Complexity in planning urban transport: safety and environmental issues

La complexité de la programmation des transports urbains: problèmes d'environnement et de sécurité

D. Mohan
Transportation Research and Injury Prevention Programme, Indian Institute of Technology, New Delhi, India.

ABSTRACT: This paper focuses on issues concerning mobility, pollution and safety in cities of less motorised countries (LMCs). Urban transportation problems in LMCs have become very complex because of the intense mix of modern (fast) motorised vehicles with non-motorised modes along with very complex social and economic concerns. Issues discussed in this paper are: Urban transport patterns, infrastructure development, control of private vehicles, para-transit and public transport, pedestrian and bicycle environments and road safety.

RESUME : Cet exposé se concentre sur les questions relatives à la mobilité, à la pollution et à la sécurité dans les villes des pays les moins motorisés (LMCs en anglais). Les problèmes de transport urbain dans les LMCs sont devenus très complexes en raison du mélange très dense de véhicules rapides motorisés avec des modes de transport non motorisés, et des rapports que cela entretient avec de très complexes problèmes sociaux et économiques. Les questions discutées dans cet exposé sont les suivantes : schémas de transport urbain, développement des infrastructures, contrôle des véhicules privés, transport artisanal et transports en commun, piétons et bicyclettes, environnement et sécurité routière.

1 INTRODUCTION

Most of the megacities in the world are already located in less motorised countries (LMC) and many more cities in these countries will grow to populations of ten million or more in the next few decades (World Health Organisation, 1998). All these cities are faced with serious problems of inadequate mobility and access, vehicular pollution and road traffic crashes and crime on their streets. Increasing use of cars and motorised two-wheelers add to these problems and this trend does not seem to be abating anywhere. Many recent reports suggest that improvements in public transport and promotion of non-motorised modes of transport can help substantially in alleviating some of these problems (Mohan et al., 1996; Wu Yong and Li Xiaojiang, 1999; OECD, 2000; Commission of the European Communities, 2001).

Howevr, LMC cities have very mixed land use patterns, a very large proportion of all trips are walk or bicycle trips; of the motorised trips more than 50% are by public transport or shared para-transit modes; compared to highly motorised countries (HMC), trips per capita per day are lower and significant proportion of trips can be less than 5 km in length; and costs of motorised travel are high compared to average incomes (Mohan et al. 1996). In spite of these structural advantages, the air pollution levels in LMC cities remain high. What these cities do not have are very efficient public bus systems, safe and convenient walkways and bicycle lanes, the best in fuel quality and vehicle technology and strict and efficient vehicle maintenance systems. However, improvements in these will take time, and large financial investments and may be difficult to implement for a variety of reasons.

In addition to the problems of pollution, deaths and injuries due to road traffic crashes are also a serious problem in LMCs (Asian Development Bank 1998). According to one estimate the losses due to accidents in LMCs may be comparable to those due to pollution (Vasconcellos 1999). These problems become difficult to deal with because there are situations in which there are conflicts between safety strategies and those that aim to reduce pollution (OECD 1997). For example, smaller and lighter vehicles can be more hazardous but they are less energy consuming, congestion reduces probability of serious injury due to crashes but increases pollution, increase in bicycling rates can decrease pollution but may increase crashes if appropriate facilities are not provided.

Such issues make transport planning in LMC cities a very complex affair. HMC cities have not experienced the existence of such a large proportion of motorised two-wheelers, para-transit vehicles and non-motorised modes of transport sharing road space with cars and buses. The following sections of this paper discuss some of these issues

2 MIXED TRANSPORT

Transport and land use patterns found in LMC cities are different from those existing in most HMC cities. These patterns reflect a new phenomenon and have not been seen in the West since its earlier days of motorization and urbanization. Intense mixed land use, short trip distances, and high share of walking and non-motorised transport characterize such urban centre. The rising cost of transport within the city and long working hours force the workers to live close to their places of work. Unlike the traffic in cities in HMCs, bicycles, pedestrians and other non-motorised modes are present in significant numbers on urban streets. Their presence persists despite the fact that engineers design these facilities for fast moving uninterrupted flow of motorised vehicles.

