From Karolinska Institutet, Department of Public Health Sciences
Division of Social Medicine, Stockholm, Sweden

Toward safety promotion among road users

Epidemiology and prevention of road traffic injuries in Iran

Davoud Khorasani Zavareh

Karolinska Institutet

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ABSTRACT

Road traffic injuries (RTIs) are a major public health problem. Iran has one of the highest RTI mortality and morbidity rates in the world. This thesis aims to contribute understandings on fatal road-user patterns and characteristics as well as RTI numbers and rates, and to explore stakeholders' perceptions both on barriers to - and facilitators of – road-user safety and on prevention of this problem in the Iranian region. **Quantitative and qualitative methods** have been combined to explore road traffic injury phenomena. This thesis includes a cross sectional study (Paper I) and employs the capture-recapture method (Paper II), and grounded theory method (Paper III and Paper IV). Data for the first two studies were collected between March 2004 and March 2005 in the West Azarbaijan Province (WAP) of Iran and data for the third qualitative study were collected between March and December 2007 in both WAP and on the national level. **Paper I** describes the pattern of fatal RTIs and crash circumstances in WAP. The majority (85%) of the deceased were men. Females were mainly killed as either car passenger or pedestrians. Close to two-thirds of victims were rescued by untrained people and nearly four out of five were taken to hospital by passenger car rather than by ambulance. **Paper II** presents two register-based studies estimating the number and rate of fatal RTIs in WAP employing the capture-recapture method. The Death Registration System (DRS) and Forensic Medicine System (FMS) had recorded 669 and 665 fatalities respectively (roughly 22 fatal RTIs per 100 000 inhabitants). The capture-recapture method estimated 1 018 deaths (34 per 100 000). Overall, the DRS and the FMS ascertained 65% of the estimated number of fatal RTIs. In **Paper III**, the aim was to study pre-crash possibilities for prevention of RTIs and the core variable was identified as "lack of system approach to road-user safety". Related barriers were identified: human factors; lack of safety in the transportation system; and lack of organizational coordination. Suggestions for improvement included education, more effective legislation, more rigorous law enforcement, improved engineering in road infrastructure, and an integrated organization to supervise and coordinate preventive activities. Focusing on post-crash management in **Paper IV**, the major barriers were identified as: involvement of laypeople; lack of coordination; inadequate pre-hospital services; and shortcomings in infrastructure. Suggestions for laypeople included: 1) a public education campaign in first aid, the role of the emergency services and cooperation of the public at the crash site, and 2) target-group training for professional drivers, police officers and volunteers involve at the crash scene. **In conclusion** the pattern of fatal RTIs in WAP differs somewhat from similar low- and middle-income countries. More attention should be paid to vulnerable road-users; young people, the over-65s and those living in rural areas. The burden of fatal road traffic injury in WAP is 1.53 times higher than records in the current data sources suggest. The lack of a system approach to road-user safety was the most important concern in the stakeholder study. There is a need for both a major change in stakeholders' attitudes to road-user safety and an integrated system to lead and coordinate all RTI prevention activities.

Keywords: Vulnerable road-user; capture-recapture method; surveillance; system approach; coordination; road-user safety; laypeople interaction; pre-hospital services; grounded theory.

LIST OF PUBLICATIONS

I. Khorasani-Zavareh, D., Haglund, B.J.A., Mohammadi, R., Naghavi, M., and Laflamme, L. **Traffic injury deaths in West Azarbaijan province of Iran. A cross-sectional interview -based study on victims' characteristics and pre-hospital care.** *Accepted*

II. Zavareh, D.K., Mohammadi, R., Laflamme, L., Naghavi, M., Zarei, A., and Haglund, B.J., **Estimating road traffic mortality more accurately: Use of the capture-recapture method in the West Azarbaijan Province of Iran.** *Int J Inj Contr Saf Promot*, 2008. **15**(1): 9-17.

III. Khorasani-Zavareh, D., Mohammadi, R., Khankeh H.R., Bikmoradi, A., and Haglund, B.J.A. **The requirements and challenges in prevention of road traffic injury in Iran. A qualitative study.** *Submitted*

IV. Khorasani-Zavareh D, Khankeh HR, Mohammadi R, Laflamme L, Bikmoraki A, Haglund BJ.A. **Post-crash management of road traffic injury victims in Iran. Stakeholders' views on current barriers and potential facilitators.** *BMC Emergency Medicine*, 2009, **9**:8. doi:10.1186/1471-227X-9-8

CONTENTS

LIST OF ABBREVIATIONS

CI	Confidence Interval
DRS	Death Registration System
EMS	Emergency Medical Services
FMS	Forensic Medicine System
GPS	Satellite navigation System
GT	Grounded theory
HICs	High-income countries
ICD-10	International Classification of Disease, 10^{th} Revision
LMICs	Low and middle-income countries
MOHME	Ministry of Health and Medical Education
NTS	National Transport Strategy
PCM	Post-crash management
PHC	Primary Health Care
RTI	Road traffic injury
SCI	Statistical Center of Iran
SPSS	Statistical Package for the Social Sciences
WAP	West Azarbaijan Province
WHO	World Health Organization

1 INTRODUCTION

In 2004, for the first time, the World Health Organization (WHO) dedicated World Health Day to the topic of road safety. Events marking the day were held in over 130 countries – to raise awareness about road traffic injuries (RTIs), stimulate new road safety programmes and improve existing initiatives. On the same day, WHO and the World Bank jointly launched the "World report on road traffic injury prevention", highlighting the increasing epidemic of RTIs [1]. The report discusses in detail the fundamental concepts of RTI prevention, the main causes and risk factors for road traffic crashes, and proven and effective intervention strategies [2]. In 2004, the Iranian parliament introduced a national policy for the reduction of fatal RTIs in every province [3]. In 2005, as a result of collaboration between Iran and the World Bank, an evaluation on the transport system was launched and resulted in the first review of the transport sector in Iran [4].

In low- and middle-income countries (LMICs), where the burden of RTIs is the greatest, there is little or no public health leadership for the prevention and control of the consequences [2]. Provision of roads safety designed and safe vehicles may be a necessary condition to reduce road-user fatality rates, but it is not sufficient [5]. According to WHO, epidemiology, prevention and advocacy are three important components to deal with RTIs [6]. Data from WHO and the World Bank revealed that Iran ranked as having one of the highest mortality rates from fatal RTIs in the world [4, 7]. As RTIs are a major cause of death in the country [7, 8], substantial efforts have been made in recent years to prevent them. However, the number and rate of RTIs still remains high [8]. Thus, it was found fruitful, as an important first step, to explore this major public health problem in more depth using different approaches. The overall aim of this thesis is to explore RTIs phenomenon and to find possibilities to develop road-user safety and diminish the severity of RTIs.

2 BACKGROUND

Injuries due to traffic crashes, violence, burns, falls or drownings are responsible for 9% of all deaths and 16% of all disabilities in the world [2, 9]. These kinds of injuries result in tens of millions of hospital emergency room visits and overnight stays [9]. Every day almost 16 000 people die from all types of injuries around the world [2]. It is believed that these mortality rates are just the tip of the iceberg [10] compared to the whole burden of injury, including morbidity, psychological consequences, and economical damages. This also may be due to under-reporting cases of minor injuries among different socioeconomic groups or because of a greater likelihood of severe or fatal injuries[10]. The figures may in fact be far worse among deprived group [6, 11-15].

2.1 MAGNITUDE OF ROAD TRAFFIC INJURY

Road traffic injury is the dominant form of injury worldwide and it is a major public health problem, requiring concerted efforts [2]. Data from WHO revealed that deaths from RTIs account for around 25% of all injury deaths [7, 16]. Moreover, traffic crashes are the number one cause of death among children and youth between the age of 10 and 24 years [9]. Every day on average 3242 people are killed on the world's roads [17]. Without increased efforts, it is expected that the total number of RTIs will rise by 65% between 2000 and 2020 and deaths are expected to increase by more than 80% in LMICs [2, 18, 19]. It is estimated that RTIs are the 11th leading cause of death worldwide [7] and account for 2.1% of all death globally; and fatal RTIs account for 25% of all injury in the world [16]. This burden is mainly related to LMICs [2, 7], and those with a lower socioeconomic status [11-15].

2.2 RISK FACTORS OF ROAD TRAFFIC INJURIES

A number of risk factors for RTIs had been identified and discussed by WHO [2]. These factors are summarized as:

(1) Factors influencing exposure to risk; e.g. economic factors like economic development and social deprivation [6]; demographic factors; mixture of high-speed vehicles [1] with unprotected road-users; insufficient attention to traffic laws and speed limits.

(2) Risk factors influencing crash involvement; e.g. inappropriate and excessive speed [1]; presence of alcohol or recreational drugs; fatigue; being a young male road-user, a vulnerable road-user in an urban setting; travelling in darkness; unsafe vehicles and road design.

(3) Risk factors influencing crash severity: e.g. inappropriate and excessive speed; inadequate use of seat-belts or child restraints as well as insufficient helmet wearing by two-wheeled vehicle road-users; and insufficient vehicle crash protection.

