Road-traffic injuries: confronting disparities to address a global-health problem

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Evidence suggests that the present and projected global burden of road-traffic injuries is disproportionately borne by countries that can least afford to meet the health service, economic, and societal challenges posed. Although the evidence base on which these estimates are made remains somewhat precarious in view of the limited data systems in most low-income and middle-income countries (as per the classification on the World Bank website), these projections highlight the essential need to address road-traffic injuries as a public-health priority. Most well-evaluated effective interventions do not directly focus on efforts to protect vulnerable road users, such as motorcyclists and pedestrians. Yet, these groups comprise the majority of road-traffic victims globally in low-income and middle-income countries, and consequently, the majority of the road-traffic victims globally. Appropriately responding to these disparities in available evidence and prevention efforts is necessary if we are to comprehensively address this global-health dilemma.

In 2002, an estimated 1·2 million people were killed and 50 million injured in road-traffic crashes worldwide, costing the global community about US$518 billion.1 The International Federation of Red Cross and Red Crescent Societies has described the situation as “a worsening global disaster destroying lives and livelihoods, hampering development and leaving millions in greater vulnerability”.2 Without appropriate action, road-traffic injuries are predicted to escalate from the ninth leading contributor to the global burden of disease in 1990 to the third by 2020.3

Acknowledging its enormous effect on the global community, WHO designated “road safety” as the theme for world health day in April, 2004. A comprehensive report on road-traffic injury prevention4 was released by WHO and the World Bank on the same day, and an unprecedented plenary session of the UN General Assembly devoted to the global crisis of road crashes followed, culminating in a resolution that challenged all governments to address road-traffic injuries as a public-health priority. Most well-evaluated effective interventions do not directly focus on efforts to protect vulnerable road users, such as motorcyclists and pedestrians. Yet, these groups comprise the majority of road-traffic victims globally in low-income and middle-income countries, and consequently, the majority of the road-traffic victims globally. Appropriately responding to these disparities in available evidence and prevention efforts is necessary if we are to comprehensively address this global-health dilemma.

In this Review, we aim to summarise the characteristics of the rise in road-traffic injuries and present an evidence-based approach to prevent road-traffic crashes. Our Review uses the substantial work undertaken by international experts contributing to the 2004 world report and data published since that time. We particularly highlight gaps

Search strategy and selection criteria

For this review we identified studies from electronic databases (Cochrane databases, MEDLINE, EMBASE, and CINAHL), and by hand-searching peer-reviewed journals in the injury field (in particular, Injury Prevention, Injury, Journal of Trauma, Accident Analysis and Prevention, Injury Control and Safety Promotion, and Traffic Injury Prevention). We also found relevant studies in the 2004 world report on road-traffic injury prevention, in bibliographies of content-specific articles and reports, and from sources of information identified by the authors, colleagues, and partners in the Road Traffic Injuries Research Network. The identified sources included documents published in non-peer-reviewed formats, which provided useful otherwise inaccessible data pertaining to low-income and middle-income countries. Articles specifically cited were selected for their relevance in addressing the key objectives of the report.
in knowledge that show the disparities between the extent of the burden and the available evidence, for low-income and middle-income countries.

Road-traffic injuries: a global-health burden
Current estimates of the global burden

The 2004 world report used information from a range of sources, including the WHO mortality database and global burden of disease estimates, the World Bank, the transport research laboratory, and specific studies identified through electronic databases, websites, organisations, and individuals.

In 2002, road-traffic injuries ranked as the 11th leading cause of death in the world. The aggregate rates of road-traffic fatality per 100,000 population were lowest in high-income countries in the European region (11·0), whereas the highest rates were reported in the low-income and middle-income countries in eastern Mediterranean (26·4) and African regions (28·3). However, estimates for 35 of the 110 countries used to calculate these regional figures were based on incomplete data or epidemiological information. When analyses were restricted to the 75 countries reporting vital registration statistics including road-traffic injury data, the highest rates of death from road-traffic injury were noted in some Latin American countries (eg, 41·7 and 41·0 per 100,000 in El Salvador and Dominican Republic, respectively), Europe (eg, 22·7 per 100,000 in Latvia), and Asia (21·9 and 21·0 per 100,000 in South Korea and Thailand, respectively). Notably, the most complete data were available from high-income countries, with the lowest fatality rates, whereas no or negligible data were available from the poorest regions and countries in the world, which arguably have the highest fatality rates. As a result, the present global estimates of the burden of road-traffic fatalities might seriously underestimate the true extent of the problem.