For example, in Delhi, average speeds during peak hour range from 10 to 25 km/h in central areas and 25 to 60 km/h on arterial streets and Delhi's traffic fatalities in 2000 were more than double that of other mega cities in India. In 2000 there were 915 (46%) pedestrian and 255 (13%) bicyclist fatalities in Delhi (Tyagi, 2001). In a similar period (April 2000-March 2001) buses operated by the Delhi Transport Corporation were involved in 928 crashes of which 152 were fatal. A comparison of bus crash statistics of four major cities in India show that fatalities per 100 million passenger km range between 0.40 and 1.04. These rates are unacceptably high compared to an average rate of 0.33 for the USA. (Federal Transit Administration, 1999). No data are available for injuries and fatalities on access trips by passengers.

There is ample evidence to illustrate the mismatch between current urban planning methods and the growing transportation problems. Unless we understand the basic nature of problems faced by our mega cities, the adverse impact of growing mobility on the environment and safety would continue to multiply in future.

3 SAFETY ISSUES

The safety record of bus transit operations has been reasonably good in most cities of the world as compared to other modes of transport. Yet people prefer to use their cars and motorcycles if they can afford it and when it convenient to do so. The main problem of safety as perceived by commuters is not as a passenger inside the bus, but as a pedestrian or bicyclist on the access trip. A study of risk of accidents by different travel modes in Copenhagen (Jorgensen, 1996) concluded, "There is no reason for a traveller to choose bus instead of car for the point of view of his own safety," and that "From a social point of view there would be a safety benefit through a change of car driving into bus driving". These conclusions were based on the fact that the risk of death per trip for a bus user was very high on access trips.

The high risk of injuries and fatalities in urban areas to pedestrians, bicyclists and commuters in access trips have been documented from all over the world. The greatest risk to schoolchildren from bus related injuries was found to be as pedestrians after alighting from a bus in New South Wales, Australia (Cass et al. 1997); in Mexico City 57% of deaths from traffic crashes involve pedestrians (Hijar et al. 2001); injury to pedestrians was the most frequent cause of multiple trauma (54%) among children 0-16 years in a large Spanish urban area (Sala et al. 2000); in California a motor vehicle versus pedestrian accident study reported that these accidents are common and the high mortality rate among the elderly indicated the need for more aggressive and effective prevention efforts (Peng & Bongard 1999); a study from Canada showed that children's exposure to traffic (number of streets crossed) and injury rates were positively correlated (Macpherson et al. 1998); in Kumasi, Ghana, the most common mechanisms of injury (40.0%) to children were pedestrian knockdowns (Abantanga, & Mock 1998); A study of older people's lives in the inner city in Sydney, Australia, showed that the environmental hazards, such as pedestrian safety and traffic management, affect the whole population and require interventions at government level (Russell et al. 1998); a study from Seattle shows that 66% of the fatal injuries occurred on city or residential streets, and 29% occurred on major thoroughfares, and a single urban highway accounted for 12% of pedestrian fatalities and represented a particularly hazardous traffic environment (Harruff et al. 1998).

Quite obviously, people's fears regarding safety on the roads when using public transport are not unjustified. A large proportion of the decrease in road traffic injuries and deaths in HMCs is the result of the availability of cars which provide much greater safety to the occupants in crashes, and the result of a very significant reduction of the presence of pedestrians and bicylists on HMC streets and highways. Recent estimates from UK suggest that the number of trips per person on foot fell by 20% between 1985/86 and 1997/99 (House of Commons UK 2001). Mohan and Tiwari (1998) also show that in LMCs buses and trucks are involved in a much greater proportion of crashes than in HMCs, but relevant safety standards for these vehicles are lacking. In particular, a strong case can be made for evolution of pedestrian friendly fronts for buses and trucks, but such issues are not given any priority at present.

