

Contents lists available at ScienceDirect

International Journal of Surgery Open

journal homepage: www.elsevier.com/locate/ijso

Research Paper

The rise in road traffic injuries in Lilongwe, Malawi A snapshot of the growing epidemic of trauma in low income countries

Leonard Ngoie Banza^{a, b, f, *}, Jared Gallaher^d, Eva Dybvik^e, Anthony Charles^d, Geir Hallan^c,
Jan-Erik Gjertsen^{c, f}, Nyengo Mkandawire^{b, g}, Carlos Varela^{a, b, f}, Sven Young^{a, b, c}

^a Department of Surgery, Kamuzu Central Hospital, P.O. Box 149, Lilongwe, Malawi

^b Department of Surgery, College of Medicine, University of Malawi, Blantyre, Malawi

^c Department of Orthopaedic Surgery, Haukeland University Hospital, 5021 Bergen, Norway

^d Department of Surgery, University of North Carolina, Chapel Hill, NC, USA

^e The Norwegian Arthroplasty Registry, Haukeland University Hospital, Bergen, Norway

^f Institute of Clinical Studies (K1), University of Bergen, Bergen, Norway

^g School of Medicine, Flinders University, Adelaide, Australia

ARTICLE INFO

Article history:

Received 27 July 2017

Received in revised form

16 November 2017

Accepted 19 November 2017

Available online 7 December 2017

Keywords:

Road traffic injuries

Low income countries

Scaling up trauma system

Increasing burden of injuries

ABSTRACT

Introduction: Road traffic injuries (RTIs) and death are a major public health issue worldwide. Unless appropriate action is taken urgently, the burden of RTIs will continue to increase globally. This will be particularly pronounced in developing countries where rapid motorization is likely to continue over the next decades. Malawi is one of these countries with a population of 17.2 million and a Gross National Income per capita of 340 US\$. The impact of the rising burden of injury on the health sector is considerable. However, data to demonstrate this development is lacking.

Methods: This study is an analysis of data from the Kamuzu Central Hospital (KCH) Trauma Registry. KCH is a 900-bed tertiary care public hospital in Lilongwe, the capital city of Malawi. The KCH Trauma Registry was established to collect patient demographic information, clinical characteristics, and outcome data for all patients presenting to the emergency department with injuries. All patients who presented to the emergency department with injuries between January 2009 and December 2015 were included in the study.

Results: A 96,967 patients with injuries between 2009 and 2015 were registered in the KCH Trauma Registry. The mean age of these patients was 23.3 years and 36.8% were children younger than 18 years. 25,193 (26.2%) patients had road traffic related injuries, of these 19,244 (76.4%) were men. There was a 62.4% rise in the number of RTI victims treated at KCH from 2447 in 2009–3975 in 2015. If this trend continues, 7997 patients will be expected to need treatment for RTIs at KCH in 2030, doubling the numbers seen in 2015 in just 15 years. The highest number of injuries occurred in pedestrians (32.3%) and cyclists (28.2%) and continually rose over the years studied. The length of hospital stay for RTIs increased from 6.4 ± 9.1 days in 2009 to 15.0 ± 19.4 in 2015.

Discussion: There was a rapidly growing burden of RTIs at KCH in Lilongwe, Malawi, between 2009 and 2015, and projections based on our data show that this burden will double by 2030. It is essential that surgical trauma services are scaled up to meet this challenge in Malawi. There is also a large potential for prevention of injuries involving vulnerable road users. Road traffic campaigns should focus on improved driver training, use of lights, pedestrian and cyclist visibility, and vehicle fitness. Standards should include physical separation of pedestrians and vehicles, through raised pavements or separate walk and cycle ways. The absence of a clear strategy to meet the growing epidemic of injuries in Malawi will come at a huge cost to an already strained economy, and the largest portion of the burden of injury will continue to be borne by the poorest segment of the population.

© 2017 The Authors. Published by Elsevier Ltd on behalf of Surgical Associates Ltd. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

* Corresponding author. Department of Surgery, Kamuzu Central Hospital, P.O. Box 149, Lilongwe, Malawi.

E-mail address: leonardbanza2014@gmail.com (L.N. Banza).

