



Basic Characteristics of Road Traffic Deaths in China

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Abstract

Background: This study is to report characteristics of people killed in road traffic crashes and to describe major patterns of traffic crashes in China.

Methods: Descriptive and inferential statistical analyses were conducted. Road traffic death national data, population denominator data and motor vehicles data of 2009 were obtained from the Bureau of Traffic Management at Ministry of Public Security and National Bureau of Statistics. The association between the fatalities from road traffic crashes and selected demographic factors, the time distribution, crash patterns, crash causes, and road user category were assessed in χ^2 analyses.

Results: Road traffic crashes in China disproportionately affected the following populations: males, persons 21-65 yr of age and adults aged more than 65 yr, persons living in rural areas, pedestrians, passengers, motorcyclists and bicyclists. Approximately 50% of fatalities of road traffic crash occurred in Eastern regions. The number of road traffic deaths was higher in daytime than in nighttime. Road traffic deaths in frontal crashes, side-to-side crash and crashes with an object or a person were more common than in rear-end crashes. In about 92% of road traffic deaths, auto drivers were believed to be responsible for the fatal crash. Major crash causing factors were speeding, careless driving, driving without a license, driving in the wrong lane, and driving after drinking alcohol.

Conclusions: Road traffic deaths accounted for about 70,000 premature deaths in China which should be taken into account.

Keywords: Road traffic, Death, Motorization, Crash pattern, China.

Introduction

Road traffic injuries (RTIs) are the leading cause of injury-related deaths globally (1-3). Nearly 1.26 million people die from road traffic crashes each year all over the world (1). Of these, 90% of road traffic deaths occur in low and middle income countries (2, 3). In addition, mortality from RTIs have been a tremendous increase in low and middle income countries; since the 1970s, mortality

from RTIs increased by 384% in Botswana, 243% in China, 237% in Colombia and 79% in India (4). RTIs exceeded any other causes of injury death and took first place in China (5). The mortality from RTIs will increase significantly from 5.1 million in 1999 to 8.4 million in 2020 (2). According to the prediction, rapid urbanization and motorization in low and middle income countries

will account for much of the traffic crash deaths increase, and this number is expected to increase significantly in the next two decades if without appropriate injury prevention measures to control the problem (6).

In many countries, rising rates of RTIs and consequent increases in deaths accompanied rapid economic growth and intensive motorization (7, 8). One of the main factors contributing to more road traffic crash deaths is the growing number of motor vehicles in low- and middle-income countries. According to a report, many of the deaths due to road traffic crashes occurred in the emerging motorized countries (9). In China, the number of registered motor vehicles increased from 1.59 million in 1978 to over 186.58 million in 2009. There are about 200 million drivers now in China (10). It's estimated that about 55 thousand new motor vehicles are registered in China every day.

A shortage of public health infrastructure is the other factors that may contribute to the fatalities from road traffic crashes in low- and middle-income countries. Advances in medical treatment and technology are one of the underlying factors that have reduced RTIs related fatalities in high-income countries (11). Severity of injuries causing fatalities among people was six-fold higher in low-income countries (36%) than in high-income countries (6%) (12). Although China has significantly higher rates of mortality of RTIs than high-income countries, RTIs are considered as 'a neglected epidemic' in China because there has been very little done to provide road safety statistics and to conduct road safety research.

The objectives of this paper were to report characteristics of people killed in road traffic crashes and to describe major patterns of traffic crashes in China.

Methods

Study Design and Data Source

This retrospective cross-sectional study was based on national data from the Bureau of Traffic Management at Ministry of Public Security of the People's Republic of China. Data used in our analyses covered one year period from 1 January 2009

to 31 December 2009. The information found in the registry for each crash was based on a standardized "Road Traffic Crash Information Collection Form" that is filled on-site by the traffic police. The information includes variables descriptive of the crash site and crash circumstances (e.g., crash cause, time, and place, number of deaths and number of injured people, type of crashes, pavement situation, and type of road) as well as of the victim(s). Population denominator data and motor vehicles data were obtained from the Annual Statistics Communique (10).