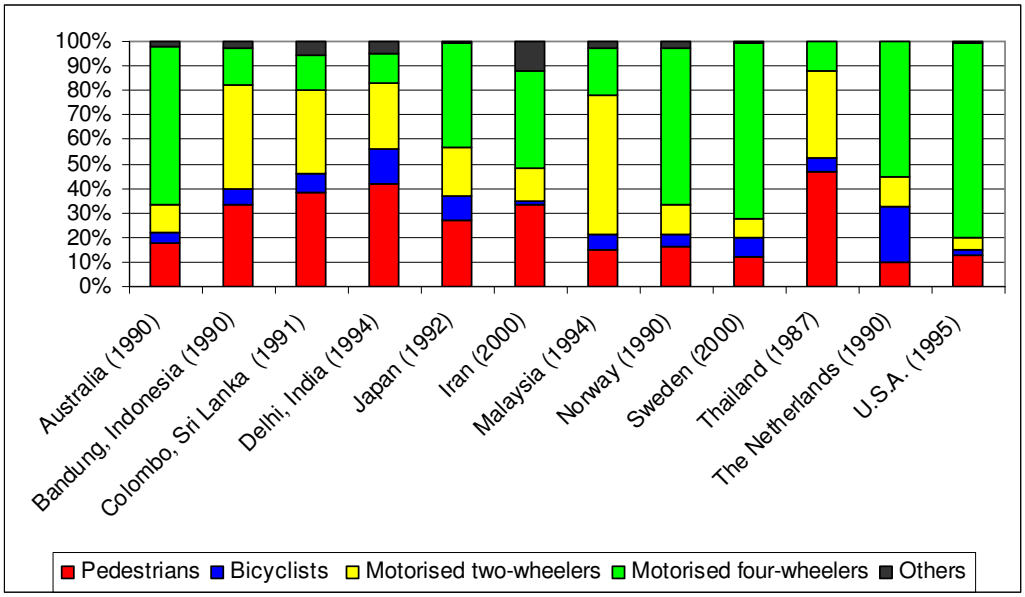
(4) Risk factors influencing post-crash injuries; e.g. delay in detecting crash and transportation of the victims to medical facilities; presence of fire due to a collision; presence of alcohol and other drugs; lack of appropriate pre-hospital services; lack of appropriate care in hospital emergency wards.

Focusing on socioeconomic factors of the victims, it is important to note that RTIs are significantly more acute and globally are on the increase in LMICs [2, 16, 18, 19]. Studies in this area revealed that there is a disproportionate impact from RTIs on poor and vulnerable road-users (pedestrians, cyclists, motorcyclists and passengers on public transport)[2, 20]. Moreover, as is often the case in high-income countries (HICs), people with a lower socioeconomic status or coming from deprived areas are more likely to sustain injuries or die from RTIs than their better-off counterparts [11, 14, 21]. People from lower socioeconomic groups usually benefit least from policies designed for motorized travel, but suffer a disproportionate share of injury, pollution and other consequences [2, 11, 14, 21, 22].

2.3 THE PATTERN OF ROAD TRAFFIC INJURIES IN DIFFERENT COUNTRIES

While all road-users are at risk from RTIs or death in a road traffic crash, there are significant differences in fatality rates between different road-user groups in different countries. In HICs, deaths among car occupants are predominant, while, in LMICs vulnerable road-users are more at risk than protected road-users and usually suffer from the greatest burden of injury [2, 13, 23, 24]. This is mainly because of the greater variety and intensity of the traffic mix and the lack of adequate separation from motorists [25, 26]. In addition, in many LMICs, where bicycles and motorcycles are often the only affordable means of transport, two-wheeled vehicles are involved in a large proportion of road traffic crashes. Therefore, in most LMICs, safety should be promoted within existing conditions [26]. Figure 2:1 shows the pattern of fatal RTIs in different countries.

Figure 2:1: Proportion of fatal road traffic injuries in various modes of transport in different countries.



Source: Reproduced with some modifications from source [27] and adding sources [28, 29]

2.4 DIFFERENT APPROACHES TO ROAD TRAFFIC INJURY PREVENTION

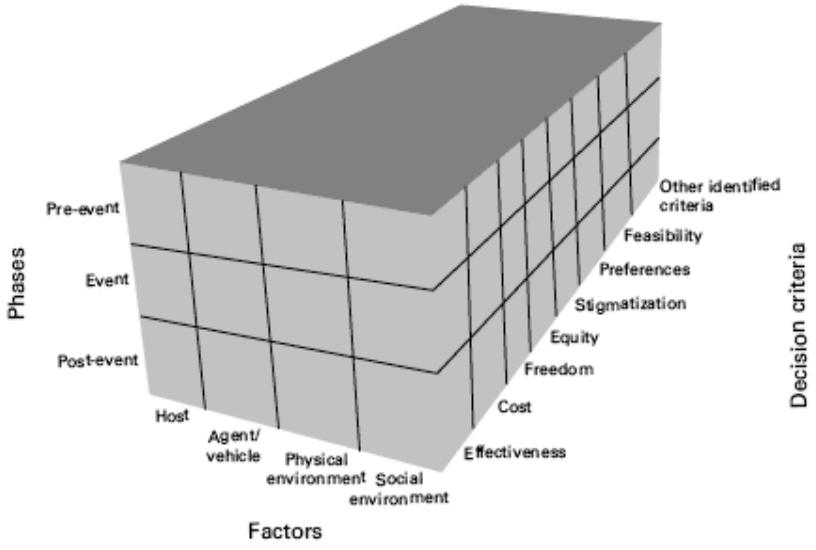
Safety promotion; safety promotion is strongly related to a concept of injury prevention that focuses on developing and maintaining optimal quality of life [30]. It is defined as "a process that aims to ensure the presence, and maintain the conditions, that are necessary to reach and sustain an optimal level of safety". As such, safety promotion relies on a multiplicity of activities, including regulatory processes, community-based programming, and ongoing surveillance [30]. Popay et al. also identified two dominant approaches: the health planning approach which emphasises on behaviour change and safety education and the community participation approach which emphasises changing the physical environment where local people shape the intervention [31].

Public health approach: This approach is helpful in the analysis of the risk factors as well as providing a framework of the phenomena that can guide decision-making throughout the entire process, from identifying a problem to implementing an intervention[2, 17]. Analysis of risk factors is one of the important component of this approach [17]. The public health approach involves four interrelated steps including: (1) determining the magnitude of the problem and its characteristics; (2) identifying the factors that increase the risk of RTIs or their severity; (3) assessing what measures can be taken for prevention of the RTIs; (4) implementing interventions that have been proven or are highly likely to be effective in RTI prevention. Step 1 looks for "who, when, where, what and how", and Step 2 looks at "why". It may also be used to define populations at high risk for RTIs and provide suggestion for interventions.

Using the Haddon Matrix approach: William Haddon developed a conceptual model, the Haddon Matrix, around more than thirty years ago [32]. As for disease and in relation to RTIs, events can be considered through two main dimension: the stage or phases of an event and the different factors associated with that event [33]. Risk factors can be identified before, during and after the crash, in relation to the road-users, vehicle and environment [17]. It is an injury causality and dynamic model, which provides scope for intervention to prevent and reduce RTIs in the before during and after phases [32]. The Haddon Matrix provides a compelling framework for a better understanding of the origins of RTI problems and to identify multiple countermeasures to address those problems [17]. In the pre-crash phase, it identifies all factors that prevent the crash occurrence, and is associated with countermeasures that prevent injury from occurring or reducing its severity if it should occur [2]. Finally, the post-crash phase involves all activities that reduce the severity and adverse outcome of the crash after it has occurred [2, 17, 32].

Moreover, Carol W Runyan in 1998 added the dimension of the decision criteria to the Haddon conceptual model [34]. The addition of the third dimension of decision criteria can facilitate its application in decision-making (see Figure 2.2). As the three-dimensional formulation is applied, users should document successes and problems in using the revised model. Runyan argued that [34] decision-makers must decide from the different alternatives for intervention, in order to achieve road safety.

Figure 2.2: Proposed three-dimensional Haddon Matrix



Source: reference [34]

Three Es: Public safety officials, researchers, policy-makers, and others have relied on a simple formula, called the "3 Es", to identify and develop effective prevention programs and policies. Enforcement of safety regulations, Education and training for at-risk groups, and Engineering (sometimes partnered with Environmental controls) are all considered effective components of injury prevention. However, no single approach taken in isolation can be considered effective to prevent injuries. Effective prevention must consider all three Es (and the related factor of Evaluation).

2.5 POST-CRASH MANAGEMENT

The best strategy for RTI prevention is crash prevention [1, 2], but this is not always feasible. It is often possible to minimize crash consequences by promptly providing effective pre-hospital services [13, 35-40]. Indeed, every year, many of the 1.2 million lives lost could be saved and much of the ensuing disability suffered by the 50 million injured could be prevented if rapid and competent pre-hospital services were available at the crash scene [41, 42]. Transport, when available, is usually provided by untrained people; e.g., relatives, taxi drivers, truck drivers, or by police officers [43, 44].Despite the fact that it may contribute to saving lives or reduce consequences, there is also a risk that the involvement of untrained people at the crash scene may also engender serious neurological injuries, severe sequels or fatal consequences occasioned either when extricating victims from vehicles or when transporting them without adequate immobilization [43, 45-47]. Thus, pre-hospital services mainly leave much to be desired especially – but not exclusively – in LMICs. According to the Haddon Model, improving the post-crash event is also an important additional aspect for prevention of RTI severity [32-34].

2.6 ESTIMATION OF NUMBERS AND RATES

In many LMICs, systematic data collection on RTIs is not well developed [17, 48] and underreporting of deaths and serious injuries is common [2, 17, 49]. RTIs can be measured in different ways e.g. including registers, census, household surveys, and surveillance systems, which all suffer from the incomplete coverage of the data [50]. The other alternative can be the combination of two or more independent data sources and applying the capture-recapture method [51, 52] (see page 16).

Road-user safety policy must be based on sound reliable data sources or surveillance systems, which are an important tool for injury prevention [53]. Policy makers need to know more about the numbers and types of injuries and about the circumstances in which injuries occur [6].Moreover, evaluation of the surveillance systems or data sources is crucial, and can even be essential for national policy evaluation, concerning the reduction of the number of RTIs. The information obtained from such a system is always useful to help policy-makers and stakeholders in order to have a better management of RTIs. In addition, a surveillance system has an important role to improve stakeholders' preventive activities and policies [54].

2.7 NATIONAL POLICY AND THE ROLE OF STAKEHOLDERS

In terms of RTI prevention, national strategies are important key factors in the reduction of RTIs and promotion of road-user safety. One of the most important goals for national policy-makers is to decrease the number or severity of RTIs. Fatal and serious RTIs can be avoided by involving all the key participants and by implementing important safety measures more widely and systematically [55]. There are some countries (see table 2.1), mainly HICs, that have a national policy for RTI prevention [2, 3, 56]. A system approach to the interaction between different components in a RTI [57], shared responsibility [55] as well as the safety philosophy behind the national policy are important requirements, when following such policies [55]. On the other hand, stakeholders' perceptions are indeed important to identified barriers [54] to and suggestions for quality improvement of relevant phenomena [58, 59].