1. Introduction

Each year 5.1 million people worldwide die from injuries. 1.25 million of these deaths are due to road traffic accidents [16] and ninety percent occur in developing countries [2,4]. More people die from road traffic injuries than from Malaria; and more people die from injuries than those that die from malaria, HIV/AIDS and tuberculosis combined [11]. This, however, is just the tip of the iceberg. It is estimated that for every death, there is at least 20 more people that survive with injuries that need treatment [11]. Worldwide over 50 million people are injured annually in road traffic crashes alone.

Africa has the highest rate of road traffic injuries (RTIs) in the world [16], despite being the least motorized of the world's 6 regions with only 2% of the world's registered vehicles. The incidence of RTI death in the WHO African Region as a whole, is estimated to be 24.1/100,000 population year [12]. This stands in stark contrast to the rate in several developed countries such as the US (10.6/100,000) and the UK (2.9/100,000) [13]. The majority of the people killed on Africa's roads are young adults, often the breadwinners of family. 62% are aged between 15 and 44 years and 3 out of 4 deaths are of males. According to the World Bank it is estimated that malaria reduces GDP growth by approximately 1.3% per year in some African countries [17], whereas road traffic accidents and their consequences are estimated to cost African governments between 0.8% and 9% of their GDP [12].

Road Traffic Injury trends observed in high-income countries have shown a rapid reduction over the last three to four decades, while a substantial increase has been reported from a number of developing countries [11]. The problem may grow further in the coming decades due to the rapid rise in vehicle ownership associated with economic growth in developing countries [1]. Globally the burden of RTIs is growing rapidly and the WHO predicts RTIs will be the fifth most frequent cause of death worldwide by 2030 [15].

Malawi is a low-income country with a per-capita gross national income of only 340 US\$ [18], but it is experiencing economic growth and a rapidly rising number of motor vehicles on the roads. The estimated rate of road traffic deaths in the country is 35 per 100,000 people per year [16], the second highest in the world, with an estimated economic impact up to 5% of GDP [7]. There have been only limited injury prevention efforts to help attenuate the rising morbidity and mortality due to road traffic injury in Malawi.

The WHO projects road traffic injury to continue to rise towards 2030 [16]. However, there is a paucity of data to verify this projected trend. At Kamuzu Central Hospital (KCH) in Lilongwe, Malawi, we established a trauma surveillance registry in 2008, which captures all trauma patients presenting to the emergency department [14]. Despite subjectively experiencing an overwhelming increase in the burden of trauma at the hospital, no local research has shown this trend over time. We therefore sought to use available data in the KCH Trauma Registry to assess rising annual numbers and model future projections for the rise in RTIs in Malawi.

2. Methods

This study is an analysis of prospectively collected data from the KCH Trauma Registry. KCH is a 900-bed tertiary care public hospital in Lilongwe the capital city, which serves as a referral center for approximately 6 million people in the central region of Malawi. The KCH Trauma Registry was established in 2008 to collect patient demographic information, clinical characteristics, and outcome data of all patients presenting to the emergency department with traumatic injuries. Data is recorded on an intake form and transferred to an electronic database. All patients who presented to the emergency department with injuries between January 2009 and December 2015 were included in this study.

Mortality related to RTIs was defined as in-hospital mortality. The definition of a patient with a RTI in the KCH Trauma Registry was any driver, passenger, pedestrian, motor cyclist or pedal cyclist injured in a vehicle-related incident on a roadway.

2.1. Statistics

Continuous variables are presented as mean values with standard deviations (SD). Linear regression curve estimations were calculated using IBM SPSS Statistics version 22 (IBM Corporation, New York, USA). Fig. 1 as made using the statistical package R version 3.0.2 (<http://www.R-project.org>). All other statistical analysis was performed using Stata SE 13.1 (Stata- Corp LP, College Station, TX). The level of statistical significance was set at 5%. The University of North Carolina Institutional Review Board (approval # 11–0373) and the Malawi National Health Sciences Research Committee approved this study (approval # 813).

3. Results

From 2009 to 2015 Kamuzu Central Hospital (KCH) registered a total of 96,967 patients with injuries (72% male) in the KCH Trauma Registry (Table 1). The mean age of these trauma patients was 23.3 years (SD 16) and 37% were younger than 18 years. Males had a mean age of 24.2 years (SD 15.2) whereas mean age for females was 20.8 years (SD 17) $p < 0.001$. 25,193 (26.2%) patients had road traffic related injuries with 19,244 (76.4%) being men. The mean age for RTI victims was 28.6 years (SD 14.9), 29.5 years (SD 15) for men compared to 26.0 years (SD 16) for females ($p < 0.001$).