Definition of Study Variables

According to the inclusion criteria of the traffic police departments around China, road traffic crashes are defined to include all traffic related crashes that result in injury or death to road users (drivers, motorcyclists, cyclists, passengers, pedestrians and others).

Road traffic crash fatalities are defined to include all traffic-related deaths that occur within 7 days after the crash event.

Mortality rate per 100,000 population: Relative figure showing ratio of fatalities to population.

Time of crash is defined using two variables: daytime (06:00-18:00h) and nighttime (00:00-06:00h, 18:00-24:00h).

Season of crash is defined using four variables: Spring (March-May), Summer (June-August), Autumn (September-November), and Winter (January-February and December).

Pattern of crash is defined using five variables: frontal crash (front-to-front crashes), Side-to-side crash (side crashes), Rear-end crash (front-to-rear crashes), Motor vehicle with object or person (single motor vehicle crashes with object or pedestrians or bicycles) and other.

Crash region is classified into three groups (13): Eastern (Beijing, Tianjin, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong, Hainan), Central (Shanxi, Jilin, Heilongjiang, Anhui, Jiangxi, Henan, Hubei, Hunan) and Western (Neimenggu, Guangxi, Chongqing, Sichuan, Guizhou, Yunnan, Xizang, Shaanxi, Gansu, Qinghai, Ningxia, Xinjiang).

Statistical Analysis

Data were entered into EpiData 3.0 and analyzed with SAS 9.1. χ^2 analyses were performed to assess the association of fatalities from road traffic crashes with selected demographic factors, the time distribution, crash patterns, crash causes, and road users category. The mortality rate per 100,000 population was calculated for road traffic crashes. The demographic factors of mortality rate per 100,000 population was compared to estimate the risk of fatality in road traffic crashes by gender, age, residence and region. First, we compared demographic characteristics of fatalities from road traffic crashes by gender, age, residence and region in China. Age was divided into eight groups (1-9, 10-20, 21-30, 31-40, 41-50, 51-60, 61-65, and > 65 years) based on established age classification of the official police annual report (14). Second, we studied the time distribution of fatalities from road traffic crashes. The proportion of road traffic crash fatalities was compared by hour of day, day of week and season of year. Finally, the proportion of road traffic crash fatalities was compared by crash pattern, crash cause and road user category. A $P < 0.05$ was considered statistically significant in our study.

Results

In 2009, a total of 67,759 individuals died from road traffic crashes in China. Given the estimated population of 1328.02 million in the same year, the mortality rate was 5.1 per 100,000 population. Sociodemographic characteristics of road traffic deaths by gender, age, residence and region are presented in Table 1. The mortality rate per 100,000 population of road traffic crashes was significantly higher in males than in females (7.5 versus 2.5, $P < 0.001$). RTIs disproportionately affected adult people, with approximately 80% of those fatalities occurred among adults aged 21-65 years. Children aged 1-20 years accounted for more than 11%, and adults aged more than 65 years accounted for approximately 11% of total road traffic deaths. The mortality rates of road

traffic crashes varied greatly by rural-urban residence in China (5.7 versus 4.3, $P < 0.001$).

Table 1: Characteristics in fatalities from road traffic crashes by gender, age, residence and region in China, 2009

	n (%)	Mortality rate/100,000 population	P value*
Gender			
Male	51428 (75.9)	7.5	<0.001
Female	16331 (24.1)	2.5	
Age (years)			
1-9	2594 (3.8)	2.0	<0.001
10-20	5133 (7.6)	2.6	
21-30	10928 (16.1)	5.9	
31-40	14546 (21.5)	6.6	
41-50	13305 (19.6)	5.8	
51-60	10563 (15.6)	5.8	
61-65	3364 (5.0)	5.6	
> 65	7326 (10.8)	6.1	
Residence			
Rural	40886 (60.3)	5.7	<0.001
Urban	26873 (39.7)	4.3	
Region			
Eastern (11 provinces)	33251 (49.1)	6.3	<0.001
Central (8 provinces)	16374 (24.1)	3.9	
Western (12 provinces)	18134 (26.8)	4.9	