Table 2.1: Examples of current fatality reduction targets in use in different countries [a]

Country of area	Base year for target	Year in which target is to be realized	Target reduction in the number of road traffic fatalities
Australia	1997	2005	-10%
Austria	1998-2000	2010	-50%
Canada	1991-1996	2008-2010	-30%
Denmark	1998	2012	-40%
European Union	2000	2010	-50%
Finland	2000	2010	-37%
		2025	-75%
France	1997	2002	-50%
Greece	2000	2005	-20%
		2015	-40%
Ireland	1997	2002	-20%
Iran	2005	2010	-50%
Italy	1998-2000	2010	-40%
Malaysia	2001	2010	< 3 deaths/10 000 vehicles
Netherlands	1998	2010	-30%
New Zealand	1999	2010	-42%
Poland	1997-1999	2010	-43%
Saudi Arabia	2000	2015	-30%
Sweden	1996	2007	-50%
United Kingdom	1994-1998	2010	-40%
United States	1996	2008	-20%

[a]*: It should be noted that some of these targets also include reductions in serious injury and are supplemented by other targets, e.g. to reduce the numbers of casualties among children.*

Source: Reproduced with some modifications from references [2, 3, 13]

It is worth noting that in Sweden one major national policy is a long-term vision for road safety, "Vision Zero". It was a revolutionary way of thinking about traffic user safety that helped Sweden to significantly reduce the number of deaths and serious injuries due to road traffic crashes. This is a road safety policy that puts the protection of the most vulnerable road-users at its centre. It is based on four elements: ethics, responsibility, a strong safety philosophy and creating mechanisms for change [2, 55]. It was adopted as the basis for road safety policy in 1997 by the Swedish parliament and then followed by some other countries [60]. Now the Vision Zero policy has been embraced in Norway and Australia, and the Swedish national policy with its powerful emphasis on safety is saving lives around the world [61].

2.8 IRAN

Iran is a middle income country [62] with a Gross National Income of 3470 US $ in 2007 [63]. The adult literacy rate is 84% and 11% of the total labour force are unemployed [64]. The country's population more than doubled from 33 to 66 million between 1975 and 1990 [65]; with a median age of 24.0 years[66]; and sex ratio (males per 100 females) of 103.9 in 2005 [64].The population pyramid changed due to rapidly decreasing death rates, thus generating a young population age structure, as the gap between the number of births and deaths widened [67, 68]. It is also because the majority of the population are in reproductive age [66]. The effect of this factor will gradually diminish as populations age, but between now and 2050 it will account for a projected increase in population of about 30 million [65]. The leading causes of death in Iran among adults are changing to chronic diseases, such as ischemic heart disease [67].

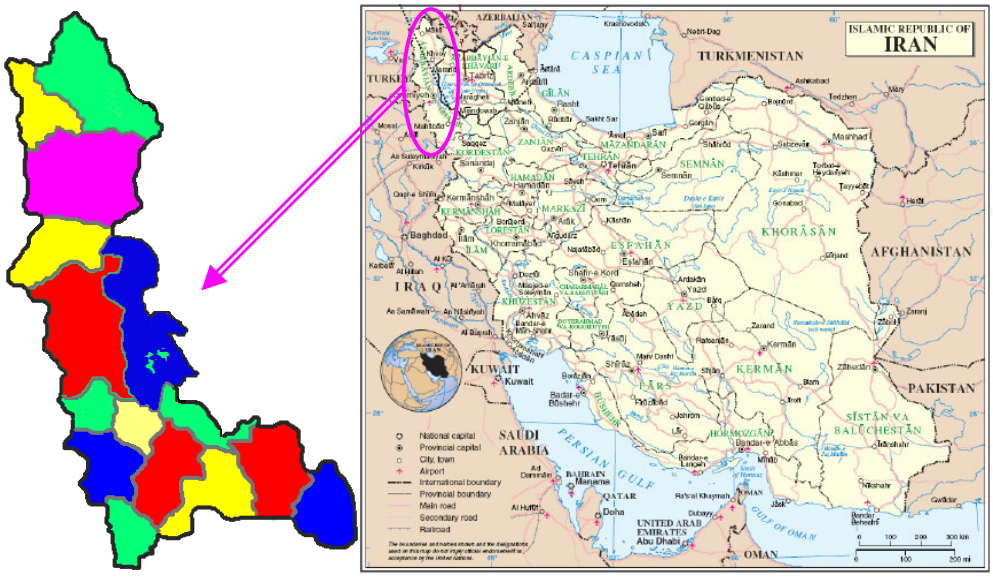
Geography

Iran has a landmass of 1 648 million square kilometres [69](see Figure 2.3), one of the largest in the Middle East and North African region [4].This is slightly larger than that of the UK, France, Spain and Germany combined [67]. Iran currently has a population density of 39 inhabitants per km^2 [70]. The terrain is characterized by rugged mountains that surround basins and plateaus [67]. The country has 30 provinces, 336 districts, 1 012 cities and approximately 64 000 villages [71]. Iran is the 18^{th} largest country in the world and 4^{th} largest in Asia [72]. Bordering on the Caspian Sea to the north and the Persian Gulf to the south and the Oman Sea, Iran is a neighbour to seven countries which makes it a natural crossroads and centre for trade flows [4]. Iran has been a key land-bridge between Europe and Asia due to the Silk Road (which is an extensive interconnected network of trade routes across the Asian continent connecting East, South, and Western Asia with the Mediterranean world, including North Africa and Europe) [73]and the Spice Road (from Russia/Northern Europe to India) [67]. However, Iran is crossed by several mountain ranges, which, in combination with some very different climates, creates a challenge for land transport as it makes both vehicle operating costs and infrastructure construction costs high [4].

Transport sector

The transport sector in Iran is of strategic importance and comprises 10% of GDP, which is unusually high [4]. Automobile manufacturing is one of the largest economic sectors in Iran and the country has the largest automobile industry in the Middle East and Central Asia [67, 74]. At the same time, fuel prices in Iran are dramatically lower than world prices [4, 75]. In 2006, Iran had almost 6 million cars and over 5 million motorized two-wheelers [67, 76], and vehicle ownership levels in Iran are significantly higher than other countries with similar income levels [67]. Moreover, in many cities, the road infrastructure is being rapidly developed, but not at the same pace as the increase in vehicles, which provides a challenge to the transport sector [4].

Figure 2.3: The map of Iran and the West Azarbaijan Province



Health status

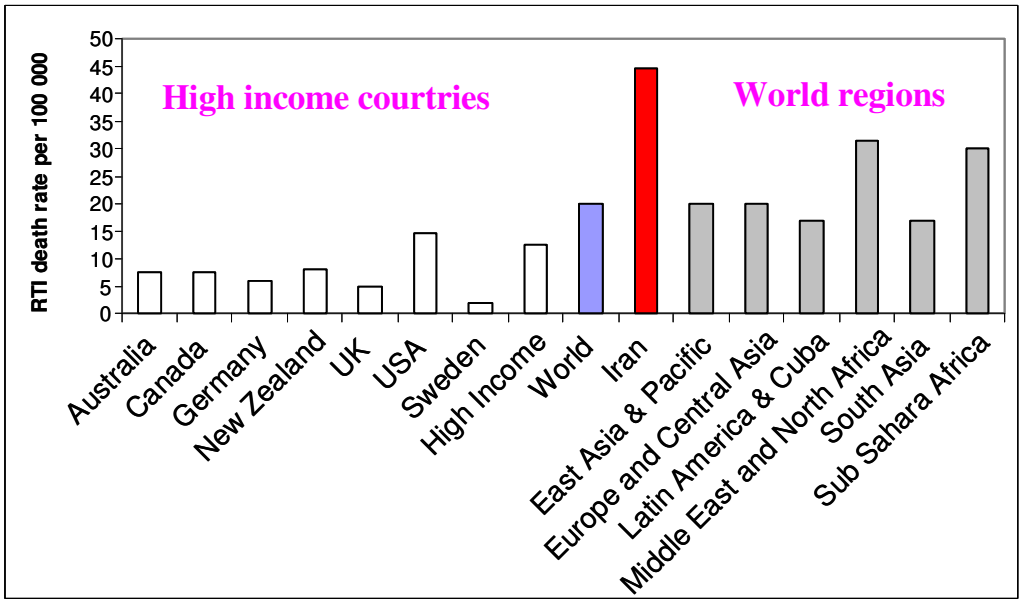
Iran is currently undergoing epidemiologic and demographic transition [68]. Thirty years ago, along with motorization, urbanization and other developments as well as a Primary Health Care (PHC) implementation, a remarkable reform in the health sector was implemented [77-79]. It resulted in great improvement in various health indices [79]. This remarkable change is partly due to the health network which has ensured provision of PHC to the vast majority of the public [77, 80]. This resulted in a dramatic decrease in neonatal, infant and maternal mortality rates as well as communicable diseases [79]. Moreover, life expectancy increased from 44.9 to 71.3 between 1950 and 2005 [64]. Some of the reasons behind this improvement have been the development of a health network system in Iran; which has aimed to increase access to PHC in rural and deprived areas [78]. The main functions of the health network establishment include educating people in health matters, providing family planning, reproductive health services, taking an annual census of the population, and case findings and disease control, promoting environmental health as well as the collecting, recording, storage and periodic reporting of health information [77, 80, 81]. Both the implementation of the health network and better access to PHC have resulted in a lot of improvements in health indicators [79]. While communicable diseases have declined and health indicators have improved, a marked shift towards non-communicable diseases have started to be dominant [79].