3.1. Number of RTIs by year

The total number of injuries treated at KCH rose by 62% from 2447 in 2009 to 3975 in 2015. The red dots (Fig. 1) represent the observed number of RTI victims treated over the last 7 years. The linear regression line shows the projected increase in RTIs over the coming years towards 2030 and the shaded area marks the 95% confidence bands of the regression line. A significant regression equation showing this increasing trend was found ($F(1,5) = 16.957$, $p = 0.009$), with a R^2 of 0.772. If this trend continues, 7997 patients will be expected to need treatment after RTIs at KCH in 2030.

3.2. Mechanism of injury

Curves representing the annual number of road traffic injuries treated at KCH according to mechanism of injury are shown in Fig. 2. Injuries in all categories of RTI mechanisms increased in the study period, except injuries to drivers of private cars, which actually declined by 36% from 796 in 2009 to 507 in 2015. The highest number of RTIs occurred in pedestrians ($n = 8,141$, 32%) and cyclists ($n = 7,100$, 28%). 79% of pedestrian and cyclist RTI victims were males.

3.3. Length of hospital stay

The mean length of hospital stay (LOS) for RTI victims was plotted year by year (Fig. 3). The LOS rose by 134% from 6.4 (SD 9.1) days in 2009 to 15.0 (SD 19.4) days in 2015. A significant linear regression equation confirmed the apparent increase ($F(1,5) = 11.215$, $p = 0.020$, R^2 of 0.692).

4. Discussion

In this study we found that there was a large and rapidly growing number of RTI victims treated at Kamuzu Central Hospital

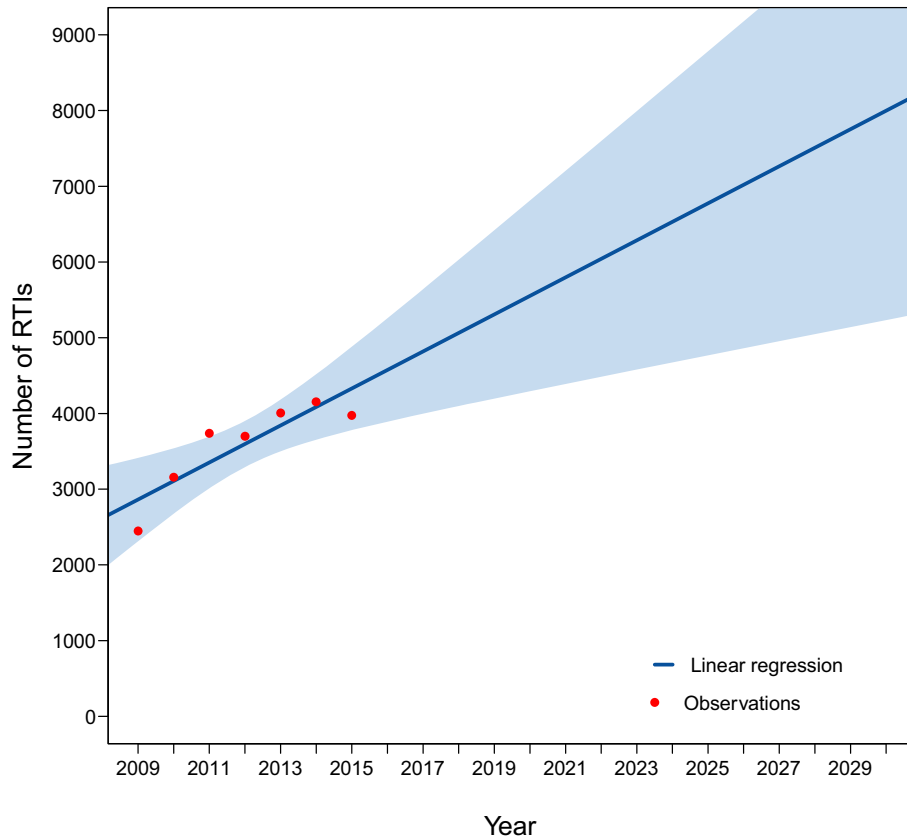


Fig. 1. The observed and projected increase in RTIs at KCH. The red dots represent the observed number of RTIs at KCH over the last 7 years. The linear regression line (dark blue) shows the projected increase in RTIs over the coming years towards 2030. The shaded area marks the 95% confidence bands of the regression line (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article).

Table 1
RTIs in KCH Trauma Database 2009 to 2015.

