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Traffic safety: emerging concerns for low and middle income countries

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Abstract

This paper examines the data available from published reports to understand the shortcomings in our present understanding of the following road safety issues: the relationship between national income and traffic safety; relative risk of different categories of road users in different societies; and urban form and traffic safety. Promoting, rather than effectively enforcing a few well-known safety countermeasures like helmet and seat belt use; weak efforts at controlling speeds and drinking and driving; and crashworthiness standards for cars may not be enough to substantially lower road traffic fatality rates internationally. Patterns of motorised two-wheeler and paratransit vehicle crash rates seem to be different in low and middle-income countries. Much more detailed research needs to be done in low and middle-income countries by establishing research centres to address local issues in these countries.

Keywords

Low and middle-income countries; Motorcycles; Small vehicle crashworthiness; Fatality rates

Introduction

The World Health Organization (WHO) released its World Report On Road Traffic Injury Prevention in 2004 (Peden et al 2004). This report focussed on road traffic injuries (RTI) and fatalities as a worldwide health problem and included a summary of the known risk factors associated with road traffic crashes and possible countermeasures that should be put in place to control the problem. It also pointed out that “Without new or improved interventions, road traffic injuries will be the third leading cause of death by the year 2020”. The publication of this report spurred some national and international agencies and civil society groups to give a little more attention to the problem of road safety and a number of resolutions have been passed by the United Nations General Assembly, World Health Assembly and the Executive Board of the WHO. The WHO has released three Global Status Reports On Road Safety in 2009, 2013 and 2015 (WHO 2009, 2013 and 2015). These reports offer a broad assessment of the status of road safety in over 175 countries. The data were obtained by the WHO from national governments using standardised survey forms.

The latest WHO Global Status Report shows that low-income and middle-income countries on an average have higher road traffic fatality rates (24.1 and 18.4 per 100,000 populations, respectively) than high-income countries (9.2 per 100,000 population). These estimates are based on regression models that rely on national death registration data and seek to correct for substantial underreporting in official government statistics that are usually based on traffic police reports. WHO’s modelled estimates exceeded official statistics by more than 20 per cent in 60 per cent of the countries.

The Status Report estimates that 49 per cent of those who die in road traffic crashes are pedestrians, bicyclists and users of motorised two-wheelers (MTW). However, this is likely an underestimate because WHO’s estimates rely on official government statistics to estimate the proportion of different types of road users killed. For example, in the latest report the data for India includes the proportion for pedestrian and bicyclist deaths as 9 and 4 per cent respectively. However, a recent research report from India suggests that pedestrian and bicyclist deaths may be in the range 39-45 per cent (Mohan et al 2015). Similarly, the Status Report and official statistics from China report that 26% of deaths are pedestrians. However, China’s national burden of disease estimate, which are based on national health data, suggest that pedestrians comprise 53% of traffic fatalities (Zhou et al 2013). Though some of the data in these Status Reports may not be accurate, they do provide a rich source of information that was not earlier available.

The 2015 Report suggests that “Changing road user behaviour is a critical component of the holistic ‘Safe Systems’ approach advocated in this report. Adopting and enforcing good laws is effective in changing road user behaviour on key risk factors for road traffic injuries

- speed, drink-driving, and the failure to use helmets, seat-belts and child restraints properly or at all." These recommendations are similar to those included in earlier reports and have been adopted by most international agencies promoting road safety in low- and middle-income countries (for example, Bloomberg Initiative for Global Road Safety and Global Road Safety Partnership). Focus on these five risk factors is unexceptionable, as they would work in every country if controlled successfully. However, all these interventions require implementation and enforcement of traffic laws that is not as straightforward or easy. For enforcement to create a meaningful deterrent threat, enforcement activity needs to be increased substantially and maintained over a long period so that road users perceive a high risk of being ticketed (Zaal 1994). Severe penalties and quick punishment are not effective unless drivers believe that there is a high risk of apprehension. However, large increases in traditional (manual) police enforcement will often not be politically acceptable, especially in settings where traffic stops are used by police as a tool for crime prevention and broader social control (Epp et al 2014). For some domains, such as speed control, there are emerging automated technologies that may allow large increases in enforcement without concomitant increase in direct contact with police personnel. However, large-scale deployment of these technologies in low- and middle- income countries remains largely untested. This may be why most local agencies and governments fall back on 'education', driver training and behaviour change campaigns that are usually not very successful (Williams 2013; Williams AF 2007; Williams AF 2007a; Robertson 2007; Haddon WJ 1968).