On the basis of economic models that were largely developed in relation to industrialised contexts, the direct costs of road crashes are estimated to be 1% of the gross national product in low-income countries, 1-5% in middle-income countries, and 2% in high-income countries. Such amounts for the economies of low-income and middle-income countries are estimated to exceed the total development assistance they receive annually.

Estimates from high-income countries suggest that 80% of the total cost of motor-vehicle crashes is attributable to non-fatal events, with 2% of non-fatal crashes accounting for 44% of life-time medical costs. The effect of non-fatal injuries on lost productivity is also estimated to far outweigh that attributable to fatal injury, worldwide. Yet, reliable data for longer term health consequences of injury, particularly disability, remain sparse, even in countries where detailed mortality statistics are assembled annually.

About a third of road-crash injuries needing hospital admission in the UK and New Zealand are not reported to the police. Poor enforcement of crash reporting and monitoring systems, lack of comparability of definitions and their interpretation across data sources, and variability of access to and use of formal medical services by injured people, both within and between countries, are regarded as contributing elements to this under-reporting.

Findings of a systematic review of risk of disability in car drivers surviving crashes showed substantial variability in derived estimates, largely as a result of the methodological difficulties in measuring the non-fatal outcomes following injuries. Although epidemiological data for road crash-related disability from low-income and middle-income countries is scarce, it is widely recognised that the costs of prolonged care, loss of income, and consequences for injured parents and their dependants, push families into poverty and impose an inequitable burden on these countries.

Trends and projections of the global burden

In just over a decade since 1990 (the base year for statistics used in the Global Burden of Disease report), WHO estimates suggest that the annual number of deaths from road-traffic injuries worldwide rose by 10%. The increase was largely influenced by a pronounced rise in both the numbers and rates of estimated road-traffic injury deaths in low-income and middle-income countries, particularly those in Latin America and the Caribbean, the middle east, north Africa, and Asia. The growing importance of the health burden in low-income and middle-income countries was also highlighted by the World Bank, which noted that road-traffic death rates per head of population between 1975 and 1998 increased by 44% in Malaysia, by 79% in India, and by more than 200% in Colombia, China, and Botswana (figure). By contrast, striking reductions in the rates of road-traffic injury fatalities over time were apparent in several high-income countries, consistent with earlier findings by Jacobs and Cutting.

In an analysis of the relation of road-traffic injury trends to economic growth, a World Bank report summarised the situation as follows: the rapidity with which the risk of road traffic fatality grows depends, by definition, on the rate of growth in motorisation and the rate of change in fatalities per vehicle. Over the past 25 years, vehicle ownership in most developing countries grew more rapidly than fatalities per vehicle fell. The converse applied to industrialised countries. Using the best available evidence on motorisation rates and related risks, and assuming no change to present prevention policies, the World Bank report projects that over the next 20 years, the global road death toll will rise by 66%. Importantly, this value subsumes an even greater divergence between rich and poor nations in the future. Although about a 28% reduction of fatalities is expected in high-income countries, a 92% and 147% rise in fatalities are anticipated in China and India, respectively.

Similar conclusions about projected increases in the health burden on lower income countries can be drawn from another report that also showed a rise in traffic-
related crashes, injuries, and deaths in lower income countries accompanies economic growth. However, the data in this report suggest that at a threshold of about US$1500–$8000 per person, economic growth would no longer lead to additional traffic deaths, although crash and injuries might continue to increase with growth.

Although high-income countries have reported substantial reductions in road crash-related deaths in recent years, evidence suggesting equivalent reductions in non-fatal outcomes is scant. Findings of a Norwegian study comparing population-based data for injuries (45% of which were traffic-related) over the period 1992–97 showed that, although the rate of fatalities fell and rates of medically treated and hospitalised injuries remained stable, the rates of permanent impairment, disability, and eligibility for disability pensions rose. These findings were judged most likely to show a real rise in numbers of people surviving crashes with injuries that result in long-term disabilities (eg, as a result of improved protection devices such as airbags in cars, improved first aid, acute care, and health services). Thus, any complacency about the effectiveness of interventions in reducing mortality needs to be tempered by limited evidence about their ability to prevent non-fatal adverse outcomes.