Road traffic injury

According to data from WHO, the RTI rate in Iran is far in excess of any other country or region of the world (see Figure 2.4), except Sierra Leone and Iraq, both of which have extremely unreliable estimates [7, 67]. In order to put the road traffic casualty rate into perspective, one needs just to consider that in the 2003, the Bam earthquake, which was extensively covered in the international media, and led to a massive international relief effort, killed 28 745 people [82]. However, in 2005, it was estimated that 30 721

people died in road traffic crashes, a statistic which received little attention [67]. One can see RTIs as a national, man-made disaster and understand that road-user safety is a particularly acute issue. With close to 22 000 crash related deaths in 2002, that is 59.9 per 100 000 [7] inhabitants, fatal RTIs in Iran are more than twenty times above the average for industrialized countries [67].

Figure 2.4: Fatal RTIs rate in Iran, compared with other countries and world regions



Source: reference [29, 67]

2.9 SUMMARY OF KNOWLEDGE AND RELEVANCE OF THE RESEARCH

Promotion of road-user safety needs a variety of measures. RTI prevention requires adequate knowledge of several areas: epidemiological characteristics, the incidence of RTIs, associated risk factors, and information on the effectiveness of prevention as well as advocacy [2, 17]. A large number of traffic-related injury policy interventions and strategies in HICs can be potentially transferable to LMICs. However, it is important to consider that country-specific factors such as feasibility and contextual barriers to RTI prevention, must be considered [83]. In LMICs, the RTIs are typically aggravated by the lack of reliable information systems and intervention policies, organization and coordination [17]. In order to understand the RTI phenomenon, stakeholders are vital sources of information to aid prevention and their perception is crucial to identify both barriers and current facilitators. Iran, despite its enormous efforts during recent years and social policy changes by policy-makers and different organizations, continues to be challenged by the sheer magnitude of this major public health problem [4]. Accordingly, it is important to explore the current situations in more depth. This thesis seeks to contribute to the understanding of RTI epidemiology, its contributors, and to explore the perceptions of stakeholders, road-users and RTI victims regarding the barriers to and the facilitators for road-user safety.

3 AIMS

The overall aim of this thesis was to increase knowledge about the patterns and characteristics of fatal road traffic injuries and their incidence rate, and to explore stakeholders' perceptions on barriers to and facilitators of RTI prevention and their severity in an Iranian region.

Three studies forming the thesis include the following specific objectives:

1. To highlight patterns and the main socio-demographic characteristics of fatal RTIs (Study I- Paper I)
2. To determine the incidence and rate of fatal RTIs (Study II- Paper II)
3. To understand stakeholders' perceptions of barriers and suggestions in RTIs prevention (Study III-Paper III)
4. To explores stakeholders' perceptions on barriers to – and facilitators of – effective post-crash management (Study III-Paper IV)

4 MATERIALS AND METHODS

Quantitative and qualitative methods have been combined to explore RTI phenomena in more depth. The thesis therefore included a quantitative approach employing cross sectional study and a capture-recapture method and qualitative approach using grounded theory (GT) method. Data were collected over two periods. The first two studies were implemented between 20 March 2004 – 20 March 2005 and data for the third study were collected between March and December 2007.

4.1 SETTING

The thesis comprised three studies, of which the first two were in West Azarbaijan Province (WAP) of Iran, while the last one was implemented in the WAP and at national level of Iran. Due to the feasibility of the study conducted in WAP, this province was chosen. WAP is located in the north-west of Iran, sharing a common border with Iraq, Turkey and Russia Azerbaijan in a mountainous area [84]. The WAP landmass is 37 612 km^2 and the population density is 77 inhabitants/km^2 [85]. The population was about 2 949 000 in 2005, of which approximately 49% were female [85]. The climate of the province is largely influenced by the rainy winds of the Atlantic Ocean and the Mediterranean. Cold northern winds affect the province during winter and cause heavy snow [84]. The total number of registered vehicles was 44 392 and the number of vehicles per 1 000 inhabitants was equal to 15.9. The total road length was 2 731 km, of which 779 km was main road including high-ways, and 1 807 km was asphalted road [70].

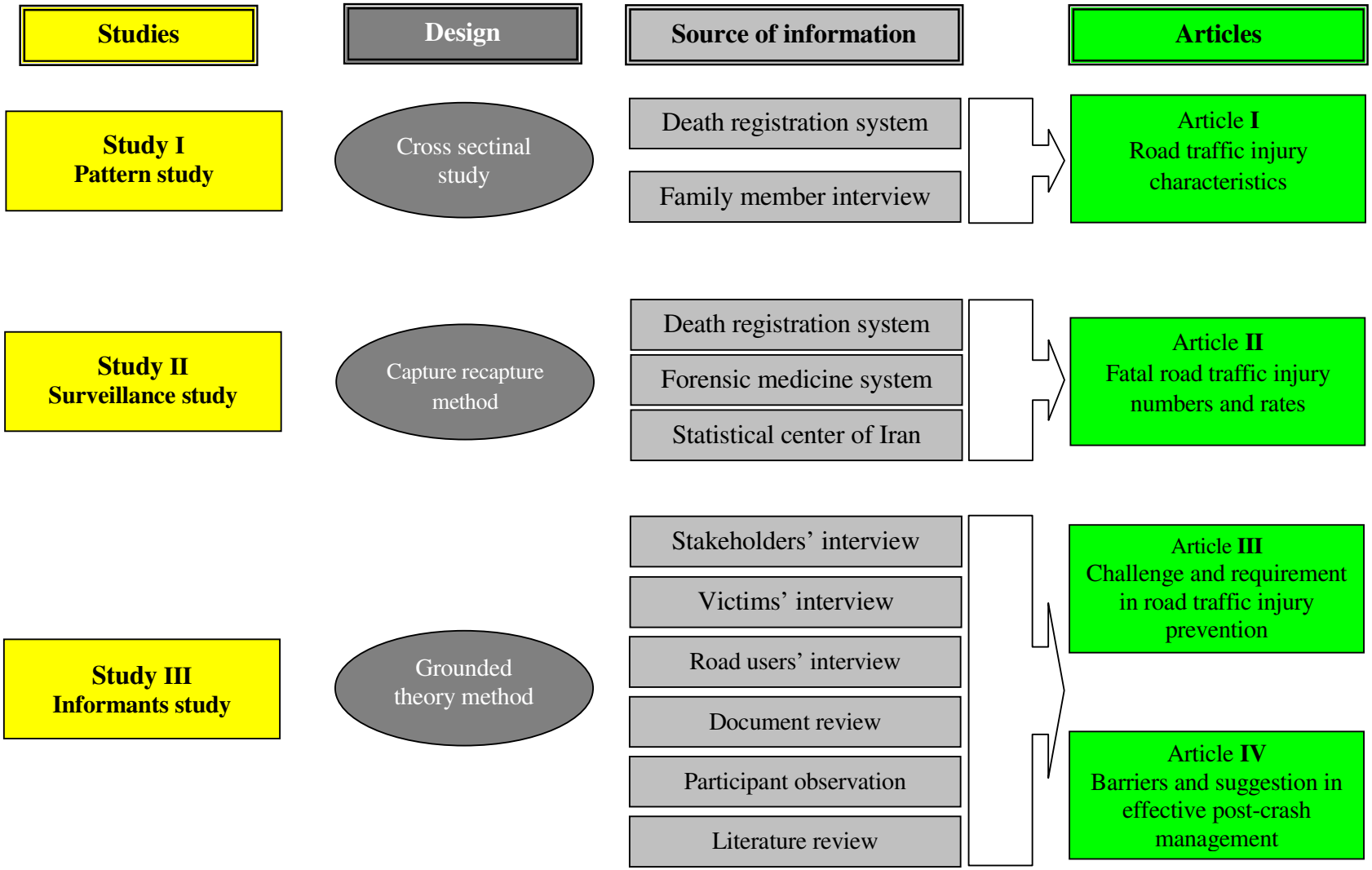
4.2 OVERALL STUDY DESIGN AND SOURCE OF INFORMATION

As Figure 4.1 shows, the thesis is structured in three studies. Study I was a cross sectional register-based study. Study II utilized a capture-recapture method employing two main data sources. Study III used GT to generate rich data from different sources.

4.2.1 Register data

In Iran, data on fatal RTIs can be obtained from a number of different sources, including the Forensic Medicine System (FMS), the Death Registration System (DRS), hospitals, ambulance reports, police records, road & transportation offices, civil registration offices, insurance offices, newspaper, cemeteries and health houses. A close evaluation was made of the completeness and independence of each source, and the DRS and FMS were retained for further analysis [28, 86]. Population as denominator was based on census information available from the Statistical Centre of Iran.

Figure 4.1: Area of study, study design and source of information



The Forensic Medicine System: This is an organization affiliated to the Judicial Authority in Iran. Fatal RTIs should be reported to the FMS in order to examine and issue the death certificate [87]. The recorded variables for deaths due to RTIs include: victim's socio demographic characteristics, vehicle type, place of crash, place of death, date of crash, date of death, and cause of death. Bodily examination of fatal RTI victims is carried out by a trained physician, named coroner, to determine more detail information about the death and its cause [87]. There is a close collaboration between FMS, police office and Road & Transportation Office, for fatal collecting of the fatal RTIs.

Death Registration System: This records all deaths by cause with other variables including demographic information about victims, date of death, place of death, place of death registration and home address of the deceased. DRS collects data from different data sources [67, 86, 88], including: public and private district hospitals and maternity wards; health houses; community health volunteers; and district cemeteries (see figure 4.2). The DRS registers causes of death by means of both medical certificates and verbal autopsy using descriptive guidelines [88]. In most cases physicians provide death certification. There is also close collaboration between the Civil Registration Organization and health centres in order to complete all missed cases from each source. After deleting duplicate cases, data collected at district and provincial level are forwarded to a national register based at the Ministry of Health and Medical Education (MOHME) which publishes morbidity and mortality data as a mean of evaluating its own performance [78].

Population statistics: Population statistics: Denominators were determined using population data for the WAP, extracted from the Statistical Centre of Iran. This centre generates data by census every ten years for the whole county. Between censuses, the annual population is assessed on the basis of population growth[70].