Another important stream in global intervention strategies is in the promotion of universal motor vehicle safety standards. There are two approaches to improving car design: (1) legislation that prescribes requirements with which vehicle manufacturers need to comply, and (2) information programs by organisations like Global New Car Assessment Programme (Global NCAP) that provide safety ratings for cars and allow car buyers to pick safer cars. Again, this activity is desirable and must be promoted to make cars safer for their occupants.

However, these approaches need to be tailored to the particular context of every country. Creating a market for safety through star ratings of cars can influence drivers to buy vehicles that protect vehicle occupants but are unlikely to influence vehicle design improvements for the safety of road users outside the car. However, in many countries car occupants comprise less than 10-20 per cent of road traffic fatalities (WHO 2015; Mohan 2015). Thus, it is important to legislate vehicle design standards that improve the safety of pedestrian, bicyclists and motorcyclists in collisions. Furthermore, these standards need to include buses and trucks, which comprise a large proportion of vehicles that impact vulnerable road users (Mohan 2015){Epp, 2014 #2556}. Exclusive focus on cars also ignores some important issues of relevance to low and middle-income countries (LMIC), such as safety of paratransit vehicles (three-wheeled taxis, tuk-tuks, jeepneys, etc.).

The WHO reports do mention the need for focussing on safer street design in urban areas, but urban planners and policy makers in most LMIC are not giving enough attention to this issue. This is possibly because the role of urban planning in promoting road safety is still not well understood. It is only recently that some of these issues have been highlighted by Cho et al 2009; Dumbaugh 2013; Ewing and Dumbaugh 2009; Miranda-Moreno 2011 and Mohan and Bangdiwala 2013. They suggest that the existence of big urban blocks, high proportion of wide arterial streets and even proliferation of big box stores may increase road traffic crash risk. Urbanisation is going to be an important feature of development in most LMIC, therefore, it is essential that we develop a more nuanced understanding of these issues so that road safety can be promoted in a more integrated manner.

In this paper the data available from published reports is examined to understand the shortcomings in our present understanding of the following road safety issues:

- Relationship between national income and traffic safety
- Relative risk of different categories of road users in different societies
- Urban form and traffic safety

National income and traffic safety

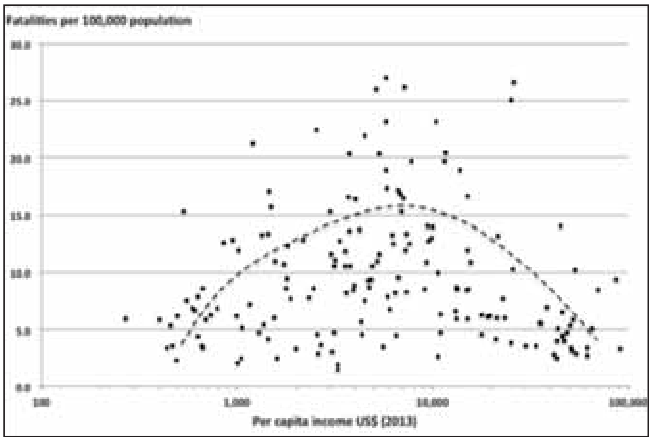

Figure 1. Fatalities per 100,000 population (official data from countries) vs. national per capita income for 171 countries. Source (WHO 2015)

Figure 1 shows a plot of fatalities per 100,000 population versus per-capita income of various countries based on the official reports from countries as reported by WHO (WHO 2015). Fatalities per 100,000 population is used for most comparisons in this paper because the index is a good indicator of the health burden on the population. Fatalities per population can also be used as proxy for risk of death per trip, as international experience suggests that the average number of trips per person remains relatively stable over time, incomes and place according to Knoflacher (2007). Knoflacher further states that average trip rates in cities around the world vary from 2.8 to 3.8. That total trip rates do not vary much and generally remain between three and four trips per person per day has been supported by many studies around the world (Giuliano and Narayan 2003; Hupkes 1982; Santos et al 2011; and Zegras 2010.