Effect of the health burden on vulnerable road users
Substantial published work shows the tendency of some road-user groups, particularly pedestrians and people using motorised and non-motorised two-wheel vehicles, to be vastly over-represented among crash victims at a global level, and to be at high risk of crash-related disability. Not surprisingly, the burden relating to such vulnerable road users is also largely borne by low-income and middle-income countries, where factors such as the intensity of traffic mix and the lack of separation of these vulnerable groups from fast-moving motorised vehicles heighten the risk of injury for these less-protected road users. In a review of road-traffic injuries published in 1997, pedestrian injuries accounted for 41–75% of all road fatalities in most studies from less developed countries. Pedestrians are the most frequently injured road users in Africa, the eastern Mediterranean region, Latin America, and the Caribbean. Studies that focus specifically on Asia suggest that motorcyclists have especially high rates of injury in countries such as Korea, China, and Thailand, where they also account for a high proportion of seriously injured road users.

Passengers in formal and informal modes of public and mass transport constitute another important road-user group that are a common feature in road crash data from less-resourceful environments, particularly Africa. Vehicles associated with road crashes are typically privately owned buses, mini-buses, converted pick-up trucks, and taxis. The postulated risk factors include driver fatigue and other forms of risky driving, overcrowding of vehicles, poor condition of vehicles, and poor road networks. Pedestrians are often double-exposed to high risks of injury because they are most likely to also use these forms of transport.

By contrast, car occupants are the most common (and a rising proportion) of fatally injured road users in high-income countries, indicating the size of the vehicle fleet and frequency of its use as a mode of transport. In New Zealand, car occupants accounted for 50% of road deaths in 1970 and more than 80% of road deaths in 2000. Although cyclists, pedestrians, and motorcyclists account for smaller proportions of the overall number of deaths, even in high-income countries, they are more likely to be killed or disabled in the event of an injury than car occupants.

Notwithstanding the value of published reports, reliability of data from low-income and middle-income countries becomes an even greater drawback at the level of specific road-user groups. Surveys in Ghana suggest that only 8% of pedestrian injuries were reported to police. Limitations in reliable crash data for motorised two-wheeled vehicles further compromise aggregate-level data from countries where this form of transport is especially common (eg, India, Indonesia, Thailand, and Pakistan). Despite these reporting biases, most of the estimated 1.2 million people killed on roads in 2002 were not car occupants.

Effect of the health burden on different demographic groups
In most countries, both rich and poor, the experience and results of road injury are also disproportionately borne by particular sociodemographic groups. Steep class gradients by socioeconomic status are noted for morbidity and mortality from road-traffic injury with rates being higher in lower social classes. These findings, which are especially evident in data for vulnerable road users, such as children, might partly, be attributable to differences in exposure to higher speeds of traffic flow and a more complex mix of traffic.

Data compiled in several reviews note that people aged 15–44 years account for more than half the road-traffic...
Burden
- Establishment of routine collection and reporting of deaths from road-traffic injuries in low-income and middle-income countries
- Establishment of routine collection and reporting of non-fatal injuries from road-traffic injuries

Intervention strategies
- Identification of interventions that provide clear benefits to pedestrians, bicyclists, and motorcyclists
- Identification of interventions that provide clear benefits to road users in low-income and middle-income countries

Prevention of road-traffic injuries: a global evidence-based perspective
As highlighted in the previous section, despite the absence of reliable and valid information about the incidence of road-traffic injuries, there can be no doubt that the health burden will grow in the next few years, mostly in low-income and middle-income countries. Although the continued rise in motorisation in these countries suggests a degree of inevitability, many high-income countries have had great successes in reducing the incidence of road-traffic injuries in past decades despite continued rises in motorisation. As a result, real opportunities are available to lessen the extent of this growing burden if intervention strategies that are known to be effective or have the greatest potential to be effective are implemented.

However, much evidence comes from high-income countries, with very scant evidence from low-income and middle-income countries. Similarly, many of the proposed strategies have been developed primarily from the perspective of preventing injuries to vehicle occupants, and little consideration has been given to their effect on vulnerable road users. Arguably, since vulnerable road users form the greatest proportion of road-traffic injury victims worldwide, they should be a substantial, if not the primary, focus of present global prevention efforts.