	Patients, n (%)	Male, n (%)	Mean Age years (SD)	Age under 18 n (%)	Admissions n (%)	Mean LOS days (SD)	Mortality, n (%)
Total no. injuries	96,967 (100)	69,901 (72.1)	23.3 (15.7)	35,638 (36.8)	16,192 (16.7)	13.3 (18.5)	1797 (1.9)
Non RTI	70,975 (73.8)	50,060 (70.5)	21.3 (15.6)	30,378 (42.8)	10,445 (14.7)	13.1 (17.6)	927 (1.3)
Road traffic injuries	25,193 (26.2)	19,244 (76.4)	28.6 (14.9)	5050 (20.1)	5638 (22.4)	13.7 (19.6)	838 (3.3)
Pedestrian	8141 (32.3)	5948 (73.1)	25.0 (16.2)	2677 (32.9)	1864 (23.0)	15.5 (22.8)	413 (5.1)
Cyclist	7100 (28.2)	6081 (85.7)	29.9 (15.8)	1376 (19.4)	1418 (20.1)	13.4 (22.8)	142 (2.0)
Driver or passenger in car	4574 (18.2)	3227 (70.6)	29.9 (12.0)	466 (10.2)	1013 (22.3)	10.9 (14.8)	132 (2.9)
Passenger on truck/lorry bed	1464 (5.8)	1033 (63.1)	31.5 (13.1)	146 (10.0)	388 (26.5)	12.7 (18.6)	53 (3.6)
Driver or passenger in minibus	1638 (6.5)	1033 (63.1)	30.9 (13.3)	166 (10.1)	329 (20.1)	14.0 (17.9)	39 (2.4)
Motorcycle	907 (3.6)	816 (90.0)	33.9 (11.4)	37 (4.1)	259 (28.6)	14.2 (18.3)	29 (3.2)
Other RTI	1369 (5.4)	1112 (81.2)	30.2 (12.3)	182 (13.3)	367 (27.2)	13.1 (16.6)	30 (2.2)

from 2009 to 2015 and a projected new doubling of the burden of RTIs at KCH over the next 15 years. This is bound to have a devastating impact on a country with one of the lowest gross national incomes per capita in the World, at only 340 US\$ [18].

A national trauma surveillance data registry in Malawi is in progress. However, according to the WHO Global Status reports on road safety (2009, 2013 & 2015) there were 130,000 vehicles registered in Malawi in 2007, 173,800 in 2011 and 437,416 in June 2014. This exponential growth of the number of vehicles in the country can likely explain much of the rise in road traffic injuries. The Malawi health system cannot currently support the overall burden of disease and this is further compounded by the increasing burden of trauma [8,14]. There is a severe lack of infrastructure and equipment as well as shortage of human resources and drugs. Between 2009 and 2015 Kamuzu Central Hospital had the same number of beds, staff, theatre and theatre sessions. The average total annual hospital budget has fluctuated between USD 680,164

and USD 790,131. The budget allocated to Surgery/Trauma has never been enough to cover the needs (e.g. orthopaedic hardware like exfix). If we look ahead over the next decade, a rapid scale up of surgical trauma services will be needed to meet the increasing burden of RTIs in Malawi. With the rapid growth in the number of motor vehicles, serious measures for improvement of road safety will also need to be implemented.

Our study shows signs that the Malawian health system was not able to keep up with the rise in trauma. The fact that the length of hospital stay for RTI victims rose by 134% in 7 years can be explained in several ways. Previously most patients at KCH that had a severe open fracture of the lower extremity ended up with an amputation. With modern orthopaedic surgery these patients rarely need this extreme measure [19], but with limited access to operating theatres, increased length of hospital stay is inevitable. Additionally, with increased emphasis on limb saving surgery, many other injury types that meet operative intervention criteria