Such trends suggest that reduction in pedestrian, bicycle and two-wheeler fatalities in HMCs could be largely because of the reduction in exposure of these road users and less because the road environment has been made "safer" for them. In LMCs the exposure rates for pedestrians and bicyclists are much higher, and it is essential that road and vehicle designs ensure safety on all trips, including access trips for public transport. Otherwise the system may operate at sub-optimal capacities.

Car design and safety standards are decided in the HMCs with almost no input from the LMCs where there is very little expertise on these issues. Most automobiles are traded internationally these days and this has four effects:

- Vehicles exported to LMCs very often do not satisfy the existing safety standards prevalent in HMCs. Therefore, it would make sense for such vehicles to conform to some minimum international standards.
- Because very little road safety research is done in LMCs and multinational corporations dominate vehicle design, the concerns of LMCs do not get incorporated in vehicle safety standards. Some of these issues would include the possibility of making turn indicator lights more conspicuous and more easily visible to pedestrians, motorcyclists and bicyclists, pedestrian safety standards for small cars, and design standards for pedestrians, bicycles and motorcycles impacts with buses and trucks.
- Marketing of cars follows a very aggressive pattern in every country and has a huge financial backup. This results in the neglect of public transport infrastructure and other policies that would benefit a majority of the population in LMCs. The bus and rail sectors do not have as powerful international lobbies as the car and motorcycle industry. This obviously results in a higher rate of injuries, pollution levels and lack of mobility for the less well off.
- Many LMCs manufacture vehicles locally (three-wheeled scooter taxis, *tuk-tuks*, jeepneys, etc) that are not used in HMCs. These vehicles are generally used as taxis but have very little scientific input for their crashworthiness. Since they are not used in HMCs there is little pressure to improve their designs.

The above discussion shows why the replication of HMC safety policies in LMCs will not be as effective. However, we do have a body of knowledge available internationally, and we should build on this to improve the road safety situation in LMCs.

4 INTERNATIONAL KNOWLEDGE BASE FOR CONTROL OF ROAD TRAFFIC INJURIES

Road safety research in the HMCs has involved a large number of very well trained professionals from a variety of disciplines over the past four decades. Some very innovative work has resulted in a theoretical understanding of "accidents" as a part of a complex interaction of sociological, psychological, physical and technological phenomena. The results could be exchanged and solutions transferred from one HMC to another because the conditions in these countries were roughly similar. This understanding of injuries and accidents has helped us design safer vehicles, roads and traffic management systems. A similar effort at research, development and innovation is needed in LMCs. A much larger group of committed professionals needs to be involved in this work for new ideas to emerge.

International co-operation in the area of road safety should focus on exchange of scientific principles, experiences of successes and failures, and in scientific training of a large number of professionals in the LMCs. The scientific principles of road safety can be exchanged for the benefit of everyone. However, the priorities in road safety policies cannot be global in nature because of the differing patterns of traffic and traffic crashes around the world. We list below the known road safety countermeasures in the context of LMC concerns.

4.1 *Results of systematic reviews on road safety*

4.1.1 *Individual factors, legislation and enforcement*

1. Most attempts at enforcing road traffic legislation will not have any lasting effects, either on road-user behaviour or on accidents unless the effort is sustained; imposing stricter penalties (in the form of higher fines or longer prison sentences) will not affect road-user behaviour; imposing stricter penalties will reduce the level of enforcement (Bjornskau & Elvik 1992).
2. Increased normal, stationary speed enforcement is in most cases cost-effective. Automatic speed enforcement seems to be even more efficient. There is no evidence proving mobile traffic enforcement with patrol cars is cost-effective (Carlsson 1997).
3. The *only* effective way to get most motorists to use safety belts is with good laws requiring their use. When laws are in place, education and/or advertising can be used to inform the public about the laws and their enforcement (O'Neill 2001a).