* χ^2 analysis of the association between mortality rate per 100,000 population and selected demographic factors

Of the 67,759 road traffic deaths in 2009, more than three-fifth (40,886) occurred in rural areas. The numbers of road traffic deaths varied by geographic regions. Approximately 50% of fatalities of road traffic crashes occurred in Eastern, 26.8% occurred in Western and 24.2% occurred in Central regions of China. Moreover, comparing mortality rate of Eastern region (6.3 per 100,000 population), Central region (3.9 per 100,000 population) and Western region (4.9 per 100,000

population) showed that mortality rate in Eastern region was significantly higher than that of Western region and Central region ($P < 0.001$).

Table 2 presents time distribution of fatalities from road traffic crashes by hour of day, day of week and season of year. Of all road traffic deaths in 2009, compared with nighttime, a significantly higher proportion of daytime reported road traffic deaths (53.3% vs. 46.7%, $P < 0.001$). From Monday to Sunday, the proportion of road traffic deaths varied from the lowest 13.2% in Saturday, to the highest 15.0% in Wednesday. The distribution of season from road traffic deaths involved Spring (22.0%), Summer (23.1%), Autumn (27.1%), and Winter (27.8%).

Table 2: Characteristics in fatalities from road traffic crashes by time, day and season in China, 2009

	n	%	Pvalue*
Time of crash			
Daytime (06:00-18:00h)	36080	53.3	<0.001
Nighttime (00:00-06:00h, 18:00-24:00h)	31679	46.7	
Day of crash			
Monday	9604	14.2	<0.001
Tuesday	9726	14.3	
Wednesday	10137	15.0	
Thursday	10073	14.8	
Friday	9328	13.8	
Saturday	8935	13.2	
Sunday	9956	14.7	
Season of crash			
Spring	14906	22.0	<0.001
Summer	15695	23.1	
Autumn	18352	27.1	
Winter	18806	27.8	

* χ^2 analysis of the association between fatalities % and time distribution.

The characteristics of fatalities from road traffic crashes by crash patterns, crash causes and road users are presented in Table 3.

Table 3: Characteristics in fatalities from road traffic crashes by pattern, cause and road user in China, 2009

	n	%	Pvalue*	
Crash pattern				
Frontal crash	18258	26.9	<0.001	
Side-to-side crash	17247	25.5		
Rear-end crash	9276	13.7		
Motor vehicle with ob- ject or person	11284	16.7		
Other	11694	17.2		
Crash cause				
Excessive speed	9504	14.0	<0.001	
Alcohol	2665	3.9		
Wrong lane	3506	5.2		
Other violations	14426	21.3		
Careless driving	8438	12.5		
Driving without a license	5166	7.6		
Other behaviors affect- ing safety	18513	27.3		
Vehicle factors	2592	3.8		
Non-motor vehicles vi- olations	1578	2.4		
Other	1371	2.0		
Road user				
Motor drivers	8251	12.2		<0.001
Motorcyclists	14900	22.0		
Bicyclists	10558	15.6		
Passengers	16349	24.1		
Pedestrians	16683	24.6		
Other	1018	1.5		

* χ^2 analysis of the association between fatalities % and crash patterns, crash causes, and road users category.

The most common crash pattern contributing to road traffic deaths was frontal crash (26.9%) followed by side-to-side crash (25.5%), motor vehicle with object or person crash (16.7%), rear-end crash (13.7%), and other (17.2%). In about 92% of road traffic deaths, the auto drivers were believed to be responsible for the fatal crash, with the underlying causing factors of excessive speed (14.0%), careless driving (12.5%), driving without a license (7.6%), driving in the wrong lane (5.2%),

alcohol (3.9%), other violations (21.3%), and other behaviors affecting safety (27.3%). Only 2.4% of road traffic crash deaths were caused by non-motor vehicle violations. Of all road traffic deaths in 2009, vehicle defects accounted for 3.8% of these deaths. Road traffic deaths involving pedestrians (24.6%), passengers (24.1%), motorcyclists (22.0%) and bicyclists (15.6%) collectively accounted for more than 85% and auto drivers accounted for 12.2% of total road traffic deaths.