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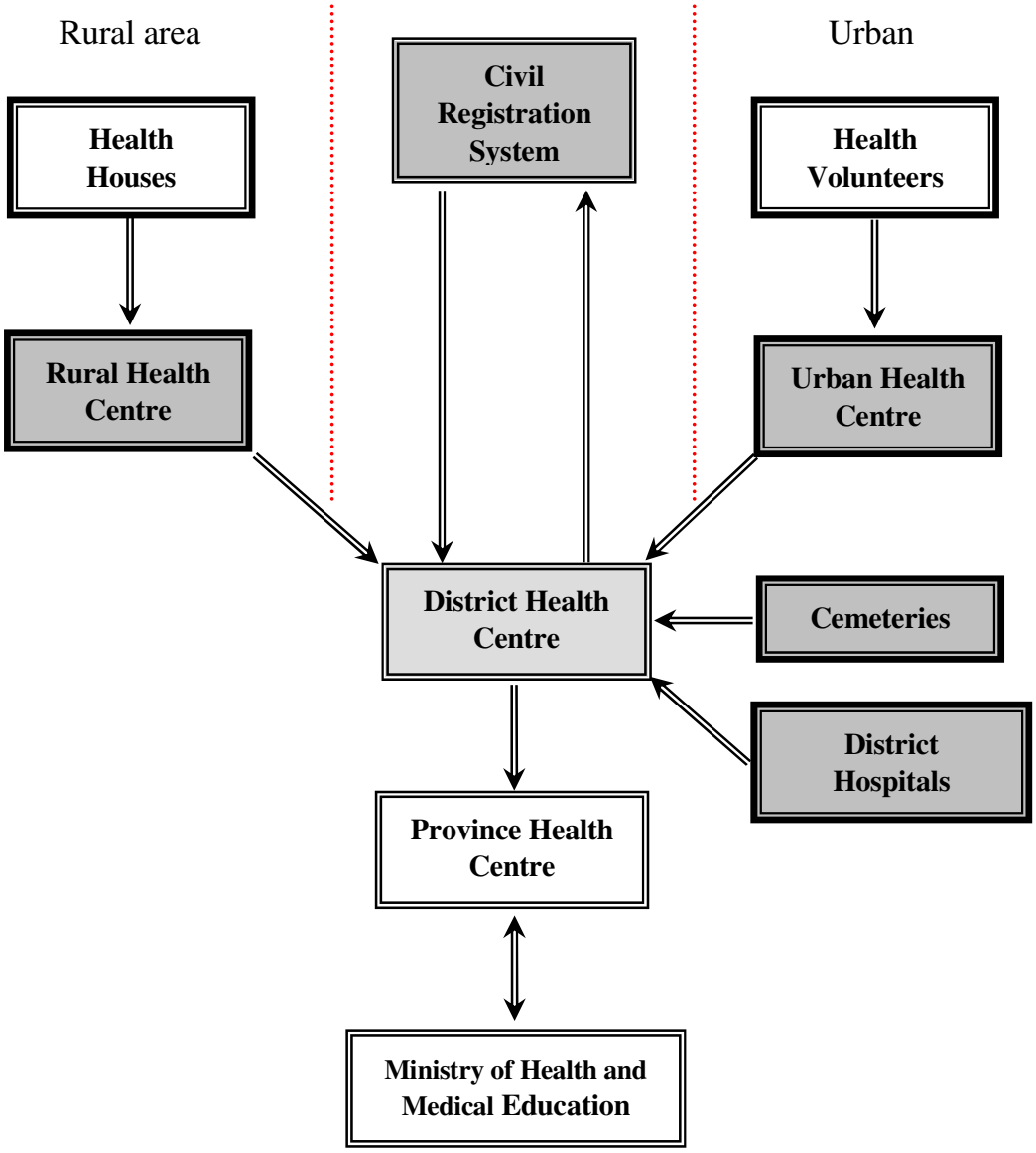
Figure 4.2: Data flow in the Death Registration System in West Azarbaijan Province of Iran during study period



4.2.2 Data generation in grounded theory method

Study III was a GT study to explore obstacles to the prevention of RTIs and to provide suggestions for limiting of their severity. GT is a suitable method when new areas are to be investigated in an explorative manner or if it has been decided to explore a known area from a fresh perspective [89-91]. In order to do this, a mixed approach including individual semi-structured interviews, observational field notes, a document review and participants' observations was employed.

4.3 SUMMARY OF STUDY DESIGN, MATERIAL AND METHODS

4.3.1 Study I

To highlight patterns and the main socio-demographic characteristics of fatal RTIs in the WAP of Iran

Study I (Paper I) was a cross sectional study that aimed to describe patterns of fatal RTIs including their socio-demographic characteristics and category of road-users as well as the association between them; and providing an overview of crash circumstances in WAP of Iran. The study was conducted based on a representative sample of RTI casualties identified in the national register of the DRS during the period 20 March 2004 - 20 March 2005. These records were thereafter documented through face-to-face interviews with family members of the victims to clarify their characteristics and the crash circumstances. A structured and standardized questionnaire, adapted from the WHO guidelines on injury surveillance and community survey, was used in the study. For the current study, the study base consists of persons resident in WAP who died in a road traffic crash including deaths which occurred within 30 days of the crash.

The distribution of injuries by category of road-user was considered for men and women, separately. Thereafter, the categories of road-users were merged into two main categories (car riders vs. vulnerable road-users). Finally, the association between category of road-user and socio-demographic attributes as well as time and place of crash was tested by means of Chi-squared test for their association.

4.3.2 Study II

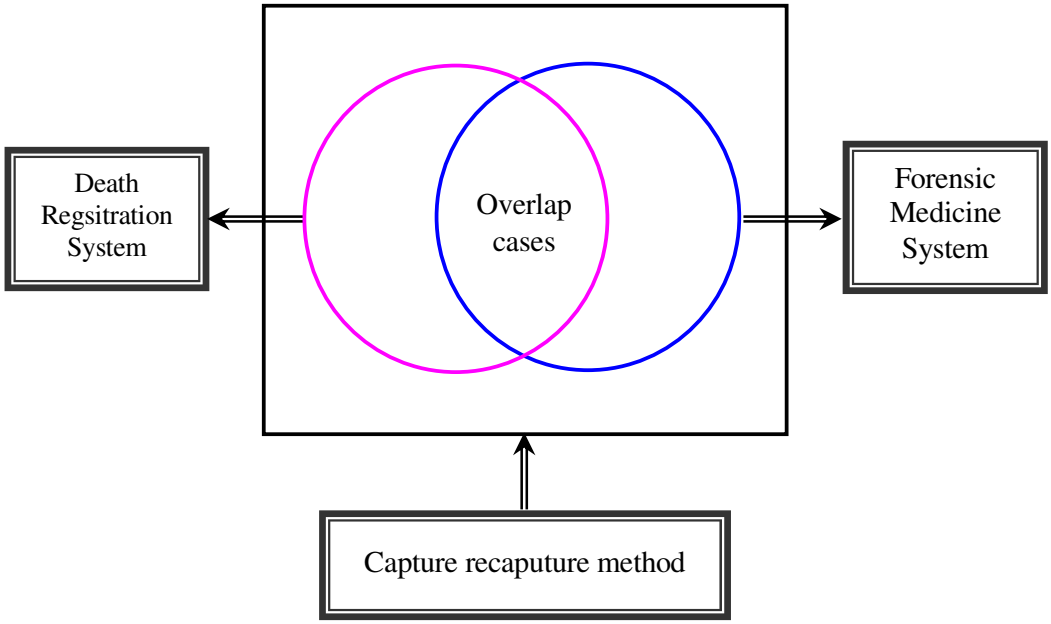
To determine the incidence and rate of fatal RTIs in the WAP of Iran

Study II (Paper II) estimated the overall number and rate of fatal RTIs in the WAP during the period 20 March 2004 - 20 March 2005, which then stratified by sex, age and category of road-users. In this study the DRS and FMS were used and a capture-recapture method was employed to obtain more accurate numbers and rates of fatal RTIs. The underreporting of cases was also determined.

Fatal RTI records from the official bodies, the DRS and the FMS, were obtained and denominators were determined using population data for the WAP, extracted from the Statistical Centre of Iran. Records from the DRS and FMS were combined and a record linkage applied, thereafter a capture-recapture method was employed. Only cases where the home address of the victim and actual fatal crash took place within WAP were included in the study.

The capture-recapture method was originally developed for estimating the demographic parameters of animal populations, and has subsequently been applied to human populations and the injury field [51, 92-109]. The method relies on the degree of overlap between incomplete and independent data sources (see Figure 4.3). In order to check dependency of the data sources, the same examination was made based on the records from the FMS and hospital data sources (see table 9.1 in appendix).

Figure 4.3: Application of the capture-recapture method on two incomplete data sources



Initially, duplicated records were determined, and cleansed from each source. In order to perform the matching process, all common variables in both FMS and DRS were considered. The records of the FMS and the DRS were matched together – using identical variables including name, gender, age, date and place of death, to ascertain the number of deaths. The SPSS version 13.00 was used to find overlapping cases. Both exact matching and progressive relaxing of each variable were used. Estimation of the number of deaths (n), the variance and 95% **CI** was carried out using the following formulas [52, 93, 110].

