Abstract
Globally, poorer population groups bear a disproportionate burden of avoidable morbidity and mortality from road traffic injuries. The distribution of road traffic injuries is generally influenced by socioeconomic factors. Poor countries bear a disproportionate burden of injuries and fatalities, and within countries, poor people account for a disproportionate portion of the ill health due to road traffic injuries. The main source of data for this paper was the road traffic injury database of the WHO World Health Report for 1999 supplemented by the WHO Global Burden of Disease Study 2000 report, and published and unpublished works. Fatality rates for 0–4 and 5–14 year olds in low- and middle-income regions, measured as deaths per 100,000 population, were six times the rates for high-income regions, while within low- and middle-income regions the rates varied widely. Within poor countries, poor people – represented by pedestrians, passengers in buses and trucks, and cyclists – suffer a higher burden of morbidity and mortality from traffic injuries. In rich countries, children from poor socioeconomic classes suffer more injuries and deaths from road crashes than their counterparts from high-income groups. The disproportionate burden of morbidity and mortality in low- and middle-income countries, and among low socioeconomic groups in those countries, illustrates problems of global inequities in health. The problems can be addressed through policies that focus on the road safety of vulnerable groups.

Keywords: Injury risk; morbidity; fatality; equity.

Introduction
The Global Burden of Disease Study 2000 ranked road traffic injuries as the ninth leading cause of death and eighth leading cause of disability-adjusted life years (DALYs) lost globally. Compared to 1998 data, road traffic injuries moved up from tenth and ninth positions as leading cause of death and DALYs lost, respectively, and are projected to become the third leading cause of DALYs lost worldwide by 2020 if current trends continue. All regions of the world are affected by the epidemic of road traffic injuries. However, global estimates of number of people killed each year in road traffic crashes vary widely from 750,000–880,000 deaths according to the Transport Research Laboratory to 1.17 million by the World Health Organization. The discrepancy in estimates stems from lack of accurate data on road traffic injuries, especially in low-income countries.

Road traffic injuries have substantial impacts on both household income and the national economy. The costs of prolonged medical care, or funeral costs, coupled with loss of income due to disability or loss of a family bread winner can push an affected household into poverty in many low- and middle-income countries. At a national level, the burden on the health budget and the economy is high. The direct costs due to road crashes are estimated at 1–2% of the GNP annually in low- and middle-income countries. Figure 1 gives the estimated direct costs of road traffic crashes for low- and middle-income regions of the world. The total cost to the economies of low- and middle-income countries, estimated at US$ 65 billion, is more than the total amount of development assistance these countries receive annually.

This paper summarizes available data on global disparities in road traffic injuries, and the underlying issues, with a focus on low- and middle-income countries. The paper draws attention to the population groups that bear a high burden of injuries and fatalities due to road traffic crashes,
and discusses policies that would address the resulting inequities in health.

**Materials and methods**

The two main sources of data were the World Health Organization database on road traffic injuries, and the database of the WHO Global Burden of Disease Study 2000. Our grouping of countries by region and by economic levels of development followed WHO’s regional groupings, as given in Appendix 2 of the report on road traffic injuries. The main indicators for measuring the burden of injuries were fatality rates per 100,000 population, and DALYs lost for different age groups and regions. The data on populations for different age groups used in calculating age-specific road injury fatality rates were extracted from Appendix 3 of the WHO injury report. Additional data were derived from published reports.

Various problems affect the quality of data on road traffic injuries, especially for low-income countries. Road traffic crashes and injuries are under-reported in many countries, different studies employ different methods for data collection, the definition of a traffic death varies, and there are limitations in some countries with regard to population denominators, registered vehicles, and other variables. These inconsistencies affect interpretation. Despite these limitations, some conclusions can be drawn about the disparities that exist in the distribution of injuries and fatalities by region and country, age and gender characteristics of victims, social class and local/urban differentials, and risks for different population groups.

