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Preventing Road Traffic Incidents in Low- and Middle-Income Countries

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Preventing Road Traffic Incidents in Low- and Middle-Income Countries

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Introduction

Globally, approximately 1.35 million people die each year due to road traffic injuries (RTIs), with millions more suffering from serious injuries and living with long-term adverse health consequences.[1,2] RTIs are the leading cause of preventable death, yet they continue to be the number one cause of death among those aged between 5 and 29 years of age.[3] Even more, motor vehicles crashes are the number one killer of healthy United States citizens in foreign countries.[4]

Low-to middle-income countries (LMICs) bear a disproportionate burden of these deaths. Ninety percent of global road traffic related-deaths occur in LMIC.[2] This not only includes the drivers and passengers but extends to motorcyclists, pedestrians, and cyclists. A road traffic injury is defined as either a non-fatal injury or fatal injury sustained as a result of a collision on a public road involving at least one moving vehicle.[5] By 2030, RTIs are predicted to be the seventh leading cause of death across all age groups worldwide. This rise is largely driven by LMICs, where emerging economies are accompanied with increasing motorization.[2,6] Many of these countries are unable to match the pace of vehicle use with road safety enforcement and policy changes.[2] The most vulnerable amongst all road users are pedestrians, bicyclists, and motorcyclists[2,6]

In recognition of this global public health problem, in March 2010 the United Nations General Assembly established the Decade of Action for Road Safety (2011-2020). It called on Member States to improve the safety of roads and vehicles, the behavior of road users, and post-crash response. The World Health Organization (WHO) served as a tool to assess the impact of these changes through its *Global status report on road safety* series.[2] From the 2018 report, the number of road traffic deaths remained unacceptably high at 1.35 million, which had increased in

comparison to the 2015 report.[2,3] It further notes that the progress in reducing road traffic deaths is far from being uniformed across countries. The rate of road traffic deaths in low-income countries is 3 times higher than in high-income countries.[3] That is significant considering that only 1% of the world's motor vehicles are in low-income countries, but 13% of deaths occur in these countries.[3]

In addition to its collaboration with the United Nations, in 2017 WHO released *Save LIVES a road safety technical package* that provides evidence-based measures to reduce road traffic injuries and fatalities. It focused on speed management, leadership, infrastructure design and improvement, vehicle safety standards, and enforcement of traffic laws and post-crash survival.[5] Its objective was to provide strategies and interventions to further support Member States in their movement of change in road safety.[5]

Indeed, there has been recent global awareness with subsequent efforts put forward to reduce road traffic injuries, however, there has been no reduction in the number of traffic deaths in any low-income country since 2013.[3] This paper will explore the potential factors and barriers contributing to the high amount of RTIs occurring in LMICs and discuss ways to reduce the global burden of road traffic deaths.

Key definitions will be used throughout this paper.

For example, a developing country and low-to-middle income country will be used as interchangeable terms that describe countries that are less developed when compared to other countries.[7] The World Economic Situation and Prospects (WESP) classifies all countries of the world into three broad categories: developed economies, economies in transition, and developing economies. Countries can also be classified by their level of development as measured by per capita gross national income (GNI). Countries with less than $1,035 GNI per capita are classified

as low-income countries, those with between $1,036 and $4,085 as lower middle income countries, those with between $4,086 and $12, 615 as upper middle income countries and those with incomes of more than $12, 615 as high-income countries. The GNI per capita in dollar terms is estimated using the World Bank Atlas method.[8] For example, Costa Rica is considered a middle income group based on its GNI per capita of $10, 840.[3]

Background: Literature Review

Choice and Options of Transportation Mode

In LMIC, the increased burden of RTI is influenced by the choice of transportation mode. Based on research, the choice in mode of transportation is not due to the lack of understanding of risks, but instead persuaded by income status.[9] The most affordable options are walking, traveling by bus or truck, or cycling, which exposes travelers to high risks for road traffic injuries. A daily commuter in Lagos, Nigeria said, "Many of us know most of the buses are death traps but since we can't afford the expensive taxi fares, we have no choice but to use the buses."[9]

Similarly related to a country's income status are their public transportation systems. LMICs have an informal system comprising of privately-owned buses, minibuses, and pick-up trucks.[10] This may appear to offer a solution to those that cannot afford a normal fare, yet there are several negative attributes that outweigh its benefits. Those include drivers working long hours in order to pay vehicle owners a daily fee resulting in sleep deprivation, reckless driving, and driving at fast speeds. Secondly, it encourages competitive and unsafe driving behavior in order to maximize the number of passengers served.[10]

