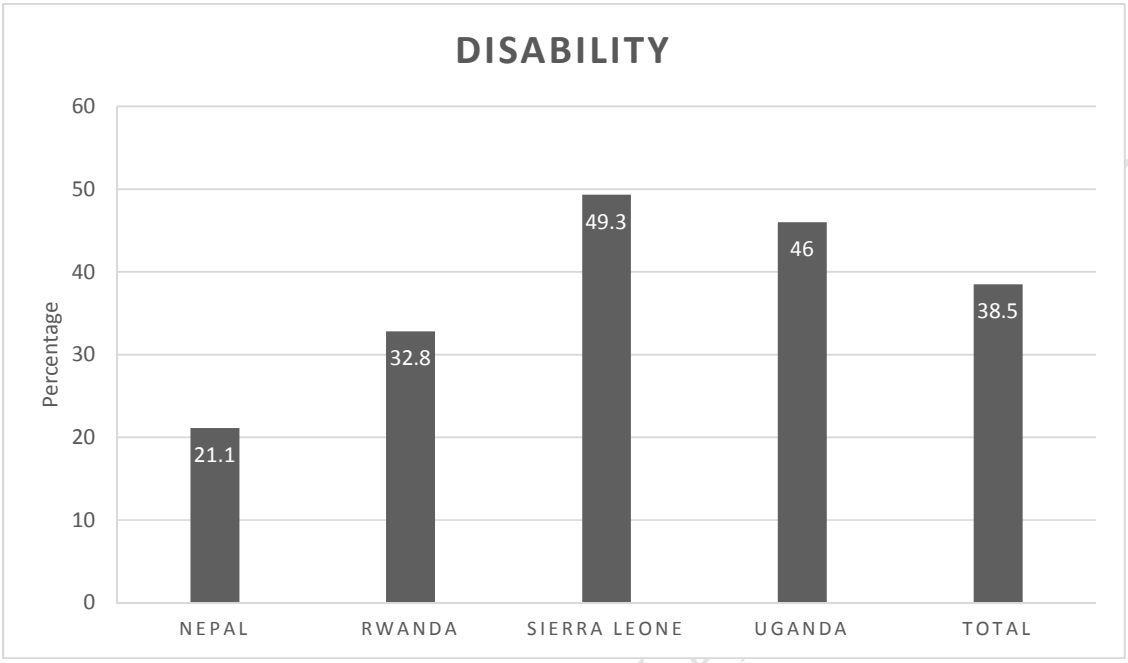
Figure 2: Major disability from road traffic injuries in each of the four countries, as a proportion of all road traffic injuries.

Supplementary Table 1: Country profile

COUNTRY	NEPAL	RWANDA	SIERRA LEONE	UGANDA	USA
Population	28.5 mil	11.6 mil	6.4 mil	39 mil	321.7 mil
GDP (millions of $)	70,091	18,901	9,966	79,884	18,562,129
Life Expectancy at birth (male/female)	68/71	61/71	49/51	60/64	77/82
Health expenditure ($) per capita	137	125	224	133	9,403
Health expenditure % of GDP	5.8	7.5	11.1	7.2	17.1
% living below 1.9 $/day	15%	60.25%	52.9%	33.2%	N/A
Violence (homicides per 100,000 people)	2.9	4.6	1.8	11.8	3.9
Vehicles per capita (per 1000 people)	5	9	6	8	797
% of motorized 2-3 wheelers (as a percent of all vehicles)	76%	44%	29%	-	3%

USA: United States of America, GNI: Gross national income, GDP: Gross domestic profit.
Data sources: World Health Organization country profiles.





Highlights

- Road traffic injury accounts for significant disability among low and middle income countries
- Motor cycle crashes account for the highest proportion of road traffic injury
- Road traffic injury epidemiology varies between low and middle income countries and local solutions need to be studied and sought.