Estimation of n= $\left[(S1+1)(S2+1)/A+1\right]-1$

Variance n = $\left[(S1+1)(S2+1)(S1-A)(S2-A)/(A+1)^{2}(A+2)\right]$

95% CI= n $\pm 1.96\sqrt{Var(n)}$

Under-reported cases were also calculated by the formula; **N=A+B+C+D** [96], using Table 4.1

Table 4.1 Overlap of cases in the FMS and the DRS

Case found in the FMS	**Case found in the DRS**			
		Yes	**No**	**Total**
	Yes	**A**	**B**	
	No	**C**	**D**	
	Total			**N**

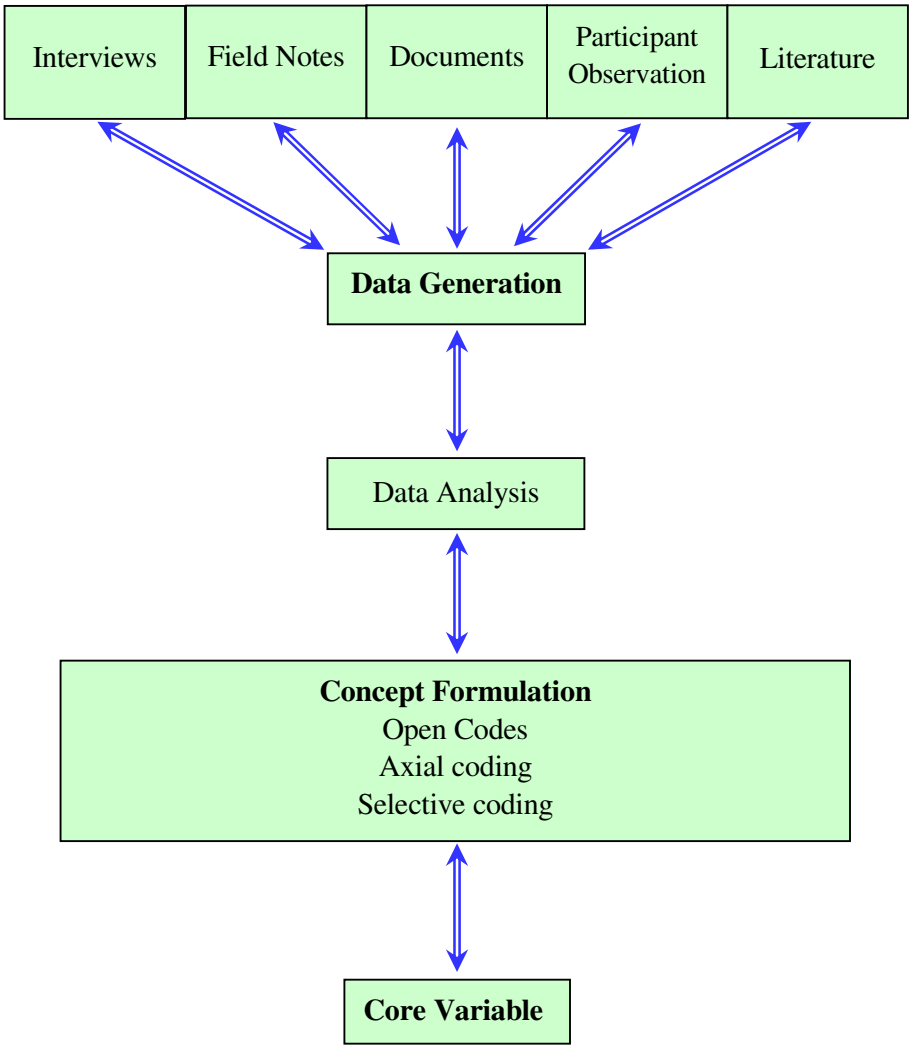
S1 and **S2** are the numbers of records in the DRS and FMS, respectively. **A** is equal to the cases common to both the DRS and the FMS, **B** equal to the cases found only in the FMS but not in the DRS and **C** equal to the cases which were in the DRS but not in the FMS. **D** stands for under-reported cases, as illustrated by capture-recapture. **N** is equal to the total population of fatal RTIs.

4.3.3 Study III

To explore stakeholders' perceptions of barriers and suggestions in RTIs prevention and its severity

Study III (Papers III and IV) was designed to identify Basic Socio Psychological Process in RTIs and road-user safety according to the GT method, employing different sources to generate richer and more valid data in relation to RTI phenomena. In terms of the crash phase, the Haddon Matrix was also considered. Figure 4.4 shows data generation and the use of GT method to indentify core variables.

Figure 4.4: Data generation and data analysis to identify the core variables in the grounded theory method.
Reproduced with some modification from reference [111]



Individual semi-structured interviews with stakeholders who were involved in RTI control, both in WAP and at national level in Iran were used. The participants included informants who were experienced or knowledgeable in RTI prevention or were themselves road-users or victims of RTIs (see Table 4.2).

Table 4.2: The list of participants in the study III

Key informants in the study	Number
Various personnel in Emergency Medical Services	7
Members in police office	6
Member in Fire fight	1
Member in car industries	1
Member in General Governor	1
Member in Red Crescent	2
Public health professions	5
Experts in Road & Transportation Office	4
Expert in Ministry of road	2
Car driver and motorcycle driver	4
Injured person due to RTIs	5
Total	**38**

The semi-structured interview is a useful and appropriate method for acquiring information because it provides rich data that addresses a wider range of factors contributing to the understandings of core variables in the relation to RTIs. An interview guideline was employed for data collection. It included open-ended questions covering the area which needed to be explored. Initially some general questions were posed and deeper questions were asked depending on the responses of each participant. The guide contains questions to explore the participants' perceptions on: barriers to and facilitators of road-users' safety, the RTI events and their circumstances; barriers to and facilitators for the prevention of RTIs; prior experience of different crash events; perceptions about the barriers to the successful management of the post-crash event; opinions about facilitators of effective PCM; opinions relating to the role of laypeople at crash scenes; opinions about the PCM organization and coordination. Each interview took between 45 and 80 minutes and was carried out between March and December 2007. All interviews were recorded, transcribed verbatim and then analyzed according to suggestions described by Strauss and Corbin [89, 90]. During the phase of open coding, the thesis author carefully read the whole text several times to get an overall understanding of the full text. During this phase key words or phrases, incidents and facts were extracted, as primary codes. The codes and data were compared for points of similarity and difference, and then categories and sub-categories were developed. The primary results were checked by four participants, as a form of member check. Moreover, the categories and sub-categories were discussed with a research team and three experts in qualitative study. Data collection and data analysis also took place simultaneously in order to increase the validity of data and to guide the next interview. After axial coding, and at the end of the selective coding phase, two core variables were identified.

The researcher had the role of observer to investigate behaviour in areas such as helmet wearing, seat belt use, traffic safety behaviour and the interaction between untrained people at the crash scene. The field notes were document review including published

papers in Persian, newspapers and magazines, movies and other kind of interviews in the media. They thereafter used in the study and analyzed for validation of the information obtained in face-to-face interview and obtaining richer data.

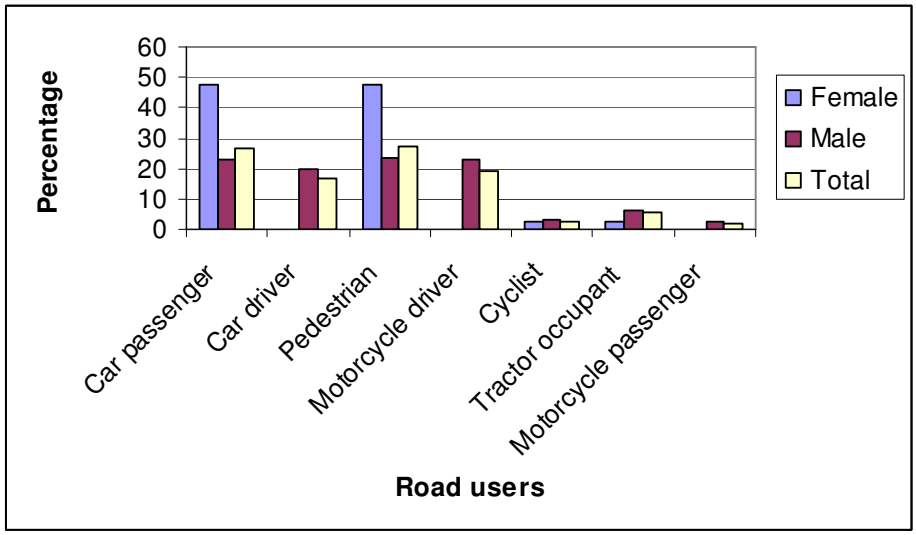
4.4 ETHICAL CONSIDERATIONS

The study was approved by the National Ethics Committee of Iran in MOHME (P391, 2005) [112]. The three studies were carried out as part of doctoral research within a joint programme between Karolinska Institutet in Stockholm, Sweden, and the MOHME in Iran. In all three studies, interviewees were informed about the purpose and design of the studies and that their participation was confidential, anonymous and voluntary. In Study I informed consent was obtained from the family members of victims of fatal RTIs. Information explaining the aim of the study was provided orally and in writing. The interviewees were also informed that they could withdraw from the sessions at any time. The interviewees then signed an informed consent form to participate in the study, which included both being interviewed (in Study I); and recorded for Study III. Informed consent was also sought to allow publication of the data. Furthermore, permission was also obtained from the MOHME, Urmia University of Medical Sciences and regional authority in WAP. All records and questionnaires were finalized without using any personal information about the subjects and all information was kept in secured files.

5 MAIN FINDINGS

5.1 STUDY I (PAPER I)

Figure 5.1: Distribution of the victims by sex and category of road-user in WAP between 20 March 2004 and 20 March 2005



Socio-demographic characteristics

Sex distribution: Figure 5.1 presents the distribution of fatal RTIs by sex and road-user category of the victim. The majority (85%) of the deceased were men, with a male-to-female ratio of 5.6/1. Females were mainly killed as either car passenger or pedestrians. Women did not sustain fatal injuries as car or motorcycle drivers. As could be expected from this, Table 5.2 shows that there is a significant association between sex of the victim and category of road-user.

Other socio-demographic characteristics: Table 5.2 presents the distribution of the victims by sex and socio-demographic characteristics and category of road-users, split into car riders and vulnerable road-users. The association between age group and category of road-user is significant (Chi squared= 36.7; d.f= 9; p=0.000), with victims less than 25 years and those more than 65 being killed mainly as vulnerable road users.