4.1.2 *Individual factors, campaigns and education*

1. Road safety campaigns are often aimed to improve road user behaviour by increasing the knowledge and by changing the attitudes. There is no clearly proved relationship between knowledge and attitudes on one hand and behaviour on the other hand (OECD 1994). Most highway safety educational programs do not

work. They do not reduce motor vehicle crash deaths and injuries. Only a few programs have ever been shown to work, and contrary to the view that education cannot do any harm some programs have been shown to make matters worse. Education programs by themselves usually are insufficient to change behaviour. They may increase knowledge, but increased knowledge rarely results in appropriate behaviour change (O'Neill 2001b). There is, however, no reason just to waste money on general campaigns. Campaigns should be used to put important questions on the agenda, and campaigns aimed at changing road user behaviour should be focused on clear defined behaviours and should by preference fortify other measures such as new legislation and/or police enforcement.

2. The effects of campaigns using tangible incentives (rewards) to promote safety belt usage have been evaluated by means of a meta-analytic approach. The results (weighted mean effect) show a mean short-term increase in use rates of 12.0 percentage points; the mean long-term effect was 9.6 percentage points (Hagenzieker et al. 1997). Research first from Australia, later many European countries, then Canadian provinces, and finally some U.S. states clearly shows that the *only* effective way to get most motorists to use safety belts is with good laws requiring their use.
3. *Licensing*: Studies show that driver education may be necessary for beginners to learn the elementary skills for obtaining a license, but compulsory training in schools leads to early licensing. There is no evidence that such schemes result in reduction in road crash rates. On the other hand they may lead to increased road crash rates (Williams & O'Neill, 1974, Vernick, et al. 1999, Mayhew & Simpson 1996, Lund & Williams 1985). While there may be a need to train professional drivers in the use of heavy vehicles, there is no evidence that formal driver education should be compulsory in schools and colleges.
4. Helmet use reduces bicycle-related head and facial injuries for bicyclists of all ages involved in all types of crashes including those involving motor vehicles (Thompson et al. 2001). Similar results have been confirmed for motorcyclists (Branas 2001)

Policing methods and enforcement techniques have to be optimised for LMCs to be effective at much lower expenditure levels. There are no systematic studies evaluating different techniques followed around the world. Research needs to be done on effectiveness of professional driver education, driver licensing methods and control of problem drivers in LMC settings.

4.1.3 *Vehicle factors*

Vehicles conforming to EU or USA crashworthiness standards provide significant safety benefits to occupants and the effectiveness of the following measures has been evaluated:

1. Use of seat belts and airbag equipped cars can reduce car occupant fatalities by over 30% (Parkin et al.1993, O'Neill & Lund 1993).
2. High mounted rear brake lights reduce the incidence of rear end crashes (ETSC 1993).
3. A meta-analysis of 17 studies that have evaluated the effects on traffic safety of using daytime running lights on cars shows that such use reduces the number of multi-party daytime accidents by about 10-15% for cars using daytime running lights (Elvik, 1996). Similar results have been confirmed for use of daytime running lights by motorcyclists (Radin et al. 1996).

However, not enough work has been done to make vehicles safer in impacts with vulnerable road users, and on vehicles specific to LMCs.

4.1.4 *Environmental factors*

1. The road environment and infrastructure must be adapted to the limitations of the road user (Van Vliet & Schermers 2000).
2. Traffic calming techniques, use of roundabouts and provision of bicycle facilities in urban areas provide significant safety benefits (Elvik 2001, Hyden & Varhelyi, 2000).
3. A great deal of additional work needs to be done for rural and urban road and infrastructure design suitable for mixed traffic to make the environment safer for vulnerable road users.