Safer transport and land use policies
As outlined in the 2004 world report on prevention of road-traffic injuries, transport and land use policies that facilitate reductions in the amount of motor-vehicle traffic, that encourage safer modes of transport, and which lessen exposure to high-risk scenarios are likely to reduce the overall burden of road crashes and the risk of injury to vulnerable road users. For example, estimates suggest that for every 1% reduction in motor-vehicle distance travelled, there is a corresponding 1-4-1.8% reduction in crash incidence.3,75

Policies that directly seek to reduce exposure to high-risk scenarios for young, inexperienced drivers have proven successful in high-income and middle-income countries. In the UK, for example, a 25% reduction in young motorcyclist casualties was recorded with the introduction of restrictions on engine size of a motorcycle that learner drivers could ride (from 250 cc to 125 cc) and on maximum power output (to 9 kw).81 In Malaysia, raising the legal age of motorcyclists from 16 to 18 years was cost-beneficial, as were restrictions on young drivers riding at night.82 Likewise, introduction of graduated driver licensing systems has proven successful in a number of developed countries, with 28% (4-43%) reductions reported in per-population injury crash rates in 16-year-olds.83

However, not all such policies are beneficial for all road users and some evidence suggests that vulnerable road users might benefit the least. For example, policies that encourage the building of overpasses, which aim to separate pedestrians from motor vehicles, can result in long, and sometimes unsafe routes of travel for these vulnerable road users. Findings from Brazil, Mexico, and Uganda suggest that, in preference to walking long distances to use overpasses, which are also perceived to be high-risk settings for personal crime, pedestrians will create their own routes through the traffic, placing themselves at increased risk of injury.85,86

Safer roads
Safety awareness in planning road networks, incorporating safety features into road design, and remedial action at high-risk crash sites have been the overarching strategies used to ensure the development of safe roads. The introduction of pavements (sidewalks) for pedestrians to walk separately from motorised traffic—especially at high-risk crash sites—has the potential to lead to substantial reductions in pedestrian injuries. Roads that do not provide pavements—a common scenario in many low-income countries—are associated with a two-fold increased risk of a crash compared with those that do.87 In
high-income countries, the construction of bicycle tracks or lanes alongside urban roads has led to a 35% reduction in cyclist casualties.86 This approach is also being used in a number of low-income and middle-income countries, including China.

Implementation of road-design measures to facilitate reductions in speed, through various traffic-calming measures, is another key strategy that can be used—with potential reductions in deaths and injuries of 11%.86 Although these findings from the Cochrane Injuries Review Group were not based on any reports from low-income and middle-income countries, a before-and-after investigation of the introduction of speed bumps in Ghana showed a 55% reduction in all deaths and a 51% annual reduction in crashes in which a pedestrian was hit.87

Other strategies that have been designed mainly to improve safety of vehicle occupants, such as installation of crash-protective measures (eg, crash cushions or crash barriers), which lead to substantial reductions in casualties,80–86 might also benefit motorcyclists. However, data that distinguishes the effect of these strategies on motorcyclists is scarce and positive benefits cannot be assumed.

Safer vehicles

Efforts to produce safer vehicles have largely focused on improving their visibility, crash-protective designs, and the production of so-called intelligent vehicles. Although these strategies are aimed predominantly to reduce injuries to vehicle occupants, they can also benefit vulnerable road users.

Meta-analyses of the introduction of laws for automatic daytime headlights in high-income countries have shown substantial reductions in daytime crashes involving more than one party. Specifically these investigations show the numbers of pedestrians and cyclists hit by cars after introduction of these laws has been reduced by 15% and 10%, respectively.88 Other measures aimed at strengthening the visibility of motorised vehicles, such as high-mounted brake lights (or stop lights) in cars,89 also seem to lead to substantial reductions in crashes and injuries for all country economies, although the specific effect of these measures on reduction of injuries to vulnerable road users remains to be elucidated. Use of daytime headlights on motorised two-wheel vehicles can also result in positive outcomes.90 Fatal daytime crashes were reduced by 15% in Singapore after legislation came into effect,91 and in Malaysia, legislation preceded by an information campaign reduced visibility-related crashes by 29%.92

Substantial design effort has been directed towards construction of safer car fronts that reduce the impacts on vulnerable road users. Implementation of performance requirements and test procedures, developed by the European enhanced vehicle-safety committee for vehicles, could result in the avoidance of up to 20% of deaths and serious injuries to pedestrians and cyclists in the European Union.93 However, unless similar efforts are directed towards implementation of comparable performance requirements and test procedures for commercial vehicles (trucks and multi-passenger vehicles), the global effect of these procedures is unlikely to be as great as 20%, in view of the much greater proportion of these vehicle fleets in low-income and middle-income countries.