**Results**

**Regional differences in morbidity and fatality rates**

Although all the regions of the world are affected by road traffic injuries, low- and middle-income countries bear a higher burden according to several indicators. The overall road traffic injury fatality rate for low- and middle-income countries, estimated from the WHO database, is reported to be 20.7 deaths per 100,000 population, which exceeds the average of 15.6 deaths per 100,000 population for high-income countries. The low- and middle-income countries account for a much greater proportion of global fatalities and injuries than their share of motor vehicles in the world. In 1998, low- and middle-income countries together owned about 32% of the world’s motor vehicles, yet they accounted for more than 85% of the global burden of fatalities and 90% of DALYs lost due to road traffic injuries.

An analysis of fatality rates by geographic region also demonstrates disparities in road traffic injuries, as shown in Figure 2. The data show that fatality rates are higher in low- and middle-income regions than in high-income regions. However, the rates in low- and middle-income regions also vary widely, from 15.5 deaths per 100,000 population for the low- and middle-income Western Pacific region to 28.2 deaths per 100,000 population for Africa. The data also show that within the same region the fatality rates are higher in poorer countries than in high-income ones. For instance, within the Americas region, Latin America and the Caribbean had an average rate of 25.3 fatalities per 100,000 population, compared to 16.1 deaths per 100,000 population for high-income countries in North America.

Trends over time show sharp differences in road traffic fatality rates among regions by income level. There has been a steady decline in the fatality rates in high-income regions in the last three decades, as shown in Figure 3, while fatality rates are increasing in low- and middle-income regions. The magnitude of this increase varies by region, with the highest increase being in Asia. The gap in fatality rates between the rich and poor regions is growing wider, as shown in Figure 3.

There are also distinct variations in the profile of road traffic injury victims in low- and middle-income regions.
compared to high-income regions. Pedestrians, cyclists and passengers in buses and trucks account for 90% of the casualties in countries in low- and middle-income regions, as compared to high-income regions where drivers constitute the majority of victims.6,7,8

Differential distribution of morbidity and fatalities within countries

The pattern of population vulnerability also varies within countries, according to local factors. For instance, death rates for road traffic injuries in Mexico in 1999 varied from 28.7 per 100,000 population in Baja California Sur to 7.9 per 100,000 population in the state of Chiapas.9 Inter-provincial and urban/rural differentials in the burden of ill health and in the profile of victims have been reported for many low- and middle-income countries.6,7,8 In some countries, pedestrians account for up to two-thirds of people injured or killed in road traffic crashes in urban areas, while in rural areas the majority of victims are passengers on buses and other vehicles.6,10 This urban/rural differential is illustrated by the example of Kenya, as shown in Figure 4.

In both poor and rich countries, exposure to injury risks, morbidity and fatality from road traffic injuries are influenced by socioeconomic factors. Ecological studies in high-income countries show that traffic injury rates tend to be higher in young people living in low social class areas than in high social class areas.11,12 Studies conducted in England

---

Figure 2. Road traffic mortality per 100,000 population, by WHO region and income group.

Figure 3. Trends in fatalities due to road traffic injuries by region of the world, 1980–1995. Source: Jacobs et al., 2000 [4].
and Wales have documented steep class gradients in fatality rates due to road traffic injuries in children, most notably pedestrians and cyclist injuries. A study comparing the data for England and Wales for 1979–82 and 1989–92 found that even though mortality from childhood road traffic injury was declining, steep class gradients in death rates persisted. The death rate for children in the lowest social class was 3.5 times the rate for the highest social class in 1979–80. Four years later, in 1982–83, the difference in injury fatality rates had increased; the fatality rate in the lowest class was 5 times that of the highest class. The decline in road traffic deaths among children in the two lowest social classes was much smaller than in the two highest classes.