Risk Factors for RTIs

It is well established that alcohol increases the risk of a traffic crash. Yet, there is a lack of emphasis on alcohol use being a considerable risk factor for RTIs especially in Latin America

and the Caribbean.[11] Borges et al developed a study to report the risk of RTIs due to consumption of alcohol within six hours of a RTI. From 2001 to 2015, there were 10 countries and 16 emergency departments in which patients arrived because of a RTI. Based on the findings, almost one in every five injury patients were treated for an RTI and one in every six RTI patients were positive for alcohol six hours prior to the event (drivers, passengers, and pedestrians). The mechanism of the RTI included: 47% due to a collision as a driver, 27.9% reported a collision as a passenger, and 25.1% were hit by a vehicle.[11] The likihood of having a RTI after consuming any alcohol was five times higher when compared to not drinking. The finding that the presence of alcohol increases the risk of RTIs highlights the importance on recognizing alcohol as a risk factor in order to accelerate preventative interventions.

While alcohol related RTIs are generally underestimated, the effectiveness of reducing the legal blood alcohol concentration (BAC) was observed in a study based in Brazil. The Brazilian government created the "Dry Law" in June 2008, which lowered the legal BAC limit from 0.06 g/dl to 0.02 g/dl.[3,12] In doing so, this law resulted in significant reductions in traffic injuries (1.8% to 2.3%) and fatalities (7.2% to 16%). Likewise, in 2010 Mexico implemented legislation to lower the legal BAC to 0.05 g/dl and had a reduction of 5.7% in alcohol-related deaths.[12] Most countries have national drinking laws in place, but the best practice is to specify a BAC limit in order to enforce the law. The United Nations recommended that the BAC limit for the general population is to not exceed 0.05 g/dl and BAC limit for young and novice drivers to be less than 0.02 g/dl due to their greater susceptibility to impairment of alcohol.[3]

Access to Medical Care

Along with the importance of reducing alcohol related RTIs, post-crash care can save lives. The proportion of patients who die before reaching a hospital in low-income countries is

over twice that in high-income countries.[3] Suryanto et al investigated the status of Emergency Medical Service (EMS) systems in LMICs.[13] In this report, there were 48 countries included as LMICs based off of the World Bank (WB; Washington, DC USA) categorization. Of these, only 16 countries had information about prehospital care. This included data on EMS systems, human resources describing the type of staffing on ambulances, patient demographics, injury type, prehospital transport, prehospital education, mortality rates, funding, and obstacles.[13]

Availability of EMS systems, prehospital transport, and prehospital education and training varied among LMICs. The majority lacked an organized EMS system, such as in Indonesia, India, Morocco, Vietnam, Armenia, Nigeria, Ghana, and Sri Lanka. In 2000, Indonesia implemented an EMS system, but only 18 cities are equipped with ambulance services and overall it is slow-moving due to financial issues. India does not have a country-wide organized EMS system and prehospital care only occurs in metropolitan areas and is non-existent in urban and semi-rural areas. Likewise, Vietnam did not have an organized EMS system and an ambulance was utilized more frequently for transporting honored guests instead of patients. Furthermore, in Ghana, most patients were transported by taxi from the scene to the hospital, while in Nigeria and India, most patients were taken to the hospital by private car. In Morocco, there is a paramedic school, yet the ambulance is staffed with only one out three that is trained in prehospital care. Nicaragua's ambulance driver, that is not trained in medical emergency care, gets paid less than $100 per month for three to four 24-hour shifts a week. In contrast, Pakistan has a more developed prehospital care system and the ambulance is the main mode of transportation. Ukraine, which also has a well-developed EMS system, has most ambulances equipped with a cardiac monitor and defibrillator.[13]

Economic Impact of RTIs

Equally important as prehospital care is awareness of the economic burden to both the country and the individual following road injuries in Latin America. Low-and middle-income countries lose approximately 3% of gross domestic product (GDP) as a result of road traffic crashes.[2] One study from the region aimed to illustrate the need for increased attention to road safety by estimating of the cost of road injuries in Colombia. The preferred method in estimation of economic losses was based on the value of a statistical life year (VSLY). There were three VSLY-based equations that quantified the range of cost estimates. Costs of road injuries in Colombia using these methods ranges from US$ 2.4 billion to US$ 11.8 billion, equivalent to 1.6% to 3.1% of national gross domestic product. The bulk of these costs were due to labor losses rather than other costs such as medical, funeral, property damage, insurance, police, and legal medicine. The costs were highest among young adults in the 15-19- and 20-24-year age groups likely do to the labor loss through disability or premature death. Based on different road user groups, pedestrian injuries were the largest contributor of total cost ranging from 35% to 41%.[14]