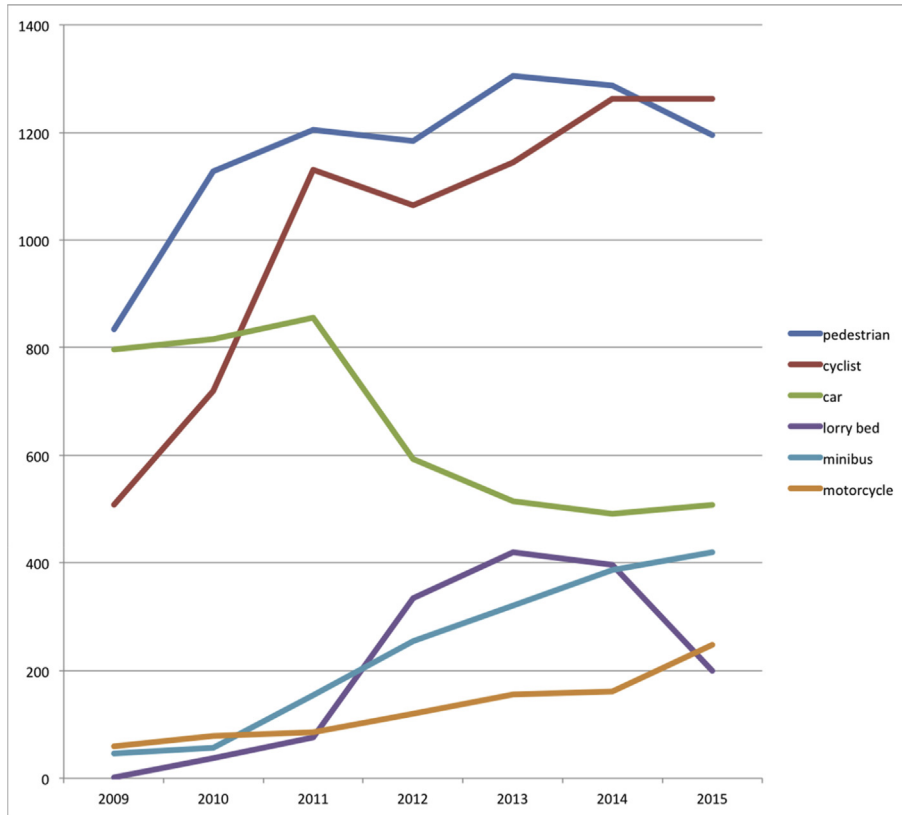


Fig. 2. The different mechanisms of injury's contribution to the rise in RTI victims. While pedestrians and cyclists were increasingly being injured, the frequency of drivers of private cars getting injured decreased from 2009 to 2015.

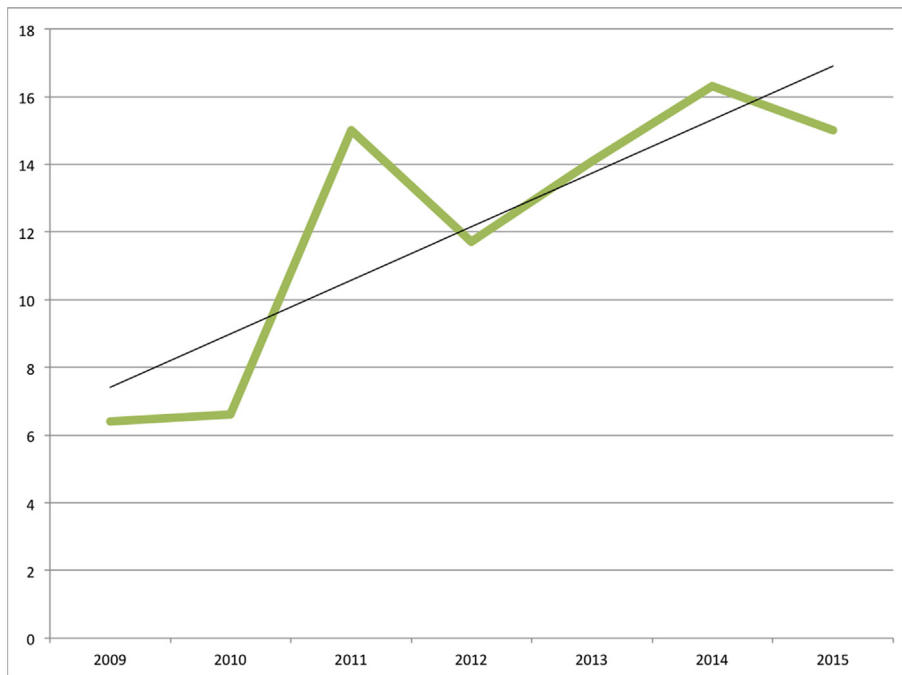


Fig. 3. Length of Hospital Stay. Mean length of hospital stay (LOS) for all RTI victims at KCH plotted year by year. The straight line is the linear regression line.

are delayed or deferred. Fractures of the femur, for example, have increasingly needed to be treated non-operatively with skeletal traction at KCH, leading to very long hospital stays for these patients [20]. Other patients with non-unions after poorly treated

fractures wait for weeks, sometimes months, in the ward before receiving necessary surgery for the same reasons.