Discussion

This paper was a descriptive study on mortality data attributable to road traffic crashes in China. Our study indicated that a lot of Chinese lives were lost to road traffic crashes. In 2009, more than 67,000 people were killed in road traffic crashes in China. We also found that risk of fatalities due to road traffic crashes were significantly associated with factors such as gender, age, urban-rural residence, geographic region, time distribution, road user type, crash pattern, and crash cause. The rapid rate of motorization taking place in China means that road traffic crashes and associated nonfatal and fatal injuries will soon become a bigger societal and public safety problem than before in the absence of appropriate road traffic crash prevention measures.

In our study, road traffic crash fatalities among males were more than three times that among females in 2009. Road traffic mortality rates are higher in men than in women in all regions regardless of income level, and also across all age groups, with an overall rate almost three times that for females: 27.6 per 100, 000 population and 10.4 per 100, 000 population, respectively (1). Males in Vietnam and Kenya had the highest mortality rates of road traffic crashes compared with other countries around the world (3). This may reflect a higher exposure to risk factors for road traffic deaths in males in these developing countries (15).

Road traffic deaths disproportionately affected young people in our study. It's reported that more than 50% of road traffic crash deaths occur among young adults aged 15-44 years in low- and

middle-income countries (1, 16). Studies from Mexico, Israel, Nigeria, Italy, and Greece suggested that road traffic crashes are the leading cause of death for persons aged between 21 to 40 years (17-21). A study estimated that road traffic crashes are the second common cause of children being orphaned in Mexico (22). In China, road traffic deaths among young adults aged 16-45 years account for approximately 60% of total deaths in that age group. Therefore, road traffic deaths in China particularly affect the most productive population. The economic impact of road traffic crashes is especially devastating, particularly for low- and middle-income countries because productive young adults are the most vulnerable to such road traffic injuries (1). Luckily, road traffic crashes are not a major cause of death for the elderly in China. Adults aged more than 65 years accounted for approximately 11% of total road traffic deaths in 2009. As vulnerable road users, given the same chance of crash, an older person is more likely to be killed or disabled than a younger one (1).

Road traffic crashes are believed to frequently occur in urban areas, especially as urbanization and motorization increase rapidly in China. However, rates of road traffic crash nonfatal and fatal injuries were higher in rural than urban areas (23). In China, more than 60% of fatalities due to road traffic crashes occurred in rural areas in 2009. Many different risk factors may contribute to many road traffic deaths in rural areas: rural drivers may be less likely to take safety measures, such as using seat belts (24), or they may be more likely to drive at greater speeds (25); rural roads may be less safe than urban road (24); road traffic crashes victims in rural areas may not receive medical care as quickly as victims in urban areas (26). Although traffic fatalities due to RTIs have declined over the last two decades, rural fatalities continue to exceed urban fatalities in the USA (27).

In China, total number of road traffic crash deaths and mortality rates seem to vary by geographic regions. Of the 67,759 road traffic deaths in 2009, approximately half [33251] occurred in Eastern region. Many road traffic crashes in low- and middle-income countries may be due to the growing

number of motor vehicles on the road (28, 29). Eastern region of China maintain one of the highest economic growth rates and the number of motor vehicles registered was 93.64 million in 2009 (10). In the same year, Central and Western regions had only 52.30 million and 40.63 million motor vehicles registered respectively (10). The degree of motorization was evidently higher in Eastern region than in Central and Western regions. Previous studies reported that a correlation between motor vehicle growth and the number of road traffic crashes and injuries exist (30, 31). Paradoxically, motorization makes our life much convenient, but the benefits have come with a price.

Our study suggested that number of road traffic deaths was significantly higher in daytime than nighttime. Many road traffic crashes occur in not bad driving circumstances, such as sunny weather, flat and straight roads, asphalted roads, and good traffic status (32). It's estimated that more than 60% of motorcycle related injuries occurred during the daytime in a developing country (28). Traffic volume has been reported as an important risk factor for road traffic crashes, and the study found a strong association between traffic volume and pedestrian crash risk (33, 34).