Data presented in Figure 1 suggest that road traffic fatalities per unit population increase initially as societies become richer but begin to decline after the society reaches a certain developmental threshold. However, it must be noted that 60 per cent of these countries, especially low and middle-income ones, may have underestimated the total number of deaths as mentioned earlier. Such multi-country data and historical data from some high-income countries from Western Europe and North America have been used by many researchers to model the relationship between per capita income and road traffic injury (RTI) fatality rates (e.g. Kopits and Cropper 2005; Koornstra 2007. The model developed by Kopits and Cropper predicts that the income level at which traffic fatality risk first declines is US$8,600 (1985 international prices). According to this model they predicted that the "road death rate in India, for example, will not begin to decline until 2042". Using a more complex model Koornstra predicted that road traffic fatalities may start declining in countries like India around 2030 if corrective actions are taken by policy makers in a 'learning scenario'. Both these predictions may be somewhat pessimistic if we take note of the more recent data and analyses made available to us.

While Figure 1 shows official statistics, Figure 2 shows the WHO estimates of road traffic fatalities for the same countries as in Figure 1, plotted against national per capita income (WHO 2015). These data have a very different distribution from that in Figure 1. Here we see a general tendency for a decrease in fatality rates with increasing incomes across countries. The rise and fall of traffic deaths in Figure 1 appears to be largely due to underreporting of traffic deaths in LMIC. Therefore, it is possible that our earlier understanding that fatality rates will continue to increase until societies reach income levels between US$10,000-20,000 (2013 international prices) before decreasing may not be correct. A study by Castillo-Manzano et al (Castillo-Manzano et al 2014) examining the trends in road traffic fatality rates in a sample of European states over the 1970–2010 period shows that "the convergence of EU countries as a whole on road safety being a clear empirical fact, as the countries with traditionally higher fatality rates at the beginning of each period have experienced a more negative average rate of change". They conclude that convergence on road safety is possible even without economic convergence, but the exact reasons for the same are not clear.

It is possible that there is not necessarily a relationship between income and road safety performance when other factors are controlled. Both Figures 1 and 2 show a very large variation in road safety performance of countries at the same income level. This is true for countries at all income levels. The reasons for such variation are poorly understood but are likely due to a wide range of structural factors that affect road safety outcomes. It would be much more useful to understand why countries at the same income level perform very differently than to understand the relationship of road safety performance with income (Bhalla and Mohan 2016).

Relative risk of different category of road users in different societies

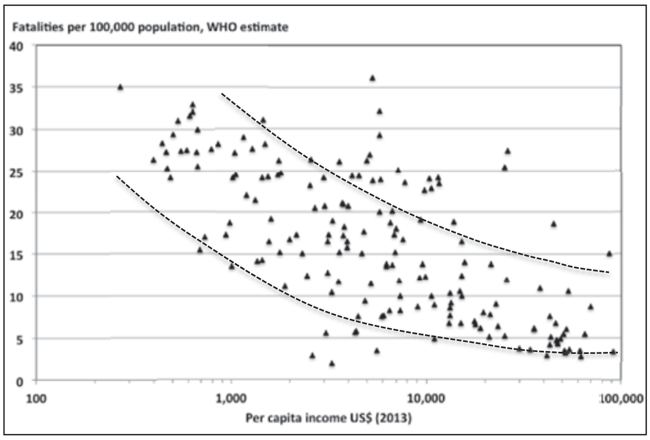

Figure 2. Estimated fatalities per 100,000 population (WHO estimates) vs. national per capita income for 171 countries. Source (WHO 2015)

Almost all our understanding of road safety issues derives from the experience of about a hundred years of motorisation in the high-income countries of today. This experience is based on traffic systems where the safety of car occupants remained the central concern. In these countries cars have been the dominant part of traffic systems unlike in many of the LMIC where MTW and paratransit vehicles like three-wheeled taxis, tuk-tuks, jeepeneys (TWT in this paper) constitute a significant proportion of traffic on roads. Since we do not have detailed epidemiological studies on the effect of these latter vehicles on traffic safety in LMIC we do not have a good understanding of the risks faced by occupants of these vehicles where these vehicles form a dominant mode of transport. Here data available from research reports originating from India are compared with the experience of OECD countries to get an initial understanding of the differences in traffic safety issues around the world.

Relationship between MTW share in vehicle fleet and fatalities

Figure 3 shows the percentage of motorised two-wheeler (MTW) fatalities in OECD countries for the years 2001 and 2011 and Indian cities in 2013 vs. the percentage of MTW in fleet (OECD/ITF 2015; Jacobsen 2015). Data for countries is not strictly comparable with urban data as vehicles on urban roads may operate under different conditions than those on rural roads. However, these data do provide us with some pointers for further study. These data show that though there is a general tendency for the proportion of MTW fatalities to increase with an increase in the proportion of MTW in the fleet, the relationship is not very strong.