According to our findings nearly two thirds of RTI victims in Lilongwe, Malawi were vulnerable road users. Cyclists and

pedestrians were the most frequent victims of RTI. This suggests that road traffic trauma is a growing epidemic mostly of a particular segment of the population. In fact, we found a decreasing number of patients who were drivers of private cars. This probably reflects a relatively new pool of cars with good safety features for the drivers. Also, most of the cars are used in towns where speeds generally are not high enough to cause serious injury to the driver, but are more than sufficient to injure vulnerable road users. Our findings showing that a large proportion of the road crash victims were pedestrians or cyclists support the findings in the WHO “World report on road traffic injury prevention” [16]. Vulnerable road users benefit the least from policies designed for motorized travel, but bear a disproportionate share of the perils of motorization in terms of injury.

Malawi has an annual total health expenditure per capita of only 29 US\$, the lowest in the world (World bank 2015), and 85% of the population depend on subsistence farming. More than half the population lives below the poverty line [3]. Estimates for most LMICs (with a GNI per capita of more than \$ 1045 but less than \$ 12,736; [17]) suggest that 10–15% of RTA victims end up with a permanent disability of some kind [16]. Our results showed that most of the RTA victims were male (72%). With men often being the breadwinners in many families in Malawi, This has a negative impact on the whole household of the patient resulting in the financial vulnerability of the patients and their respective families and predisposition to extreme poverty [6,9].

According to our findings more than one third (37%) of the total number of patients with injuries were under 18 years and of these 20% were related to RTIs. This again increases the negative impact on the entire community and future generations, as most of the victims are still young and productive members of the society.

For the necessary scale up of trauma services in Malawi to be possible, long-term planning and build up of surgical training centers are essential. Surgery as a field has been neglected for too long in the global public health discussion. However, there is clear evidence emerging that surgery is as cost-effective as many well-funded interventions for communicable diseases and maternal health [5]. The Lancet Commission on global surgery actually found that it would cost more *not* to invest in surgery than to scale up surgery in Low and Middle Income Countries over the coming years [10]. Building up and supporting surgical training centers can be a cost-effective and sustainable way to scale up to meet the increasing burden of injuries [8,19].

Prevention is an important component of public health efforts and for RTIs there is a huge potential for reduction in crashes involving vulnerable road users. Unfortunately, many road traffic campaigns were developed in high-income countries and sent to LIC without changing context or catering to the local environment and audience. In Malawi, much of the focus on prevention is on car drivers (speed reduction, use of seat belts etc.). Our data, however, suggests that preventive focus should be on the vulnerable road users. Information should focus on improved driver training, use of lights, pedestrian and cyclist visibility, and wearing of reflectors at night, and vehicle fitness. Foreign contractors build many of the Malawian roads in Malawi with foreign aid. The Malawian government should insist on road design and standards that protect vulnerable road users. Standards should include physical separation of pedestrians and vehicles, through raised pavements or separate walk and cycle ways in towns.

The limitations of this study are those inherent to any registry study including missing or unrecorded data. In addition, though all patients that arrived at the casualty department at KCH were registered in the trauma registry, some patients were missed. Patients that did not present at all due to minor injury, or patients that presented to other health care facilities or could not afford to

attend the hospital were not captured in the registry, exposing the database to presentation bias. Most patients with an isolated fracture of a limb that did not require hospitalization were treated in the orthopaedic outpatient department (OPD) and were not registered in the KCH trauma database. More than 13,000 patients are seen in OPD every year, so the number of missed patients could be quite large. However, the available data leaves little doubt about the increasing epidemic of RTIs in Malawi.

5. Conclusion

This study demonstrated a rapidly growing burden of Road Traffic Injuries at KCH in Lilongwe, Malawi, from 2009 to 2015. Linear regression projections based on our data demonstrate that the burden of RTIs at KCH could double again by 2030. More than 60% of this burden of injury and disability is borne by vulnerable road users. A national strategy to scale up trauma care is imperative. With investment in trauma centers and established surgical training programs, this challenge can be met in a timely, cost-effective and sustainable manner.

Ethical approval

The University of North Carolina Institutional Review Board (approval # 11-0373) and the Malawi National Health Sciences Research Committee approved this study (approval # 813).