A recent population-based cohort study in Sweden showed that the injury risks of pedestrians and bicyclists are 20% to 30% higher among children of manual workers than in children of intermediate and high-salaried employees, again showing the existence of social class differentials in rich countries. These differences applied to pedestrians, cyclists, moped riders, motorcyclists and drivers. Further evidence for a socioeconomic gradient has been provided by a recent study by Hippisley-Cox and colleagues, in a cross-sectional survey of the severity and mechanisms for all childhood injuries in England. The study confirmed the existence of a socioeconomic gradient in injury morbidity in children, with pedestrian injuries showing one of the steepest gradients. The pedestrian injury rates among children from areas with the highest economic deprivation were 3 times the rates for children in the most affluent areas.

The relationship between socioeconomic status and road traffic injuries in low- and middle-income countries has not been systematically investigated. But the available data can be interpreted as showing that poor people bear a higher burden of morbidity and mortality from road traffic crashes in low- and middle-income countries. The populations with the greatest traffic injury burden in these countries are pedestrians, bicyclists, and passengers of buses, trucks, and minibuses, and these road users typically belong to the low socioeconomic group. In Kenya, for instance, 27% of commuters who had never been to school commuted on foot; 55% usually used public transport, mostly the informal transport system described later; and 9% used a private car. On the other hand, those with more than secondary/high school level education usually traveled in private cars (81%), none walked, and 19% used public transport. The level of education affects income, which in turn influences the choice of transport and the associated road traffic risks. So, for poor population groups the affordable transport modes were walking, bicycling, and traveling by bus, minibus, and truck.

The means of transport frequently used by poor people – walking, travel by bus, truck or minibus, and cycling – are associated with a high crash injury risk in low- and middle-income countries. People who walk or cycle must compete with fast-moving motor vehicles for space on multipurpose roads and streets, making them highly vulnerable to crash injury. These groups cannot afford the safer transport mode used by higher socioeconomic groups, namely, private cars. Passengers of multi-passenger vehicles, such as buses, minibuses and pick-up trucks, are also vulnerable to increased crash risk.

Transport mode and differential risk of injury

Public transport systems are not well developed in low- and middle-income countries. Instead, an informal transport mode has evolved to fill this gap. Consisting of privately owned buses, minibuses, and pick-up trucks, this mode of transport has become a major player in ferrying fare-paying members of the public in many countries. This transport
mode falls between the private automobile mode and the conventional public transport system. It includes, for instance, the vehicles popularly known as the *matatus* in Kenya, the light buses of Hong Kong, the minibuses of Singapore, the *Jeepneys* of Manila, the *Colt* of Jakarta, the *Dolmus-minibus* of Istanbul, the *dala dala* of Tanzania, the *tro-tro* of Ghana, the *tap-tap* of Haiti, the *molue* (locally dubbed ‘moving morgues’) and *danfo* (‘flying coffins’) of Nigeria, and the taxis of Uganda and South Africa.

This intermediate transport mode has both positive and negative attributes. The positive features are fares that are affordable to poor people, the convenience of stopping anywhere to pick up or drop off passengers, and unfixed time schedules. However, in many countries, passenger overloading, aggressive acceleration and disregard for other road users are common negative attributes. The drivers work long hours to pay vehicle owners a daily fee, resulting in driver fatigue, sleep deprivation, overloading, reckless driving and high vehicle speeds. These factors predispose the passengers to high risk of injury due to the high rates of involvement of these vehicles in fatal road crashes.6,18,19 Acute sleep deprivation of drivers increases the risk of a crash in which a vehicle occupant is injured or killed.20

This transport mode also encourages unsafe driver behaviors, such as the deliberate jumping of red lights and dangerous overtaking of other vehicles. This behavior can have dire consequences. For instance, the driver of one *danfo*, meaning ‘flying coffin,’ in Nigeria swung his vehicle from his lane and into the opposite lane, to beat a traffic snarl-up, and sped on until he encountered an oncoming truck that would not yield. The *danfo* was flung into the Lagos Lagoon and all the occupants drowned.21 Heavy competition for passengers, in order to maximize the drivers’ income, is also commonplace, despite the risks involved. For instance, two buses collided on a bridge near the coastal town of Malindi in Kenya, and both plunged into the river, leaving over a hundred passengers dead. The two buses were reported to have been racing each other for 20 kilometers in order to get to Malindi first to pick up other passengers.22 Incidents such as these are common in low-income countries.