5 NEED FOR IMPROVING THE QUALITY OF PEDESTRIAN & BICYCLE ENVIRONMENT

Non-motorised modes of travel are the only modes that are non-polluting. However, pedestrians (including commuters on access trip for public transport) and bicyclists are the ones who are involved in a disproportionate share of traffic crashes in LMC cities. It is clear that unless non-motorised modes are given importance and roads specifically designed for their needs, it will be difficult to improve the safety levels or improve the environmental conditions in cities. This situation is not explicitly recognised in policy documents and very little attention is given to improving the facilities for non-motorised modes. For greater effectiveness, technological solutions for pollution control based on improving fuels, engines and vehicles must be also accompanied by improvements in road cross-sections and providing segregated facilities for non-motorised transport.
Better facilities for pedestrians and segregated bicycle lanes would also result in enhanced efficiency of the public transport buses. Physically segregated

lanes also improve safety of the vulnerable road users by reducing the conflicts between motorised and non-motorised modes. This would smoothen traffic flow and hence reduce pollution. Data clearly indicate that if public transport use has to be promoted in mega-cities like Delhi in LMCs much more attention has to be given to the improvement in safety levels of bus commuters and the non-motorised transport segment of the road users. This is particularly important because promotion of public transport use can also result in an increase in the number of pedestrians and bicycle users on city streets. This is because every public transport trip involves two access trips that are mostly walking or bicycle trips. Unless people actually perceive that they are not inconvenienced or exposed to greater risks as bicyclists, pedestrians and bus commuters it will be difficult to reduce private vehicle use.

The above discussion shows that there is a strong link between mobility, safety and sustainable transport policy issues. In addition, streets must be safe from crime also to promote use of walking, bicycling and use of public transport.

6 CONCLUSIONS

Development of safe and sustainable transport policies for cities in Asia and Africa will require a much more intensive interdisciplinary approach than we have been used to in the past. Just improvements in vehicle and road technology will not do. Safety experts, transport specialists, urban sociologists and road engineers will have to work together in a much more integrated manner.

As far as urban transport is concerned, buses and non-motorised modes of transport will remain the backbone of mobility in LMC mega-cities. To control pollution both bus use and non-motorised forms of transport have to be given importance without increasing pollution or the rate of road accidents. This would be possible only if the following conditions are met:

6.1 *Safety policies*

Ensure the use of known safety strategies as outlined in the previous sections.

6.2 *Public transport*

Design and development of modern and sophisticated high capacity bus systems be given priority in megacities.

6.3 *Segregated lanes for non-motorised transport and safer pedestrian facilities*

a. Urban and road design characteristics that ensure the safety of pedestrians and bicyclists.
b. Provision of segregated bicycle lanes on all arterial roads.
c. Wider use of traffic calming techniques, keeping peak vehicle speeds below 50 km/h on arterial roads and 30 km/h on residential streets and shopping areas.
d. Convenient street crossing facilities for pedestrians.

6.4 *Policy measures*

a. Establish national or regional road safety and environmental agencies. These should be staffed with trained professionals and be responsible for accident data surveillance and analysis, funding of research activities, setting vehicle and road standards, and developing appropriate traffic engineering approaches.
b. Develop safety standards for the front ends of vehicles (including buses, trucks, cars, three-wheeled taxis, tuk-tuks, becaks, etc.) to make them less hazardous for pedestrians and bicyclists.
c. Develop appropriate human resources. Fewer than a dozen road safety and environmental professionals presently work in each of the less motorised countries. Training programmes should be institutionalised. This will happen only if road safety and transportation research departments/centres are set up in selected universities and research institutions.

6.5 *Integration*

The above recommendations have to be considered in an overall context where safety and environmental research efforts are not conducted in complete isolation. We have to move toward adoption and implementation of schemes that remain at a human scale and improve all aspects of human health. The authors of a report on integration of strategies for safety and environment published by the OECD suggest the following guidelines for policy makers:

- Ask leading questions about safety and environmental goals at the conceptual stage of the project and look beyond the immediate boundaries of the scheme.
- The safety and environmental consequences of changes in transport and land use should be made more explicit in technical and public assessments.
- There should be simultaneous consideration of safety and environmental issues by involving all concerned agencies.

REFERENCES

Abantanga, F.A. & Mock, C.N. 1998. Childhood Injuries in an Urban Area of Ghana a Hospital-Based Study of 677 Cases. *Pediatric Surgery International* 13(7):515-518.