Funding

We did not have any sources of funding for this research.

Author contribution

As stated in my comments, all co-authors have contributed in both editing and writing of this article.

Conflict of interest

There is no conflict of interest for this article.

Guarantor

All 9 people have accepted full responsibility for the work and the conduct of the study.

Research registration number

We did not register this study.

References

- [1] Abegaz Teferi, Berhane Yemane, Worku Alemayehu, Assrat Abebe. Effectiveness of an improved road safety policy in Ethiopia: an interrupted time series study. *BMC Publ Health* 2014;14. <https://doi.org/10.1186/1471-2458-14-539>.
- [2] Beveridge M, Howard A. The burden of orthopaedic disease in developing countries. *J Bone Jt Surg Am* 2004;86-A:1819–22. 86/8/1819.
- [3] Ferreira F, Jolliffe DM, Prydz EB. The international poverty line. *World Bank*; 2015.
- [4] Gosselin RA, Spiegel DA, Coughlin R, Zirkle LG. Injuries: the neglected burden in developing countries. *Bull World Health Organ* 2009;87: 246–246a. DOI S0042-96862009000400002.
- [5] Grimes Caris E, Henry Jaymie Ang, Maraka Jane, Mkandawire Nyengo C, Cotton Michael. Cost-effectiveness of surgery in low- and middle-income countries: systematic Review. *World J Surg* 2014. <https://doi.org/10.1007/s00268-013-2243-y>.
- [6] Haug L, Wazakili M, Young S, Van den Bergh G. Longstanding pain and social strain: patients ‘and health care providers’ experiences with fracture

- management by skeletal traction; a qualitative study from Malawi. *Disabil Rehabil* 2017;39(17):1714–21.
- [7] Jacobs G, Aeron-Thomas A, Astrop A. Estimating global road fatalities. Crowthorne: Transport Research Laboratory; 2000 (TRL Report 445).
- [8] Kendig Claire, Tyson Anna, Young Sven, et al. "The effect of a new surgery residency program on case volume and case complexity in a Sub-Saharan African Hospital". *J Surg Educ* 2015 Jul-Aug;72(4):e94–9. <https://doi.org/10.1016/j.jsurg.2014.09.011>.
- [9] Kohler RE, Tomlinson J, Chilunjika TE, Young S, Hosseinipour M, Lee CN. "Life is at a standstill" Quality of life after lower extremity trauma in Malawi. *Qual Life Res* 2017 Apr;26(4):1027–35. <https://doi.org/10.1007/s11136-016-1431-2>.
- [10] Meara JG, Leather AJM, Hagander L, Alkire BC, Alonso N, Ameh EA, et al. Global Surgery 2030: evidence and solutions for achieving health, welfare, and economic development. *Lancet* 2015;386(9993):569–624.
- [11] Patton GC, Coffey C, Sawyer SM, Viner RM, Haller DM, Bose K, et al. Global patterns of mortality in young people: a systematic analysis of population health data. *Lancet* 2009;374(9693):881–92.
- [12] Peden M, Kobusingye O, Monono ME. Africa's roads: the deadliest in the world. *South Afr Med J* 2013;103(4):228–9. <https://doi.org/10.7196/SAMJ.6866>.
- [13] Peden M. World report on road traffic injury prevention. Geneva: World Health Organization; 2004.
- [14] Samuel JC, Akinkuotu A, Villaveces A, Charles AG, Lee CN, Hoffman IF, et al. Epidemiology of injuries at a tertiary care center in Malawi. *World J Surg* 2009;33(9):1836–41.
- [15] WHO. Global status report on road safety: time for action. Geneva: World Health Organization; 2009.
- [16] WHO. Global status report on road safety 2015. Geneva: World Health Organization; 2015.
- [17] World bank (2015) <http://www.worldbank.org/en/topic/health/brief/malaria>.
- [18] World bank. Gross Income per Capita ranking. Atlas Method and Purchasing Power and Parity; 2016.
- [19] Young S, Banza L, Mkandawire N. The impact of long term institutional collaboration in surgical training on trauma care in Malawi. SpringerPlus 2016;5(1):1–5.
- [20] Young S, Banza LN, Munthali BS, Manda KG, Gallaher J, Charles A. "The impact of the increasing burden of trauma in Malawi on orthopaedic trauma service priorities at Kamuzu Central Hospital". *Acta Orthop* 2016 Dec;87(6):632–6.