Many low- and middle-income countries typically contain mixed lane use of road traffic, such as pedestrians, handcarts, bicycles, motorcycles, vans, cars, trucks and buses (1). Drivers in China may be more likely to have frontal crashes because traffic flows are not divided in many regions. Drivers may also be more likely to have single motor vehicle crashes with objects or pedestrians and bicycles because roadsides do not have guardrails or there is no separate space earmarked for them. These traffic crash patterns have not been reported recently in high-income countries maybe because urbanization and motorization have already happened several decades ago. Our study suggested that more than 26% of road traffic crash deaths occurred in frontal crashes, more than 25% occurred in side-to-side crashes, 17% occurred in motor vehicle crashes with an object or a person, and 14% occurred in rear-end crashes. Therefore, frontal crashes, side-to-side crashes

and crashes with an object or a person are more common than rear-end crashes in China.

Comparing causes of road traffic crashes suggested human behavioral factors as the main cause, with a smaller contribution of vehicle and road factors (9, 35, 36). Our study suggested that human errors might have accounted for 92% of road traffic crash deaths in 2009 in China. Common risk factors contributing to road traffic deaths include speeding, followed by careless driving, driving without a license, driving in the wrong lane, and driving after drinking alcohol. Identifying major risk factors for road traffic crashes could guide preventive measures and enforcements of traffic laws in China. Unfortunately, developing countries still see road traffic crashes as 'accidents' that cannot be prevented (37). These countries need to learn from the experience of developed countries and realize that road traffic crashes are both preventable and controllable.

Road traffic deaths involving motorcyclists, bicyclists, passengers and pedestrians collectively account for most of the deaths in low- and middle-income countries (1, 38). However, most of these deaths among auto drivers occur in high-income countries. For example, more than 60% of road traffic deaths occur among auto drivers in the USA, whereas auto drivers represent less than 10% of road traffic deaths in the developing countries (39). We found that more than 86% of road traffic deaths occurred in motorcyclists, bicyclists, passengers and pedestrians, and 12% of road traffic deaths occurred in auto drivers in 2009 in China. The choice of type of transport in low- and middle-income countries is often influenced by socioeconomic factors, particularly family income (40). It has been reported that fatalities as a result of road traffic crashes differ by road users (41, 42). Although all types of road users are at risk of being killed in road traffic crashes, the actual risk varies considerably between low- and middle-income countries and high-income countries.

There are some limitations to be considered when interpreting findings from our study. Under-reporting biases are well known from studies conducted in the developing countries (38, 35, 43, 44). As our data came from police traffic crash records,

under-reporting might be a major study limitation. Second, because the data were collected in a retrospective cross-sectional study, we could not calculate road traffic fatality incidence rates. Our rates were rough estimations because the miles travelled are not available in China. Third, detail information of road traffic crash deaths was not available from the police registry database. Because of these limitations, our study only provided results about some basic characteristics of road traffic crash deaths in China.

Road traffic deaths still were an important social and public health problem, and were responsible for more years of life lost of the Chinese. The patterns of road traffic deaths are very different in China compared to those in high-income countries. Our study indicates that sociodemographic characteristics, crash time, crash patterns, crash causes and road user category are associated with road traffic deaths in China. Human behavioral factors are the principal cause of road traffic deaths.

Ethical considerations

Ethical issues (Including plagiarism, Informed Consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc) have been completely observed by the authors.

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Reference

1. Peden M, Scurfield R, Sleet D, Mohan D, Hyder A, Jarawan E, et al. (2004). *World report on road traffic injury prevention*. Geneva:

WHO. Available:

http://www.who.int/violence_injury_prevention.

Accessed November 20, 2009.