**Differential impact of road traffic injuries among population age groups**

The ranking of road traffic injury morbidity and mortality for the three age groups most affected is summarized in Table 1, based on data from the World Health Organization’s 1998 database on injuries. Globally, for age 5–14 years, road traffic injuries were the third leading cause of death, after malaria and acute lower respiratory tract infections. For age 15–44 years, road traffic injuries were the second leading cause of death, after HIV/AIDS, and fourteenth leading cause of death for children aged 0–4 years. In terms of DALYs lost, the WHO database ranked road traffic injuries as the fifteenth cause of DALYs lost for age 0–4 years, but second cause after trauma due to falls for age 5–14 years, and third cause of DALYs lost for age 15–44 years after HIV/AIDS and unipolar major depression.

### Table 1. Relative position of road traffic injuries among leading causes of disability – adjusted life years (DALYs) lost and death, 1998.

<table>
<thead>
<tr>
<th>Position in age groups</th>
<th>0–4 years</th>
<th>5–14 years</th>
<th>15–44 years</th>
<th>45–59 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>High-income countries</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The Americas</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Europe</td>
<td>7</td>
<td>5</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Western Pacific</td>
<td>6</td>
<td>5</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Eastern Mediterranean</td>
<td>&lt;15</td>
<td>&lt;15</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Low- and middle-income countries</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Africa – sub-Sahara</td>
<td>&lt;15</td>
<td>&lt;15</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Asia (India)</td>
<td>12</td>
<td>10</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Asia (other countries)</td>
<td>11</td>
<td>9</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Western Pacific (China)</td>
<td>&lt;15</td>
<td>12</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Western Pacific (others)</td>
<td>11</td>
<td>9</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>The Americas</td>
<td>13</td>
<td>10</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Eastern Mediterranean (others)</td>
<td>&lt;15</td>
<td>&lt;15</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Europe</td>
<td>&lt;15</td>
<td>14</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Globally</td>
<td>15</td>
<td>14</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

The fatality per capita indices for different age groups, for all WHO regions, measured as number of deaths per 100,000 population for the particular age, are shown in Table 2. Overall, the data in Table 2 reveal that for age 0–4 years, fatality rates due to road traffic injuries in low-income regions were higher than in high-income regions. However, among low-income regions the rates varied widely, from 5.6 per 100,000 population in the Eastern and Central Europe region to 29.5 fatalities per 100,000 population in South-East Asia and the Western Pacific region. In between is India, with a rate of 19 fatalities per 100,000, population, and Latin America and the Caribbean, with a rate of 10.1 fatalities per 100,000 population. The fatality rate for 0–4 years was substantially lower in high-income regions (4.5 deaths per 100,000 population).

Large differences between rich and poor regions in the fatality rates for 5–14 years can also be seen in Table 2. Africa had a fatality rate of 28.1 deaths per 100,000 population, 3 to 6 times higher than the rates for high-income regions (4.8–8.9 deaths per 100,000 population). However, different low- and middle-income regions showed a wide variation in fatality rates. For instance, the rate for China, estimated at 6.5 deaths per 100,000 population, was 4.3 times lower than that for Africa.

In high-income regions, the road traffic mortality rates for the 15–44 years age group clustered together (20.5–21.3 deaths per 100,000 population), and were 4 to 5 times the rates for younger age groups in the same regions. The low- and middle-income regions also had high fatality rates in this age group, which varied from 14.4 deaths per 100,000 population in China to 32.8 deaths per 100,000 population in Africa. However, unlike high-income regions, significant differences in fatality rates were not observed among the age groups.