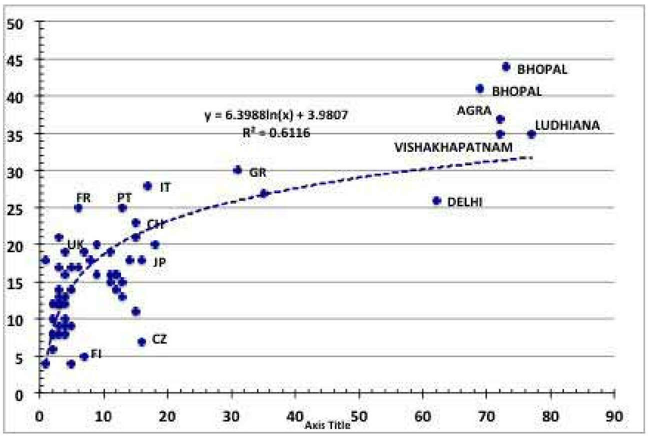

Figure 3. Per cent motorised two-wheeler (MTW) fatalities in OECD countries (no labels) for the years 2001 and 2011 and Indian cities (with labels) in 2013 vs. per cent MTW in fleet (Data from Bhalla and Mohan 2016; OECD/ITF 2015)

For example, in 2011 Finland, Japan and Switzerland had similar proportions of MTW in their fleets (13%, 14% and 15% respectively) but MTW fatality shares were very different at 13%, 18% and 23% respectively (OECD/ITF 2015). In the six Indian cities the share of MTW in the fleet is similar, but proportion of MTW fatalities differ substantially.

The explanations for differences in MTW fatalities could include differences in driving speeds, distance driven per year, helmet use, dominant age group using MTW, and engine size of MTW. The data also show that the safety in numbers effect may be true for MTW riders also as MTW fatalities do not seem to increase in proportion to MTW in the fleet, especially when MTW proportions are high. Safety in numbers is the phenomenon by which the per road user frequency of being killed declines as the proportion of those road users increase in a city or country (Jacobsen 2015; Beanland et al 2014).

Fatality rates for different vehicle occupants in OECD countries and Indian cities

Table 1 shows data for selected OECD countries for fatalities of MTW and car occupants per billion vehicle kms. Car occupant fatality rates range from a low of 2.1 in the United Kingdom to a high of 10.5 in the Czech Republic, and, for MTW riders from a low of 39 in Switzerland to a high of 253 in the Czech Republic. There are no clear explanations available why car occupant risk rates differ by a factor of five and MTW rates by a factor of six in these OECD countries.

Figure 4. Example of a three-wheeled scooter taxi (TWT)

Table 1. MTW and car occupant fatalities per billion vehicle km in OECD countries (Data source: OECD/ITF 2015)

Country	Fatalities/billion vehicle km		MTW/ Car Radio
	MTW	Car	
Australia	71.8	5.2	14
Austria	59.7	4.7	13
Belgium	76.9	5.9	13
Canada	62.9	4.9	13
Czech Republic	252.6	10.5	24
Denmark	49.5	4.2	12
France	72.4	4.9	15
Germany	59.5	3.3	18
Ireland	60.8	2.5	24
Israel	45.7	5.1	9
Netherlands	64.0	3.0	21
Slovenia	112.5	4.3	26
Sweden	43.9	2.2	20
Switzerland	39.2	2.3	17
United Kingdom	72.0	2.1	34
United States	155.0	5.0	31

The last column in Table 1 gives the ratio between car and MTW fatality rates per billion vehicle kms for each country. In Israel MTW riders have nine times higher risk of dying than car occupants and in United States this ratio is 31.

Table 2 shows estimates of fatalities of MTW, TWT and car occupants per billion vehicle kms for selected Indian cities (Mohan et al 2016; Mohan et al 2014). These data are not available at the country level. Vehicle mileage data for Delhi and Vishakhapatnam were obtained from special surveys (Mohan et al 2014). Vishakhapatnam vehicle-use data were used for other cities as they are similar in size. TWTs are paratransit vehicles used as taxis and an example is shown in Figure 4. Helmet use is compulsory for all MTW riders by law in India (Ministry of Road Transport and Highways 1988) but out of the six cities included in Table 2 the law is being enforced only in Delhi with compliance rates around 90% in the daytime (Patel and Mohan 1993), which may explain the relatively low fatality rate in Delhi. Agra has the highest fatality rates for the three categories of vehicles compared to the other cities. The reasons for this are not known.