2. Murray CJ, Lopez AD (1997). Alternative projections of mortality and disability by cause 1990-2020, Global Burden of Disease Study. *Lancet*, 349(9064):1498-504.
3. Nantulya VM, Reich MR (2002). The neglected epidemic: road traffic injuries in developing countries. *BMJ*, 324(7346):1139-41.
4. Mock C, Kobusingye O, Anh LV, Afukaar F, Arreola-Risa C (2005). Human resources for the control of road traffic injury. *Bull World Health Organ*, 83(4):294-300.
5. Wang SY, Li YH, Chi GB, Xiao SY, Ozanne-Smith J, Phillips MR, et al. (2008). Injury-related fatalities in China: an under-recognised public-health problem. *Lancet*, 372(9651):1765-73.
6. United Nations General Assembly (2004). *Improving global road safety, resolution A/RES/58/289*. Geneva: United Nations. Available:
http://www.who.int/violence_injury_prevention/media/news/en/unga_58_289_en.pdf. Accessed November 20, 2009.
7. Kopits E, Cropper M (2005). Traffic fatalities and economic growth. *Accid Anal Prev*, 37(1):169-78.
8. Soderlund N, Zwi AB (1995). Traffic-related mortality in industrialized and less developed countries. *Bull World Health Organ*, 73(2):175-82.
9. El-Sadig M, Norman NJ, Lloyd OL, Romilly P, Bener A (2002). Road traffic accident in the United Arab Emirates: trends of morbidity during 1977-1998. *Accid Anal Prev*, 34(4):465-76.
10. National Bureau of Statistics of China (2009). Annual statistics communique. Available online at: <http://www.stats.gov.cn/tjgb/> Accessed November 20 2009.
11. Noland RB (2003). Medical treatment and traffic fatality reductions in industrialized countries. *Accid Anal Prev*, 35(6):877-83.
12. Mock CN, Adzotor KE, Conklin E, Denno DM, Jurkovich GJ (1993). Trauma outcomes in the rural developing world: comparison with an urban level trauma center. *J Trauma*, 35(4):518-23.