Asian Development Bank 1998. *Road Safety Guidelines for the Asian and Pacific Region.* Manila: ADB.

Bjornskau, T. & Elvik R. 1992. Can Road Traffic Law Enforcement Permanently Reduce the Number of Accidents? *Accident Analysis and Prevention* 24(5):507-20.

Branas C.C. & Knudson M.M. 2001. Helmet laws and motorcycle rider death rates. *Accident Analysis and Prevention* 33:641-48.

Carlsson, G. 1997. Cost-Effectiveness of Information, Campaigns and Enforcement and the Costs and Benefits of Speed Changes. European Seminar On Cost-Effectiveness Of Road Safety Work And Measures, Luxembourg.

Cass, D.T., Ross, F. & Lam, L. 1997. School Bus Related Deaths And Injuries In New South Wales. *Medical Journal of Australia* 166(2):107-108.

Commission of the European Communities 2001. *White Paper European Transport Policy For 2010: Time To Decide*. Brussels, Com(2001) 370 Final.

Elvik R. 2001. Area-Wide Urban Traffic Calming Schemes: A Meta-Analysis of Safety Effects. *Accident Analysis and Prevention* 33(3):327 – 336.

Elvik, R. 1996. A Meta-Analysis of Studies Concerning The Safety Effects of Daytime Running Lights on Cars. *Accident Analysis and Prevention* 28(6): 685-94.

ETSC. 1993. Reducing Traffic Injuries Through Vehicle Safety Improvements. Brussels: European Transport Safety Council.

Federal Transit Administration 1999. *Safety Management Information Statistics (SAMIS), 1997 Annual Report*. FTA-MA-26-5002-99-01, DOT-VNTSC-FTA-99-3, U.S. Department of Transportation, Research and Special Programs Administration. Cambridge, MA: John A. Volpe National Transportation Systems Center.

Hagenzieker, M.P., Bijleveld, F.D. & Davidse, R.J. 1997. Effects of Incentive Programs to Stimulate Safety Belt Use: A Meta-Analysis. *Accident Analysis and Prevention* 29(6): 759-77.

Harruff, R.C., Avery, A. & Alter-Pandya, A.S. 1998. Analysis of Circumstances and Injuries in 217 Pedestrian Traffic Fatalities. *Accident Analalysis and Prevention* 30(1):11-20.

Hijar, M.C., Kraus, J.F., Tovar, V. & Carrillo, C. 2001. Analysis of Fatal Pedestrian Injuries in Mexico City, 1994-1997. *Injury*, 32(4), 279-284.

House of Commons, UK 2001. *Walking in Towns and Cities*. Select Committee on Environment and Regional Affairs Eleventh Report, London: House of Commons.

Hyden, C. & Várhelyi, A. 2000. The Effects on Safety, Time Consumption and Environment of Large Scale Use of Roundabouts in an Urban Area: A Case Study, *Accident Analysis and Prevention*, 32(1):11–23.

Jorgenesen, N. O. 1996. The Risk of Injury and Accident by Different Travel Modes. International Conference on Passenger Safety in European Public Transport, 17-25, Brussels: European Transport Safety Council.

Lund, A.K. & Williams, A.F. 1985. A Review of The Literature: Evaluating the Defensive Driving Course. *Accident Analysis and Prevention* 17:449-60.

Macpherson, A., Roberts, I. & Pless, I.B. 1998. Children's Exposure to Traffic and Pedestrian Injuries. *American Journal of Public Health* 88(12):1840-1843.

Mayhew, D.R. and Simpson, H.M. 1996. Effectiveness and Role of Driver Education and Training in a Graduated Licensing System. Ottawa, Ontario: Traffic Injury Research Foundation.

Mohan, D and Tiwari, G. 1998. Road Safety in Low Income Countries: Issues and Concerns. In *Refelections on the Transfer of Traffic Safety Knowledge to Motorising Nations* 27-56. Vermount, South Australia: Global Traffic Safety Trust.