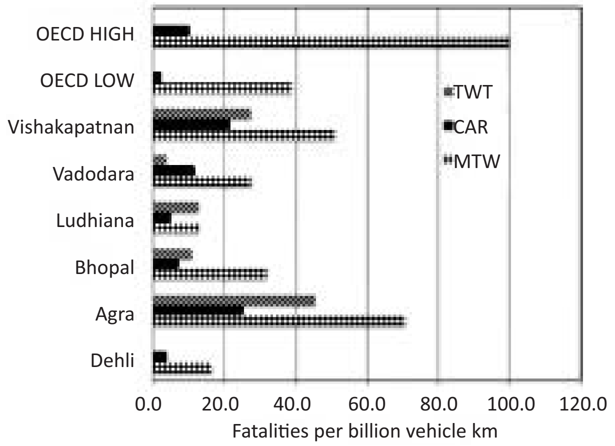

Figure 5. Fatalities per billion vehicle km on OECD countries and six Indian cities for MTW, TWT and cars.

The fatality rates per billion vehicle kilometres for each category of vehicles differ by more than a factor of five. The differences among these cities are similar in magnitude as those observed for OECD countries. Detailed epidemiological data are not available at present to account for these differences. It would be very useful if data are obtained to understand the reasons for the differences between high rate and low rate cities for each category of vehicles.

OECD country and Indian city comparison of fatality rates per billion vehicle km for cars.

The fatality rates per billion vehicle kms for selected OECD countries for cars and MTW and the ratio of MTW and car rates are given in Table 1 and the rates for MTW, cars and TWT along with MTW/car and TWT car ratios in Table 2. Figure 5 compares the rates in Indian cities with the highest and lowest rates in OECD countries. Though country and city data are strictly not comparable we think that comparison of these statistics will give us leads for greater examination of these issues.

The average fatality rate for car occupants in six Indian cities is 4.9 fatalities per billion vehicle km with a high of 25 and low of 3.8. The average for OECD countries is 4.4 fatalities per billion km with a high of 10.5 and low of 2.1. The highest and lowest values differ by a factor of about five for both the groups.

Table 2. MTW, TST and car occupant fatalities per billion vehicle km in selected Indian cities (Data source: Bhalla and Mohan 2016; Beanland et al 2014)

Indian city	Fatalities/billion vehicle km			MTW/ Car Radio	TWT/ Car Radio
	MTW	TWT	Car		
Australia	71.8	-	5.2	14	-
Austria	59.7	45.3	4.7	13	1.8
Belgium	76.9	11.1	5.9	13	1.5
Canada	62.9	12.8	4.9	13	2.6
Czech Republic	252.6	3.8	10.5	24	0.3
Denmark	49.5	27.4	4.2	12	1.3

In OECD countries, all cars are required to conform to crashworthiness standards; and seat belt wearing rates in a majority of the countries are more than eighty per cent (IRTAD 2014). In contrast, cars in Indian cities do not have to conform to crashworthiness standards (Mohan et al 2015) and seatbelt use is likely to be less than twenty per cent overall, as the law is applicable only to front seat passengers and not enforced strictly except in Delhi during daytime (Mohan 2009). Use of seat belts by drivers, front seat passengers and rear seat passengers is expected to reduce fatalities by 50%, 45% and 25%, respectively (Elvik and Vaa 2004). According to Farmer and Lund (Farmer and Lunk 2015), between the years 1984 and 2009 the risk of driver death declined by an estimated 42% in cars, 44% in pickups, and 75% in SUVs in USA. Therefore, we should expect fatality rates of car occupants in Indian cities to be about double those in the OECD countries with better safety records, based on this factor alone. Average country fatality rates for vehicles can be higher than city rates due to lower average velocities in the latter, therefore it is possible that the car fatality rate per billion vehicle km is higher than the average city rate quoted above. However, it appears that the highest and lowest fatality rates for cars on an average in India are about double those in the OECD countries. If all cars in India satisfied the NCAP crashworthiness norms we could expect a reduction in fatalities by more than 50%. It is estimated that car occupant fatalities in India are about 10,000-13,000 (7%-9%) of the total of 141,526 fatalities. Therefore, if all cars in India had similar crashworthiness characteristics as those in OECD countries in 2014 and seat belt laws were being enforced, we would at least halve the annual car occupant fatalities and save about 5,000-6,000 (~4%) lives annually. At present growth rates it will take about 15 years for ninety per cent of the car fleet to be replaced in India (Mohan et al 2014). Therefore, while it is imperative that all cars in India satisfy international crashworthiness standards, it will only result in a reduction of death rates by less than 4% over the next 15 years.