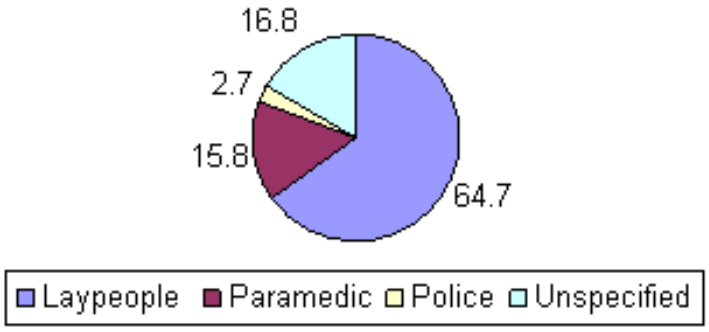
Table 5.2: Socio-demographic characteristics of RTI victims by type of road-user in WAP between 20 March 2004 and 20 March 2005

Socio-demographic characteristics	Car riders	Vulnerable road-users	Total	population reference in the WAP
	N=126	N=166	N=292	
	%	%	%	%
Gender				
Male	83.3	86.1	85	51.0
Female	16.7	13.9	15	49.0
	Chi squared= 0.44; d.f=1; p=0.5			
Age				
<1	1.6	0.6	1.0	8.4
1-4	1.6	3.6	2.7	
5-14	6.3	16.3	12.1	19.1
15-24	15.9	27.1	22.3	24.5
25-34	30.2	14.5	21.2	17.3
35-44	17.5	12.7	14.7	12.7
45-54	15.1	4.8	9.2	8.4
55-64	4.7	3.0	3.8	4.5
65-74	3.2	11.4	7.9	3.2
>74	3.9	6.0	5.1	1.9
	Chi squared= 36.7; d.f=9; p=0.000			
Education				
No schooling / illiterate	16.7	27.1	22.6	20.2
Primary school (grade 1 to 5)	27	27.7	27.4	23.8
Lower secondary school (grades 6 to 8)	16.7	19.3	18.2	16.9
Upper secondary school (grades 9 to 12) or above	25.4	12.1	17.8	18.4
University	8.7	3.6	5.8	6.8
Unspecified	0.8	0	0.3	5.1
N/A (children under 6 years)	4.7	10.2	7.9	8.8
	Chi squared= 18.1; d.f=6; p=0.006			
Marital status				
Married	59.5	42.2	49.7	49.2
Single	29.4	34.3	32.2	33.4
Divorced, widow or widower	4.8	7.8	6.5	0.4
N/A (under 10 years)	6.3	15.7	11.6	16.9
Uncertain				0.1
	Chi squared= 11.3; d.f=3; p=0.01			
Domicile				
Urban area	54	39.1	45.5	58.5
Rural area	46	60.9	54.5	41.5
	Chi squared=6.3; d.f=1; p=0.01			

Compliance to regulations and safety requirements: According to family member interview, among the fatal motorcyclist, only 18% were said to be habitual helmet-wearers. Moreover, accordingly, among car drivers, 21% were described as habitual seat-belt wearers. Overall, 21% of the motorcyclists had a driving licence.

Pre-hospital care of victims: In overall around two fatal RTI deaths in three occurred pre-hospital. Moreover, close to two-thirds of victims were rescued by untrained people and nearly four out of five were taken to hospital by passenger car rather than by ambulance. A few victims were transported by ambulance from the crash site (see figure 5.2).

Figure 5.2: Mode of victims' transportation in WAP between 20 March 2004 to 20 March 2005.



5.2 STUDY II (PAPER II)

Table 5.3 present the figures for all victims aggregated, and also split into categories of road users (pedestrians and others), age groups (children <15 years and others) and the genders. The DRS and FMS had recorded 669 and 665, respectively (roughly 22 fatal RTIs per 100 000 inhabitants) and the aggregated number was 897 (30 per 100,000); however, after applying the capture-recapture method, the more corrected incidence rate comprise 1018 (34 per 100 000).

Table 5.3: Frequency, percent and death rate estimation due to RTIs recorded by DRS and FMS in WAP of Iran during 20 March 2004 and 20 March 2005

Cases	DRS records	FMS records	Overlap cases	Aggregate numbers(Non overlap)	Ascertainment corrected estimate (95% CI)	Cases	DRS records	FMS records	Overlap cases	Aggregate numbers(Non overlap)	Ascertainment corrected estimate (95% CI)
Overall	669	665	437	897	1018(985-1051)						
Estimated degree of ascertainment (%)	65.7	65.3	42.9	88.1	100						
Mortality rate per 100 000	22.3	22.2	14.6	29.9	33.9						
Road users											
Pedestrian	186	174	114	246	284(265-303)	**Others**	483	491	323	651	734(707-761)
Estimated degree of ascertainment (%)	65.5	61.3	40.2	86.7	100	**Estimated degree of ascertainment (%)**	65.8	66.9	44	88.7	100
Mortality rate per 100 000	6.2	5.8	3.8	8.2	9.5	**Mortality rate per 100 000**	16.1	16.4	10.8	21.7	24.5
Age											
Children 0-15	103	99	74	128	138(130-146)	**Adult**	566	566	363	769	883(851-915)
Estimated degree of ascertainment (%)	74.7	71.8	53.7	92.9	100	**Estimated degree of ascertainment (%)**	64.1	64.1	41.1	87.1	100
Mortality rate per 100 000	3.4	3.3	2.5	4.3	4.6	**Mortality rate per 100 000**	18.9	18.9	12.1	25.6	29.4
Gender											
Men	574	563	377	760	857(828-886)	**Women**	95	102	60	137	162(145-177)
Estimated degree of ascertainment (%)	67	65.7	44	88.7	100	**Estimated degree of ascertainment (%)**	58.8	63.2	37.2	84.8	100
Mortality rate per 100 000	19.1	18.8	12.6	25.3	28.6	**Mortality rate per 100 000**	3.2	3.4	2.0	4.6	5.4

Coverage of data sources and group at risk of missing: As table 5.3 shows, in overall, the DRS and the FMS ascertain 65% of the estimated number of fatal RTIs and both DRS and the FMS together had about 121 under-reported cases. Moreover, the highest overlaps were for children less than 15 years-old, 93%. Considering sex of victims, coverage was somewhat better for male, 88.7 versus 84.8 for female. Looking at the categories of road users, the study shows better coverage related to pedestrians, 87%. Capture recapture method shows female, adult and road users other than pedestrian are more likely at the risk of underestimation.

5.3 STUDY III (PAPERS III AND IV)

As participants in Study III pointed out, pre-crash and crash circumstances are quite different to post-crash circumstances. Looking at the RTI phenomena holistically, lack of a system approach to road-user safety was the core variable, which was the same with pre-crash and crash circumstances. In post-crash events, "poor quality of post-crash management" was identified as the core variable.

Paper III: Pre-crash and crash circumstances

Barriers in relation to RTI prevention were identified as: human factors (divided into two concepts of undeveloped traffic safety culture; and lack of enforcement); lack of safety in the transportation system (divided into two concepts of lack of vehicle safety and lack of road safety); and lack of organizational coordination.

Human factors

Undeveloped traffic safety culture

All participants pointed out that the current traffic culture of road-users and their safety behaviour are the most important barriers for road-user safety. Undeveloped traffic culture and poor driver attitude were particularly pronounced among people who lived in the countryside and vehicle drivers. Traffic culture was regarded as "Knowledge, values and beliefs regarding safety behaviour and compliance with traffic safety law".

(PO/1) Bad driving is a problem in our country. Most vehicle drivers like to drive so fast without attention to safety behaviour. (World Bank Report)…Although a full diagnosis is yet to be done, there are indications that this crisis (very poor road safety) is due to a number of factors that reinforce each other, including especially, drivers' attitude and behaviour…

Some participants pointed out that there is a lack of compliance with traffic law among road-users. Some parameters identified in poor traffic safety culture related to: a lack of knowledge of and belief in road-user safety and traffic laws; a sense of urgency in most road-users, which is reflected in their driving behaviour.

(RT/2) Most people, especially those living in the countryside, don't know about traffic regulations and they don't have enough information about traffic law… (PO/3) young motorcyclists usually don't wear a helmet and most of them don't have a driving license

Concerning improving road-user behaviour, all participants were of the opinion that education is the key to RTI prevention. This should take the form of campaigns directed at the general public and training targeted at specific groups. The focus of education should be on changing people's behaviour. A number of suggestions came up including: encouraging calmness and patience among all road-users, increasing safe traffic behaviour, traffic calming measures and imposing more speed limits. The mass media, especially television, should be used to achieve many of these goals. There were challenges and different views among participants for changing road-user behaviour. A few participants pointed out the importance of improvements to the infrastructure rather than simply a focus on road-user behaviour changes. On the other hand, target group training was also recommended. This included a more comprehensive training course including road-user safety training prior to the driving test to be followed up by continuous training, especially for professional drivers and those who are illiterate.

Lack of traffic safety culture is the biggest problem in the country in relation to road traffic accidents…the best to prevent them is public education campaigns using mass media, especially television…

However, one public health professional pointed out that

If we have safe vehicles, safe roads and police with authority; a safe traffic culture will come automatically…when we don't have powerful legislation and a good infrastructure, we can not expect traffic compliance and I believe that education has little effect on traffic behaviour…

Lack of enforcement

Lack of enforcement was the other important obstacle to safe behaviour among road-users, particularly among different drivers. According to participants, traffic violations in Iran are usually punished by imposing fines or driving license suspension. For dangerous behaviour, vehicles can be confiscated or driving licenses revoked. This is difficult in practice, however. Lack of enforcement also was identified by the World Bank as an important cause in relation to poor road safety. This problem can be addressed by strengthening the legislation, and providing modern equipment for traffic police monitoring and law enforcement.

(PO/4)I believe that the current authority for law enforcement is not adequate and it is difficult for us to punish traffic offences. Since revoking a driving license is a very difficult process, we prefer to not do that

Lack of sufficient attention to instructions given by traffic police, old-fashioned police monitoring of traffic behaviour at interurban roads and lack of adequate public cooperation with the police were the other concerns. According to participants and the World Bank (2005), the current driving test is easy and should be made more difficult. Moreover, the legislation needs to be strengthened, the level of fines and other sanctions should be increased, and the issuing of driver's licenses should be more restricted with a greater focus on driving training and skills. However, a recent new policy has led to the traffic police being more restrictive in the issuing of driving licenses.