Overall, young adults (age 15–44 years) account for most of the fatalities and injuries from road traffic crashes. Several published studies, reviewed by Odero et al., show this population group to account for 48–78% of all fatalities. Krug et al. estimate, using data from the 1998 WHO database, that up to 70% of the total years of life lost due to road traffic injuries is accounted for by this age group. These are also the prime years of economic productivity, magnifying the economic impacts of the burden.

Males are more likely to be injured or killed in road traffic crashes. Based on the 1998 WHO database, the fatality rate for males, estimated at 28.8 per 100,000 population, was almost 3 times the rate for females, estimated at 10.8 per 100,000 population. An analysis of forty-six published studies showed that males consistently outnumbered females among people killed in road traffic injuries: between 67 and 99.5% of deaths involved males. The preponderance of males, who account for about three-quarters of the casualties in several published studies, may reflect gender disparities in access to economic opportunities and in exposure to road traffic injury risks as drivers and passengers.

### Table 2. Fatality rates per 100,000 population for three age groups in different WHO regions.

<table>
<thead>
<tr>
<th>Regional Grouping</th>
<th>0–4 years</th>
<th>5–14 years</th>
<th>15–44 years</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Low- and middle-income countries</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Africa</td>
<td>NA</td>
<td>28.1</td>
<td>32.8</td>
</tr>
<tr>
<td>Americas</td>
<td>10.1</td>
<td>17.2</td>
<td>29.3</td>
</tr>
<tr>
<td>Europe</td>
<td>5.6</td>
<td>7.9</td>
<td>27.5</td>
</tr>
<tr>
<td>South-East Asia</td>
<td>29.5</td>
<td>12.7</td>
<td>21.8</td>
</tr>
<tr>
<td>West Pacific</td>
<td>29.5</td>
<td>12.7</td>
<td>21.7</td>
</tr>
<tr>
<td>India</td>
<td>19</td>
<td>17.1</td>
<td>20.6</td>
</tr>
<tr>
<td>East Mediterranean</td>
<td>NA</td>
<td>10.5</td>
<td>19.5</td>
</tr>
<tr>
<td>China</td>
<td>6.2</td>
<td>6.5</td>
<td>14.4</td>
</tr>
<tr>
<td><strong>High-income countries</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>West Pacific</td>
<td>4.5</td>
<td>4.8</td>
<td>21.3</td>
</tr>
<tr>
<td>East Mediterranean</td>
<td>NA</td>
<td>8.9</td>
<td>21.2</td>
</tr>
<tr>
<td>Europe</td>
<td>4.6</td>
<td>4.9</td>
<td>20.7</td>
</tr>
<tr>
<td>Americas</td>
<td>4.5</td>
<td>4.9</td>
<td>20.5</td>
</tr>
</tbody>
</table>

Source: Database World Health Report, 1999 [2]; NA = Data missing.

**Discussion**

Globally, the risks of injury and severity of health outcomes of road traffic crashes vary, by region, country, and geographic locality, and also by age, gender, and road user category. The morbidity and mortality rates are higher in low- and middle-income regions of the world than in high-income regions. This gap between rich and poorer regions of the world is increasing. The influence of income is most evident in the distribution of morbidity and mortality rates among young age groups. The data presented in this paper show that the morbidity and mortality rates in low- and middle-income regions are higher than in high-income regions, especially in young age groups.

Recent evidence suggests that income also influences the distribution of the burden of road traffic injuries within countries. In high-income countries, injuries are more severe and fatality rates are higher among young age groups from low socioeconomic classes compared to cohorts from higher socioeconomic classes. A similar situation may apply to low- and middle-income countries, as suggested by available data on fatality rates by age, gender, and road user category for people who are injured in these countries. By inference, the population groups exposed to highest risks of injury and fatality from traffic crashes in low-and middle-income countries — pedestrians, passengers of buses, minibuses, pick-up trucks, and cyclists — are from lower socioeconomic groups. These population groups are exposed to higher risks of injury.
because the modes of transport affordable to them carry higher risks than private cars. These population groups also have limited access to emergency health care, when crashes occur.24 These disparities need to be studied systematically, both at the global level and at national levels.