OECD country and Indian city comparison of fatality rates per billion vehicle km for motorised two-wheelers.

The average fatality rate per billion km for MTWs in the selected OECD countries is 81.2 with the lowest being 39.2 and the highest 252.6. The average rate for the six Indian cities is 21.3 with lowest being 12.8 and highest 70.7. The lowest fatality rate in Indian cities is about one third of the lowest rate in OECD countries and the highest in India slightly more than one third of the highest in OECD countries. The much lower rates in Indian cities are probably partly due to lower powered MTWs (most have engines < 175 cc), lower velocities in urban areas, and because MTWs in Indian cities tend to be used by an older age group for regular urban commuting and less for sporting or recreational purposes. However, differences in rates by a factor of three probably cannot be explained by these issues alone.

Use of daytime running lights by MTWs is negligible in all Indian cities and the helmet law enforced only in Delhi among the cities included in Table 2. Helmet laws are expected to reduce fatalities by about thirty to forty per cent (Elvik and Vaa 2004; Cochrane database 2003) and daytime running lights on MTWs by about fifteen per cent in tropical countries (Radin 1996; Yuan 2000). Therefore, if daytime running lights were in use in India and helmet laws observed by all MTW riders, the fatality rates may have been lower by 40%-50%. In that case the Indian city MTW fatality rates would be about five times lower than the OECD country MTW rates. The ratio of risk for MTWs compared to cars range from 2.3 to 4.4 for Indian cities and 9 to 34 for OECD countries. Such a large difference in MTW risks and risk ratios cannot be explained by knowledge presently available with us.

According to recent estimates MTW fatalities constitute 20%-34% (~29,000-49,000 fatalities) of the total fatalities in India (Mohan 2015). Daytime running lights and helmet use can be enforced almost immediately and would reduce fatalities by about 12,000 to 20,000 lives annually. This is a saving of lives greater than 3-5 times than ensuring crashworthiness of cars and use of seat belts.

Comparison of fatality risk of occupants of three-wheeled taxis with that of car occupants in Indian cities

The fatality rates of TWT occupants per billion vehicle km range from 0.3 times to 2.6 times that for car occupants. The average occupancy of cars ranges from 1.8 to 2 and that of TWTs from 3-8 (Mohan et al 2016; Arora and Jawed 2011; Gadapalli 2016; Chanchani and Rajkotia 2012). Since the average occupancy of TWTs can be more than two times that of cars, and the fatality rate of TWT occupants per billion km less than twice that for car occupants, the risk of fatality per passenger km for the two vehicles could be similar. This is a very surprising finding because TWTs weigh less than a third of cars (Gawade 2004), have no surrounding steel shell and have to subscribe to a minimum of safety standards. Studies comparing safety of large cars with small cars have consistently found that larger cars provide better protection than small cars (Broughton 2008; Wood 1997; Buzeman et al 1998). All these studies have been done in high-income countries where all cars are capable of similar driving speeds.