Preventing RTIs

The UN General Assembly has recommended implementation of eight vehicle safety features (Figure 1) to reduce RTIs. However, not all new and used vehicles are required to be equipped with these internationally recognized standards. For example, features such as electronic stability control and advanced braking are examples of vehicle safety standards that can prevent a crash from occuring or reduce the severity of injuries. Currently, there are no recommendations for countries to prioritize on which safety feature to implement first in vehicles. Forty countries, that were mainly high-income countries, had implemented at least seven or all eight of these features and 124 countries had applied zero or one of the eight.[3]

Additionally, the UN General Assembly has recommended new car assessments to improve vehicle safety and crash avoidance. The New Car Assessment Programmes (NCAPs) carry out safety ratings through crash tests and technology assessments.[3]

Given the potential factors contributing to the high number of RTIs in LMICs, the next step is to assess the effectiveness of RTI prevention initiatives specifically in LMICs. Several studies have reviewed and analyzed interventions aimed at reducing crashes, injuries, and fatalities in LMICs.[6,12] In terms of cost-effectiveness, speed bump installation was the only measure listed as being very cost-effective[6]. In a South African study, speed bumps reduced the number of serious pedestrian-vehicle collisions by 22% and 23% in two different locations respectively, and fatal pedestrian-vehicle collisions by 50% and 68%.[12] Furthermore, legislation interventions were the most common measure and had the best outcomes.[12] In Ethiopia, legislation was passed that mandated motorcycle helmet use, banned cellular phone use while driving, and seat belt laws that transpired in reduction of overall injury, crashes, and deaths.[12] Meanwhile, enforcement of current road safety laws by increased police presence on four major roads in the capital of Uganda had a 17% reduction in the number of road traffic deaths on these roads.[12]

In contrast, public awareness and speed control interventions were cost effective but appeared to not have significant effects on reducing road traffic fatalities.[6,12] In Mexico, there was an awareness campaign that targeted seat belt and child restraint and had a reduction in road traffic collisions but not in injuries or fatalities. Furthermore, in Brazil and Thailand there was no change in the number of deaths following an educational intervention that focused on safety for bicyclists and motocyclists.[12] Unfortunately, a Tanzanian study found that after road quality was improved by pavement of a highway, RTIs increased in that community.[12]

Methods

A search of the literature was undertaken using Google Scholar, PubMed, and Center of Disease Control and Prevention. Search terms included: "road traffic injuries" AND "low-to middle-income countries" AND "costs of road traffic injuries". These search terms were also used on Google Scholar to identify relevant online articles from sources such as the CDC and WHO. All articles analyzed and those with adequate and supportive information were used in this study. Articles not written in English were excluded. Two main sources of data were the World Health Organization database on road traffic injuries and the WHO Global Burden of Disease Study 2015, 2018.

Discussion

The number of road traffic deaths remains unacceptably high and is a serious problem globally. Road traffic injuries are the leading cause of death in children and young adults and are the eighth leading cause of death among all ages. There continues to be a strong association between the risk of a road traffic death and the income level of countries that cannot be ignored. That risk is three times higher in low-income countries (27.5 deaths per 100,000 population) than in high-income countries (8.3 deaths per 100,000 population).[3] Another point of emphasis is that low-income countries own 1% of the world's motor vehicles, with 13% of deaths occuring in these countries.[3] Unequivocally, it can be stated that low- and middle-income countries bear the greatest burden of road traffic injuries and death. While progress has been made in addressing road safety and post-crash care, it is not occuring at a pace fast enough and is underrepresented in low-and middle-income countries.

Without knowledge and evidenced-based research highlighting the magnitude of the problem, the ability of recognizing the burden of RTIs in LMICs is blurred for government and

policy makers. Limitations found amongst the literature was that there was insufficient evidence and few systemic reviews conducted specifically in LMIC settings.[6,11,12,13] Therefore, the political commitment and financial investments in road safety results is a lower priority to other public health challenges and diseases.