13. The Central People's Government of the People's Republic of China (2005). *Development of the western region on the implementation of some policies and measures*. Available at: http://www.sdpc.gov.cn/wzly/zc/g/wzxczh/t20050714_35457.htm. Accessed November 20, 2009.
14. Bureau of Traffic Management of the Ministry of Public Security of PRC. *China road traffic accidents statistics*. Beijing; 2010.
15. Monarrez-Espino J, Hasselberg M, Laflamme L (2006). First year as a licensed car driver: Gender differences in crash experience. *Safety Sci*, 44(2):75-85.
16. Peden M, McGee K, Sharma G (2002). *The injury chart book: a graphical overview of the global burden of injuries*. Geneva. WHO. Available: <http://whqlibdoc.who.int/publications/924156220X.pdf>. Accessed November 20, 2009.
17. Hajar M, Arredondo A, Carrillo C, Solorzano L (2004). Road traffic injuries in an urban area in Mexico: An epidemiological and cost analysis. *Accid Anal Prev*, 36(1):37-42.
18. Marmor M, Parnes N, Aladgem D, Birshan V, Sorkine P, Halpern P (2005). Characteristics of road traffic accidents treated in an urban trauma center. *Isr Med Assoc J* 2005;7:9-12.
19. Ekere AU, Yellowe BE, Umune S (2005). Mortality patterns in the accident and emergency department of an urban hospital in Nigeria. *Niger J Clin Pract*, 8(1):14-8.
20. Giorgi Rossi P, Farchi S, Chini F, Camilloni L, Borgia P, Guasticchi G (2005). Road traffic injuries in Lazio, Italy: a descriptive analysis from an emergency department-based surveillance system. *Ann Emerg Med*, 46(2):152-7.
21. Pikoulis E, Filias V, Pikoulis N, Daskalakis P, Avgerinos ED, Tavernarakis, G (2006). Patterns of injuries and motor-vehicle traffic accidents in Athens. *Int J Inj Contr Saf Promot*, 13(3):190-3.
22. Hajar M, Vazquez-Vela E, Arreola-Risa C (2003). Pedestrian traffic injuries in Mexico: a country update. *Inj Control Safe Promot*, 10(1-2):37-43.
23. Zwerling C, Peek-Asa C, Whitten PS, Choi SW, Sprince NL, Jones MP (2005). Fatal motor vehicle crashes in rural and urban areas: decomposing rates into contributing factors. *Inj Prev*, 11(1):24-8.
24. Muelleher RL, Mueller K (1996). Fatal motor vehicle crashes: Variations of crash characteristics within rural regions of different population densities. *J Trauma*, 41(2):315-20.
25. Baker SP, Whitfield MA, O'Neill B (1987). Geographic variations in mortality from motor vehicle crashes. *N Engl J Med*, 316(22):1384-7.
26. Clark DE (2003). Effect of population density on mortality after motor vehicle collisions. *Accid Anal Prev*, 35(6):965-71.
27. National Highway Traffic Safety Administration (2007). *Traffic safety facts 2007 Data: rural/urban comparison*. NHTSA's national center for statistic and analysis. Available at: <http://www-nrd.nhtsa.dot.gov/Pubs/810996.PDF>. Accessed November 20, 2009.
28. Wells S, Mullin B, Norton R, Langley J, Connor J, Lay-Yee R, et al. (2004). Motorcycle rider conspicuity and crash related injury: case control study. *BMJ*, 328(7444):857-62.
29. Suriyawongpaisal P, Kanchanusut S (2003). Road traffic injuries in Thailand: trends, selected underlying determinants and status of intervention. *Inj Control Safe Promot*, 10(1-2):95-104.
30. Winston FK, Rineer C, Menon R, Baker SP (1999). The carnage wrought by major economic change: ecological study of traffic-related mortality and the re-unification of Germany. *BMJ*, 318(7199):1647-9.
31. Ghaffar A, Hyder AA, Mastoor MI, Shaikh I (1999). Injuries in Pakistan: directions for future health policy. *Health Policy Plan*, 14(1):11-7.
32. Qin HL, Zhao XC, Zhou JH, Qiu J, Yang ZL, Jiang ZQ, et al (2004). Effect of environment on extremely severe road traffic crashes: retrospective epidemic analysis during 2000–2001. *Chin J Traumatol*, 7(6):323-9.
33. Christie N (1995). *The high risk child pedestrian: socio-economic and environmental factors in their accidents*. TRL research report, p.:117.
34. Roberts I, Norton R, Jackson R, Dunn R, Hassall I (1995). Effects of environmental factors on risk of injury of child pedestrian by motor vehicles: a case-control study. *BMJ*, 310(6972):91-4.

35. Li GH, Baker SP (1997). Injuries to bicyclists in Wuhan, People's Republic of China. *Am J Public Health*, 87(6):1049-52.
36. Lyznicki JM, Doege TC, Davis RM, Williams WA (1998). Sleepiness, driving, and motor vehicle crashes. *JAMA*, 279(23):1908-13.
37. Sharma BR (2008). Road traffic injuries: A major global public health crisis. *Public Health*, 122(12):1399-406.
38. Odero W, Garner P, Zwi A (1997). Road traffic injuries in developing countries: a comprehensive review of epidemiological studies. *Trop Med Int Health*, 2(5):445-60.
39. Mohan D (2002). Traffic safety and health in Indian cities. *J Transp Infrastructure*, 9(1):79-94.
40. Sharma BR, Harish D, Singh G (2003). Pattern of fatal head injury in road traffic accidents. *Babrain Med Bull*, 25(1):22-5.
41. Sharma BR, Harish D, Sharma V, Vij K (2001). Road traffic accidents - a demographic and topographic analysis. *J Med Sci Law*, 41(3):266-74.
42. Mayou R, Bryant B (2003). Consequences of road traffic accidents for different types of road user. *Injury*, 34(3):197-202.
43. Nakahara S, Wakai S (2001). Underreporting of traffic injuries involving children in Japan. *Inj Prev*, 7(3):242-4.
44. Zheng YY, Cooper PJ, Dean CB (2007). Modeling the contribution of speeding and impaired driving to insurance claim counts and costs when contributing factors are unknown. *J Safety Res*, 38(1):25-33.