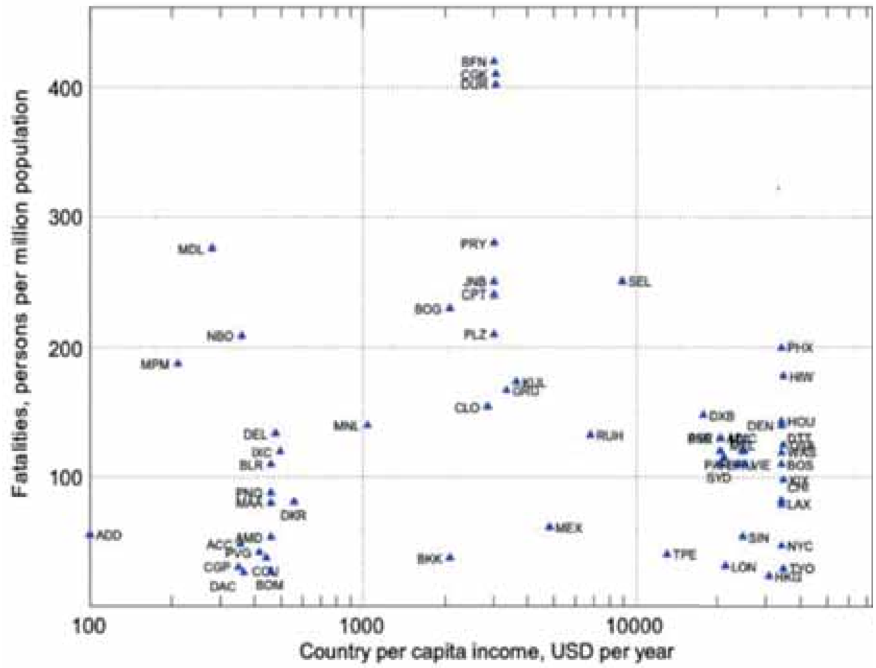

Figure 6. Fatality risk in traffic crashes by city. Cities are represented by their respective airport codes (Airport codes in Appendix 1, Source: Gadapalli and Rajkotia 2012)

No previous studies are available on safety records of motor vehicles that are not capable of high speeds operating in mixed traffic in urban areas. TWTs operating in Indian cities have engines smaller in size than 175 cc and generally cannot exceed velocities greater than 50 km/h. The experience of TWTs in Indian cities suggests that small lightweight vehicles with limited speed capabilities operating in the urban environment can result in low occupant fatality rates. The lower operating speed of TWTs also implies that they pose a much lower risk to pedestrians, bicyclists, and other road-users. This issue needs to be studied in greater detail, and if found true, it may suggest that there may be a need for less severe crashworthiness standards for such vehicles as compared to those capable of higher operating speeds.

Urban form and traffic safety

Figure 6 shows road traffic fatalities per million population for 56 cities around the world (Mohan 2008). These data show that there are wide variations across income levels and within similar income levels. The fatality rate varies by a factor of about 20 between the best and the worst cities. Some characteristics are summarised below:

- Overall fatality risk in cities with very low per-capita incomes (less than USD 1,000) and those with high incomes (greater than USD 10,000) seems to be similar.
- There is a very high variability in fatality risk in middle income countries (USD 10,000-20,000).
- There is a great deal of variation even in those cities where the per capita income is greater than USD 20,000 per year.

These patterns appear to indicate that it is not sufficient to have the safest vehicle technology to ensure low road traffic fatality rates uniformly across cities in those locations. Even in low and middle-income countries, the absence of funds and possibly unsafe roads and vehicles does not mean that all cities have high overall fatality rates. It is possible that the numbers reported for some of the low income cities may be underestimates. Provision of safely designed roads and modern safe vehicles may be a necessary condition for low road fatality rates in cities, but not necessarily a sufficient one. The fact that there are wide variations for overall fatality rates among high income cities, where availability of funds, expertise and technologies are similar, indicates that other factors like land use patterns and exposure (distance travelled per day, presence of pedestrians, etc.) may play an important role also.

Various studies suggest that (Dumbaugh 2013; Ewing and Dumbaugh 2009; Mohan and Bengdiwala 2013; Clifton et al 2009; Gronlund 2013; Risom and Mookerjee 2013; Hanson et al 2013; Marshall and Garrick 2011):

- Fatality rates in cities are not solely determined by income levels or city size. RTI fatality rates among cities with similar incomes or similar population levels can vary by a factor of 3-5. This indicates that city street structure and urban form can have a very significant effect on RTI fatality rates over and above issues of vehicle design and enforcement.
- It may be more useful to compare cities with very different RTI fatality rates rather than taking all cities in the sample to tease out the real factors influencing road safety.
- Cities with a higher proportion of wide streets and low density road networks appear to have a much higher RTI fatality rate.
- Urban form and street design patterns may have to be given much more importance to improve safety of pedestrians, bicyclists and transit users.

This suggests that we must spend more time in understanding the role of urban design and its influence on traffic safety as the present knowledge is inadequate.