Achieving global and national road safety goals largely involves improving and enforcing legislation on key risk factors to prevent death and injuries. In November 2017, Member States, with the support of WHO, the United Nations Economic Commission for Europe, United Nations Children's Fund (UNICEF) agreed on a set of 12 Voluntary Global Performance Targets for Road Safety Risk Factors and Service Delivery Mechanisms that involve road safety management, post-crash response, and safer roads, vehicles, and users (Table 1). The intention is to set a framework to guide and monitor the implementation of legislation among all countries.[3]

One of the largest pillars highlighted in the voluntary global targets is the importance of safer road users. This could change the high number of pedestrian deaths (25%) and motorcyclist deaths (40%) observed in Costa Rica.[3] Augsburg University's Physician Assistant program recently traveled to Costa Rica and had a conversation with Susie Aguirre, a Nicaraguan registered nurse. She currently works in the emergency department in Rafael Ángel Calderón Guardia Hospital located in San José, Costa Rica. She described the hospital as "filled" with motorcyclists due to a combination of driving too fast, night racing, and having alcohol and or drugs on board. In her opinion, there is a high number of motorcyclists because it is the fastest and quickest way to travel (S. Aguirre, personal communication, July 3rd, 2019). Costa Rica already has implemented national laws for speed limit, alcohol, and helmet and seat-belt use. In this case the problem is not due to the lack of laws, it can be assumed that there are not enough police officers to enforce the law. Per the 2018 Global Status Report, the enforcement of these

national laws is rated between four to five out of ten.[3] This demonstrates the need for increased police presence in order to reduce road traffic fatalities, similarly observed in Uganda.[12]

In addition to the importance of enforcement of national traffic laws, undeveloped EMS systems and inadequate prehospital care could be a source of the high number of traffic deaths seen in LMICs. Funding is one of the main obstacles in establishing a well organized EMS system and assistance from developed countries is necessary to enhance the quality of prehospital care. For example, the United States and United Kingdom both helped establish an EMS system in Pakistan.[13] Another advantage gained from international support was seen in Sri Lankan, where first responders and paramedics were able to take the Australasian Registry of Emergency Medical Technicians (EMTs) regional exam because the EMT training had been provided by the United States.[13]

While financial issues and the need for better-trained health workers are common problems in LMICs, there are practical solutions that could bypass financial, geographic and institutional restraints to improve emergency care. With the worldwide shift to mobile technology, it allows the opportunity to explore the options of mobile-based training apps to improve access to learning particularly in low-income countries.[15] This would allow even the most remote areas with up-to-date information for continous health care training. In Kenya, mobile phone use is common and over 80% of the population has access to a mobile phone. Potential learning apps include videos on tracheal intubation, resuscitation algorithms, and educational games to discover safe failure.[15] However, not all clinical skills can be taught using a mobile device such as motor skills, communication, and team-working skills. This is a promising and realistic alternative in low-income countries that would allow for better access in health care training in order to improve health care outcomes.

In order to reduce the number of RTIs in LMICs, there needs to be realistic and cost-effective interventions towards making the roads safer. Specifically looking at ways to reduce the number the road traffic injuries and deaths amongst the most vulnerable road users: pedestrians, cyclists, and motorcyclists.[2,6] The speed at which a vehicle travels directly influences the severity of injuries and likelihood of death as a result from that crash.[3] Effective speed management is central to most road safety strategies. One of the most basic measures is the presence and enforcement of a national speed law as well as allowing local authorities to have the power to modify speed limits as deemed necessary. However, it is sometimes difficult for vehicles to abide by the speed limit.

Another cost-effective measure that would allow for compliance with speed limits include speed bumps. Speed bumps are physical structures that are self-enforcing rather than requiring police enforcement, appealing to those LMICs where police presence may lack. Speed bumps are designed to compel vehicles to slow their speed in order to reduce the frequency and severity of collisions and reduce the number of vehicles that exceed the recommended speed limits. One of the greatest benefits of installing speed bumps specifically in residential areas is the safety it provides to pedestrians and children. Pedestrian injuries caused by automobile collisions are a leading cause of death among children because children en route to school or at play in front of their homes are exposed to roads and street traffic.[3,16] According to the American Journal of Public Health, speed bump installation was associated with a 53%-60% reduction in injury or death in neighborhood children struck by a vehicle.[16] This study also found that children who lived within a block of a speed bump had significantly lower odds of being struck and injured by an automobile in their neighborhood.[16] Therefore, speed bumps have the potential to make living environments safer for children by modifying the traffic environment, rather their

behavior which is more difficult to control globally. Furthermore, speed bump installation was found to be very cost-effective in LMICs and could ensure that drivers abide by the posted speed.[6] These findings suggest the positive impact of speed bumps in reducing the number of road traffic injuries in LMICs as a long-term safety intervention. Further confirmation of the protective effects of speed bumps is required before supporting the installation of speed bumps in LMICs.