Mohan, D., G. Tiwari, R. Saraf, et al. 1996. *Delhi on the Move: Future Traffic Management Scenarios*. Delhi: TRIPP, Indian Institute of Technology.

O'Neill, B. & Lund, A.K. 1993. The Effectiveness of Air Bags in Preventing Driver Fatalities in the United States. *Chronic Diseases in Canada* 14:4 Supplement: S38-S46.

O'Neill, B. 2001a. Seat Belt Use: Where We've Been, Where We Are, and What's Next. 2001 Seat Belt Summit: Policy Options for Increasing Seat Belt Use in the United States in 2001 and Beyond, Appendix A. Arlington, VA: Automotive Coalition for Traffic Safety, Inc..

O'Neill, B. 2001b. Role of Advocacy, Education, and Training in Reducing Motor Vehicle Crash Losses, Background paper prepared for the Consultation to Develop a WHO Strategy on Road Traffic Injury Prevention. Geneva: WHO.

OECD 1994. Improving Road Safety by Attitude Modification. Paris: OECD.

OECD 1997. *Integrated Strategies for Safety and Environment.* Paris: OECD.

OECD 2000. *Synthesis Report on Environmentally Sustainable Transport: Futures, Strategies and Best Practices*. Vienna: Austrian Ministry of Agriculture, Forestry, Environment and Water Management.

Parkin, S., MacKay, G.M. & Framton, R.I. 1993. Effectiveness and Limitations of Current Seat Belts in Europe. *Chronic Diseases in Canada* 14:4 Supplement:S53-S59.

Peng, R.Y. & Bongard, F.S. 1999. Pedestrian Versus Motor Vehicle Accidents: An Analysis of 5,000 Patients. *Journal of American College of Surgeons* 189(4):343-348.

Radin U.R., Mackay G.M. & Hills B.L. 1996. Modelling of Conspicuity-Related Motorcycle Accidents in Seremban and Shah Alam, Malaysia. *Accident Analysis and Prevention* 28:325-32.

Russell, C., Hill, B. & Basser, M. 1998. Older People's Lives in the Inner City: Hazardous or Rewarding? *Australian and New Zealand Journal of Public Health* 22(1):98-106.

Sala, D., Fernandez, E., Morant, A., Gasco, J. and Barrios C. 2000. Epidemiologic Aspects of Pediatric Multiple Trauma in a Spanish Urban Population. *Journal of Pediatric Surgery* 35(10):478-1481.

Thompson D.C., Rivara F.P., Thompson R. 2002. Helmets for Preventing Head and Facial Injuries in Bicyclists (Cochrane Review). In: *The Cochrane Library,1*. Oxford: Update Software.

Tyagi, S.B.S. 2001. *Road Accidents in Delhi*. Delhi: Delhi Traffic Police.

Van Vliet, P. & Schermers, G. 2000. *Sustainable Safety: A New Approach for Road Safety in the Netherlands*. Traffic Rotterdam: Research Centre, Ministry of Transport.

Vasconcellos, E. A. 1999. Urban Development and Traffic Accidents in Brazil. *Accident Analysis and Prevention* 31(4): 319-28.

Vernick, J.S., Guohua, L., Ogaitis, S., MacKenzie, E.J., Baker, S.P. & Gielen, A.C. 1999. Effects Of High School Driver Education On Motor Vehicle Crashes, Violations, And Licensure. *American Journal of Preventive Medicine* 16:40-46.

Williams, A.F. and O'Neill, B. 1974. On-The-Road Driving Records of Licensed Race Drivers. *Accident Analysis and Prevention* 6:263-70.

World Health Organisation 1998. *Healthy Cities: Air Management Information System.* AMIS 2.0 CD. Geneva: WHO.

Wu Yong & Li Xiaojiang 1999. Targeting Sustainable Development for Urban Transport. Workshop on Urban Transport and Environment, Beijing: CICED.