Conclusions

In this paper, data available from published reports are examined to understand the shortcomings in our present understanding of road safety issues in low and middle-income countries. It is possible that there is not necessarily a relationship between income and road safety performance as there is a very large variation in road safety performance of countries at the same income level. This is true for countries at all income levels. The reasons for such variation are poorly understood but are likely due to a wide range of structural factors that affect road safety outcomes. It would be much more useful to understand why countries at the same income level perform very differently than to understand the relationship of road safety performance with income. Some of the issues that need much greater understanding is the safety performance of motorised two-wheelers and para transit vehicles in low and middle income countries and the effect of urban form on road safety.

The data analysed show that though there is a general tendency for proportion of MTW fatalities to increase with increase in proportion of MTW in the fleet, the relationship is not very strong. The data also show that a “safety in numbers” effect may exist for MTW riders also as MTW fatalities do not seem to increase in proportion to MTW in the fleet, especially when MTW proportions are high.

Focussing solely on car occupant safety is not likely to make a substantial dent in fatalities in low income countries. In India, car occupants comprise less than 10% of all deaths. Therefore, while it is imperative that all cars in India satisfy international crashworthiness standards, this will only result in a reduction of death rates by less than four per cent annually over the next 15 years.

MTW safety in India seems to differ substantially from that in OECD countries. The risk statistics for MTWs compared with cars range from 2.3 to 4.4 for Indian cities and 9-34 for OECD countries. Such a large difference in MTW risks and risk ratios cannot be explained by knowledge presently available with us. Daytime lights and helmet use can be enforced almost immediately and would reduce fatalities by about 50 per cent – about 12,000 to 20,000 lives annually. This is a saving of lives greater than 3-5 times than ensuring crashworthiness of cars and use of seat belts.

The risk of fatality per passenger for cars and para transit vehicles like TWTs and cars seems to be similar in India. This is a very surprising finding because TWTs weigh less than a third of cars, have no surrounding steel shell and have to subscribe to a minimum of safety standards. The experience of TWTs in Indian cities suggests that small lightweight vehicles with limited speed capabilities operating in the urban environment can result in low fatality rates. This issue needs to be studied in greater detail, and if found true, it may suggest that there may be a need for less severe crashworthiness standards for vehicles with operating speeds much lower than standard cars.

International data on fatality rates in cities show that there are wide variations across income levels and within similar income levels. The risk varies by a factor of about 20 between the best and the worst cities. These patterns appear to indicate that it is not sufficient to have the safest vehicle technology to ensure low road traffic fatality rates uniformly across cities in those locations, and urban form and street structure may have a significant effect on road traffic fatality rates. Since urban growth is going to continue in low and middle income countries it is very important that we develop a clearer understanding on what kind of city forms will ensure safe travel patterns.

Promoting a few well-known safety countermeasures like helmet and seat belt use; weak efforts at controlling speeds and drinking and driving; and crashworthiness standards for cars may not be enough for lowering road traffic fatality rates internationally. Much more detailed research needs to be done in low and middle-income countries by establishing research centres in these countries. Researchers in these centres would have to focus on the differences in patterns of crashes of the kind outlined in this paper and determine the underlying causes for the same. This would go a long way in helping achieve the objectives of the UN Decade for Road safety.

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Appendix 1

CODE	CITY	CODE	CITY	CODE	CITY
ACC	Accra	DEL	Delhi	MEX	Mexico City
ADD	Addis Ababa	DEN	Denver	MNL	Manila
ADL	Adelaide	DKR	Dakar	MPM	Maputo
AMD	Ahmedabad	DTT	Detroit	MUC	Munich
BER	Berlin	DUR	Durban	NBO	Nairobi
BKK	Bangkok	DXB	Dubai	NYC	New York City
BNE	Brisbane	GRU	Sao Paulo	PAR	Paris
BOG	Bogota	HIW	Honolulu	PEK	Beijing
BOM	Mumbai	HKG	Hong Kong	PHX	Phoenix
BOS	Boston	HOU	Houston	PNQ	Pune
BRU	Brussels	IXC	Chandigarh	PRY	Pretoria
CCU	Kolkata	JNB	Johannesburg	RUH	Riyadh
CGK	Jakarta	KIX	Osaka	SEL	Seoul
CGP	Chittagong	KUL	Kuala Lumpur	SIN	Singapore
CHI	Chicago	LAX	Los Angeles	TPE	Taipei
CLO	Cali	LON	London	TYO	Tokyo
CPT	Cape Town	MAA	Chennai	VIE	Vienna
DAC	Dhaka	MEL	Melbourne	WAS	Washington