Not only is it important to ensure that the roads are safe, vehicle safety features have potential benefits in reducing road traffic deaths and injuries. The United Nations set eight vehicle safety standards, however, there were no guidelines stating which features should be prioritized and implemented in used and new vehicles. Member States included specific targets on road safety in the 2030 Agenda for Sustainable Development to help monitor implementation. Included was that by 2030, all new and used vehicles must meet high quality safety standards, such as the eight vehicle safety standards recommended by the United Nations.[3]

Conclusion

Road traffic crashes are increasing every year in low-to middle-income countries compared to high-income countries, which show decreasing trends. Although there has been global recognition in reducing the number of road traffic deaths, evidence of cost-effectiveness interventions to prevent road traffic injuries in low-to middle-income countries is limited. The evaluation of road safety interventions is needed to generate evidence base for effective future traffic injury prevention programs specific in low-to middle-income country settings. In turn, this would guide a country's decisions on where to focus their efforts in reducing road traffic injuries and deaths. Future research should evaluate the effectiveness of speed bumps in reducing road

traffic injuries and deaths. This was one of the few interventions that was found to be cost-effective in low-to middle-income countries.

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Figures and Tables

Figure 1: Priority UN vehicle safety standards

1-2: Frontal impact protection and side impact protection (R94 and R95): ensure that cars withstand the impacts of a frontal and side impact crash when tested at certain speeds. These crashworthiness regulations help to protect occupants withstand the impact of front and side impact crashes.

3: Electronic stability control (R140): prevents skidding and loss of control in cases of over-steering or understeering and is effective at reducing crashes and saving lives. It is effective in avoiding single car and roll over crashes, reducing both fatal and serious injuries.

4: Pedestrian front protection (R127): provides softer bumpers and modifies the front ends of vehicles (e.g removes unnecessarily rigid structures) that can reduce the severity of a pedestrian impact with a car.

5-6: Seat-belts and seat-belt anchorages (R14 & R16): ensure that seat-belts are fitted in vehicles when they are manufactured and assembled and that the seat-belt anchor points can withstand the impact incurred during a crash, to minimize the risk of belt slippage and ensure that passengers can be safely removed from their seats if there is a crash.

7: Child restraints (R129): ensure that the child seat is in place with the adult seat-belt and that ISOFIX child restraint anchorage points are fitted to secure the restraint.

8: Motorcycle anti-lock braking systems (R78): help the rider maintain control during an emergency braking situation and reduce the likelihood of a road traffic crash and subsequent injury.

Data adapted from Global status report on road safety[3]

Table 1: Global Voluntary Performance Targets for Road Saftey Risk Factors	
Target Number	Description
Target 1	By 2020, all countries establish a comprehensive multisectoral national road saftey action plan with time-bound targets.
Target 2	By 2030, all countries accede to one or more of the core road saftey-related UN legal instruments.
Target 3	By 2030, all new roads achieve technical standards for all road users that take into account road saftey, or meet a three star rating or better.
Target 4	By 2030, more than 75% of travel on existing roads is on roads that meet technical standards for all road users that take into account road saftey.
Target 5	By 2030, 100% of new (defined as produced, sold, or imported) and used vehicles meet high quality saftey standards, such as the recommended priorty UN Regulations, Global Technical Regulations, or equivalent recogonized national performance requirements.
Target 6	By 2030, halve the proportion of vehicles traveling over the posted speed limit and achieve a reduction in speed-related injuries and fatalities.
Target 7	By 2030, increase the proportion of motorcycle riders correctly using standard helmets to close to 100%.
Target 8	By 2030, increase the proportion of motor vehicle occupants using saftey belts or standard child restraint systems to close to 100%.
Target 9	By 2030, halve the number of road traffic injuries and fatalities related to drivers using alcohol, and/or achieve a reduction in those related to other psychoactive substances.
Target 10	By 2030, all countries have national laws to restrict or prohibit the use of mobile phones while driving.
Target 11	By 2030, all countries to enact regulation for driving time and rest periods, for professional drivers, and/or accede to international/regional regulation in this area.
Target 12	By 2030, all countries establish and achieve national targets in order to minimize the time interval between road traffic crash and the provision of first professional emergency care.
Data adapted from Global status report on road safety[3]	

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