The installation of seat-belts is arguably one of the most important safety measures with the potential to facilitate reductions in occupant injuries, in high-income and low-income countries alike. When used, seat-belts lessen the risk of serious and fatal injuries by 40% and 65%, respectively94 and when they are combined with airbags, are effective in reducing deaths by about 8–14%.95 However, anecdotal evidence suggests that vehicles in many low-income and middle-income countries do not have functioning-seat belts, even if they are installed.96

Safer people

If all current road safety laws were enforced in the European Union, deaths and serious injuries could be reduced by up to 50%.89 Comparable benefits might well be seen in other regions, including in low-income and middle-income countries. For example, in Brazil, an intervention comprising legislation to impose stiff penalties, media coverage of the new regime, and better enforcement achieved a 25% reduction in traffic fatalities.89 However, caution is needed when implementing such laws without due consideration to the ways in which they are administered. In Mexico for example, because legal trials are very complicated, laws aimed at strengthening reporting of pedestrian injuries, have, paradoxically, led to 90% of cases of cars hitting pedestrians being classified as hit and run.97

The benefits of speed enforcement strategies are clear for vehicle occupants and vulnerable road users and although there is little direct evidence from low-income and middle-income countries, enforcement strategies targeted at high-risk sites have shown casualty benefits in many country settings. In the UK findings have shown, for example, that (at individual crash sites), speed cameras lead to a 56% reduction in pedestrians killed or injured.98 In South Korea speed cameras were associated with a 28% reduction in crashes and a 60% decline in deaths at high-risk sites.99 Although direct evidence of the benefits of drink-driving laws and enforcement strategies in low-income and middle-income countries, particularly relating to vulnerable road users, is scarce, in high-income regions, several strategies have had a substantial effect on the numbers of alcohol-related crashes and casualties.100–103

Other compliance strategies that show evidence or promise of a positive effect in high-income countries, for vehicle occupants and vulnerable road users, include red-light cameras104 and restrictions on drivers’ hours of work in commercial and public transport.1 The benefits of these strategies might be especially relevant for many low-income and middle-income countries, in view of the pronounced reliance on commercial vehicles for public
transport and emerging evidence of long hours of work for many drivers.10

Although of limited relevance for the safety of vulnerable road users, setting and securing compliance with occupant-restraint laws, including child restraints, has led to increases in restraint use51,106,107 and substantial reductions in deaths and moderate-to-severe injuries.91,113,114 However, even with such legislation, failure to use helmets, use of non-standard helmets, and use of improperly secured helmets is not uncommon, highlighting the importance of complementary prevention strategies.10,116

Conclusions

Motorisation has enhanced the lives of many individuals and societies. However, the benefits have come with a price. Although the numbers of lives lost in road crashes in high-income countries indicate a downward trend in recent decades, for most of the world’s population, the burden of road-traffic injury—in terms of societal and economic costs—is rising substantially.

The best available evidence suggests the burden is greatest and growing in low-income and middle-income countries—but estimates in these regions are unreliable. Surveillance systems that can enable countries to monitor patterns of injuries and effects of preventive strategies must be established. Such systems must capture not only deaths but also non-fatal outcomes, in view of the potentially catastrophic effects of non-fatal injuries on families and communities who must care for these individuals.

Data for successful interventions are largely derived from high-income countries and focus mainly on benefits for vehicle occupants. However, such interventions form the smallest proportion of road users at a global level. Efforts to adapt, implement, and assess the effectiveness of strategies that are relevant in low-income and middle-income country settings must be prioritised. Since comparatively little attention is directed to vulnerable road users up to now, it is also imperative that innovative and context-appropriate prevention strategies that protect these road users are actively investigated.

A continuing global commitment to address the recommendations of the 2004 world report, and in particular those aspects of the report that recognise the current disparities between the burdens and resources for high-income countries, compared with low-income and middle-income countries is required.10 This will only be possible with the concerted effort of not only public-health workers worldwide, but also colleagues from several disciplinary areas,6 working within a common framework, as envisaged and supported by the UN:7

Conflict of interest statement

We declare that we have no conflict of interest.

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