High-income countries have recorded remarkable achievements in reducing fatalities due to road traffic injuries in the last 30 years, even though disparities persist in risks of injury for low socioeconomic groups.5 The low- and middle-income countries can learn from the experiences of high-income countries. However, policies implemented in rich countries cannot be transferred directly to the low- and middle-income countries, because the vulnerable population groups at risk and national sociopolitical contexts are different.6,8,25

The disparities in the distribution of injury risks, and the morbidity and mortality rates associated with road traffic injuries, are socially determined. The key determinants are social class and income.6,11–17 The high risks of injury and the high morbidity and mortality rates among poor population groups could be substantially reduced, often by low-cost and effective policies. These disparities are unfair to the vulnerable population groups, who are subjected to high risks associated with road transport conditions, over which they have little choice, and consequently bear a disproportionately high burden of injuries and fatalities. This notion of social justice is closely associated with the idea of equity. According to this perspective, the disparities in road traffic injuries described in this paper represent important health inequities (both between countries and within countries), since they are preventable and unfair.26

Perceiving the root causes of road traffic injuries from this social justice perspective raises critical questions about social policies focused on the vulnerable populations that bear an unfair burden of road traffic injuries.27 What policies would make a difference in protecting the vulnerable populations in low- and middle-income countries?

For pedestrians and cyclists, the root cause of many crashes is the intense competition for space on multipurpose roads and streets, especially the role of fast-moving motor vehicles. The conflict is most severe on streets passing through crowded low-income urban residential areas and in settlements along major roads passing through rural areas. To reduce the crash and injury risks experienced by vulnerable population groups, key stakeholders need to be mobilized to support the development and implementation of policies that protect these groups. To achieve this, a paradigm shift is required, to give equal protection to all road users, so that roads and streets do not produce an unfair burden of injury and death for lower-income groups. A way to ensure that policies on road safety effectively protect vulnerable groups is to involve those groups in designing measures to reduce their risks and to increase public accountability for road safety agencies in implementing protective policies.

The protection of passengers who travel by bus, minibus, and truck presents a different set of challenges. The high crash risks associated with this transport mode result from a number of factors, including high-risk driver behaviors motivated by remuneration incentives, corrupt practices among enforcement agents, the persistence of public apathy, and power differentials between commercial drivers and their employers.6 The drivers are also victims of the power dynamics within this transport mode, as they are not unionized and generally have no job security, no guaranteed wages, and no medical or life insurance. How can this transport mode be made safer? A combination of regulation, changed driver remuneration incentives, and innovative experiments in social policy may give good results. One such experiment was the public campaign initiated by Uganda’s Head of State that encouraged the passengers of minibuses to take responsibility for their own safety by refusing to board overloaded minibuses. This intervention produced outstanding success where law enforcement agents had failed.6

The circumstances underlying the health inequities of road traffic injuries differ by country and by community. Policy interventions, therefore, need to be designed according to the local socioeconomic and political contexts, guided by local research evidence. The focus should be on policies that promote low-cost and effective technologies, supported by high-level political leadership and international support. Three factors create an opportunity for placing road traffic injuries on the global development agenda: the emerging interest in health equity; the global campaign for poverty alleviation; and the ongoing efforts at health sector reform.28 There is a need to evaluate different policy interventions, with an emphasis on their effectiveness in protecting key vulnerable groups at risk.

References
8 Nantulya VM, Reich, MR. The neglected epidemic: road traffic injuries in developing countries. BMJ. 2002;324:1139–1141.