(PO/3) The current station-based police monitoring of traffic management is out of date; the laws should provide greater authority for police. Our problem is the main form of punishment for traffic offences is fines which are too small... (RT/4) I believe that speed cameras for traffic monitoring are extremely necessary.

Transportation system

Lack of vehicle safety

According to participants, there are some important concerns regarding vehicle safety including: an insufficient attention to car fleet safety; a lack of safety standards as regards the safety and crashworthiness of vehicles on the roads; an over-production of vehicles in recent years with insufficient attention to safety design; no vehicle safety standards department to handle the crash testing of newly manufactured cars; a large number of old vehicles designed with even less concern for safety; new cars being incompatible in terms of speed with current old car fleet; a lack of competition among car manufacturers that could affect the lack of interest in safety design promotion. All these are as obstacles to vehicle safety in the country.

In recent years a new loan-to-buy system has been implemented, making it much easier to buy a car or motorcycle and resulting in a dramatic increase in both the passenger car fleet and motorized two-wheeled vehicles.

Some other concerns related to vehicles were: the shortcomings in public transport; poor vehicle visibility; a lack of well-designed seat belts and child restraints; a lack of air bags and anti-lock braking systems (ABS) in most vehicles; very poor safety standards in motorcycles and a lack of in-car safety equipment. In addition, a very cheap petrol price and a high volume of trips by private cars could indirectly make the situation worse.

In the car industry we think of everything, except safety. Petrol is also cheaper than water! Which makes the situation even worse…

Most of the suggestions to deal with vehicle safety related to long-term strategies including vehicle safety improvements in the car industry and more research. The participants also suggested that the removal of old vehicles from the vehicle fleet needs to be facilitated and periodic vehicle inspection needs to be more rigorous.

An old car fleet is one important problem both in our province and the rest of the country. Not only are old cars unsafe themselves but they are also a danger to other vehicles on the road and we should provide more incentives to remove them from the vehicle fleet

Shortcomings in infrastructure

A number of problems in relation to the transport system and its safety came up, mainly relating to the lack of sufficient traffic signs on the roads, one way streets, inadequate road lighting, a lack of special roads for low-speed vehicles, a lack of roadside protection, a poor overall level of road maintenance and repair; and a large number of accident black spots. Moreover, a lack of safe routes for pedestrians and cyclists, and incompatibility of high- and low-speed vehicles were other obstacles. More traffic

signs, quicker road repairs, installation of speed bumps in heavily populated areas and crash barriers in high-risk areas, and more alternative road junctions will all help to reduce crashes at black spots in both the short and the long term. Furthermore, a better urban infrastructure including splitting the road up into different lanes, making roads wider, and reserving special lanes for emergency services would also help matters.

There are many accident black spots on the roads throughout the country, which are dangerous for road-users…traffic police have made substantial efforts to improve road safety. However, due to poor vehicle and road safety design, the number of crashes and casualties is still high

Lack of organizational coordination

Inadequate communication and coordination between organizations in relation to road-user safety activities is one of the most important obstacles to RTI prevention. Currently, there are several organizations working in the road safety field but there is no effective liaison between them. There is no single agency with an overall authority and responsibility to monitor and arrange road safety activities. Some other examples of the lack of coordination were: a lack of a comprehensive national transport strategy for road-user safety, the same task being carried out simultaneously by two organizations (task duplication); lack of a clear allocation of responsibility for some activities; interference in the duties of other organizations; and a lack of sustainable planning with regard to road-user safety activities across sectors. As stated by the World Bank, a fragmented institutional set up does not allow the integrated management of road safety based on past international experience. Moreover, according to participants, there is no national comprehensive information system for registering motoring offences in Iran, resulting in no distinction being made between traffic offenders and law-abiding citizens.

Most participants pointed out that the most important factor in decreasing RTIs is a "National Decision", where all sectors and road-users should decide to confront this major national problem. Moreover, a number of organizations including the Police, the Road & Transportation Office, the Forensic Medicine Organization and Ministry of Health and Medical Education are endeavouring to register morbidity and mortality data on RTIs, however, there are still missing data. The solution can be addressed by the integration of comprehensive injury surveillance adopted from ICD 10. Regarding coordination and government activity, the World Bank stated that

The Government is fully aware of the problem and has started to take action. A national road safety council was created in 2003 to establish national goals and coordinate the actions of all agencies involved in road safety. The traffic police has improved its equipment and stepped its enforcement activities. Several hundreds dangerous spots in the road network have been improved. These actions now need to be expanded, better coordinated, and well monitored…

Paper IV: Post-crash event

In the post-crash event "poor quality of post-crash management" was the core variable, which mirrored the general views expressed by the participants. Four main barriers to effective PCM (involvement of laypeople; lack of coordination; inadequate pre-hospital services; and shortcomings in infrastructure) and four facilitators (public education campaign, target group training, integrated trauma system; and infrastructure improvement) were identified.

Barriers

Involvement of laypeople

The involvement of untrained people as a potential barrier during the post-crash event was mentioned by all participants. The main factors identified concerned cultural background, limitations in knowledge and late arrival of the emergency services. Altogether, these factors explain why untrained laypeople gather at a crash scene, the negative effect of their role in rescue activities and how they have the potential to indirectly increase injury morbidity and mortality. Figure 5.4 show barriers related to the role of laypeople when crashes occur.

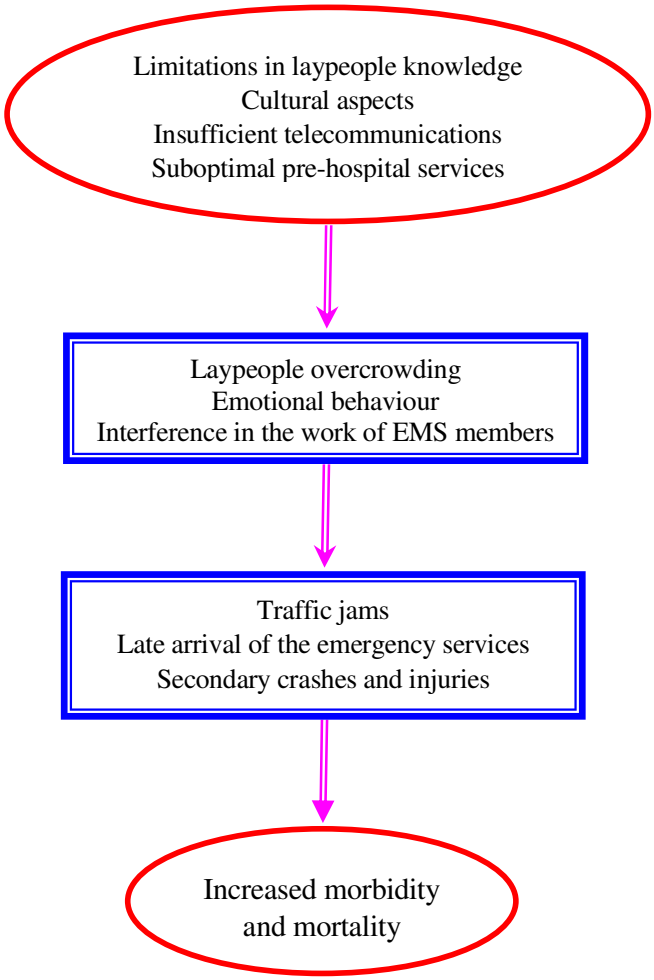
The cultural background factors included: a willingness to help, humanitarian assistance, individual curiosity, people's sense of urgency, excitement, and disorganized cooperation leading to a crowded crash scene. Untrained people's limited knowledge related to: how to interact at a crash scene; what information needs to be given to the emergency service; how to use different emergency numbers; and how to provide first aid. Participants pointed out that such knowledge limitations affected the quality of the information provided (incomplete or wrong) to the emergency services.

(EMS/1)People want to help casualties, but they usually don't know first aid, aren't sure what to do before the ambulance arrives and what kind of detailed information they need to give the emergency services when they call them. This can lead to incorrect phone-calls and the wrong information being conveyed.

Invariably, laypeople are the first to arrive at a crash site. According to most participants, laypeople are often stressed and can easily interfere with the activities of ambulance personnel. They usually remove victims too quickly and take them to hospital in their vehicles. Their involvement is regarded as necessary to alert the emergency services and seen as useful in rural and remote areas. However, untrained laypeople, when too involved in crashes occurring in urban areas, may easily waste further time, hamper the emergency services, cause secondary injuries to victims and even provoke new crashes.

(PO/3) A common problem at crash scenes is the gathering of too many people and their emotional behaviour, which could at worst lead to new crashes and new injuries to the victims

Figure 5.4: Conceptual model in barriers related to laypeople involvement in post-crash management in Iran



Lack of coordination

At many crash sites, the police must be present to take statements, which is important for insurance and legal purposes. According to EMS members, this task wastes precious time and delays the transportation of victims to hospital. Members of other organizations stated that an insufficient number of ambulance dispatch sites could also result in delayed transportation. Moreover, the fact that rescue activities are designed in different ways in different organizations could contribute to delays. Additional factors in relation to lack of coordination were: lack of a system approach to PCM; different ambulance dispatch site locations; existence of parallel organizations with the same activity (task duplication); and substandard telecommunication equipment, which might hamper coordination and cooperation among the organizations.

(EMS/2) Most of the calls made by laypeople to the emergency services or other organizations concern crashes without casualties. We dispatch our ambulance but since there are no casualties, it is a waste of both time and resources… (RA/2) there are different emergency numbers for organizations and people will be confused over which number they should call when they see a crash and an emergency situation.

Inadequate pre-hospital services

The low number of ambulance dispatch sites is viewed as a hindrance to effective pre-hospital services, together with inadequate human resources (staffing and adequate formal training) and insufficient physical resources (ambulances and their equipment). There is often a lack of police officers at many crash scenes and their lack of crash scene management skills was also seen as a hindrance to effective PCM.

(EMS/3)The fire services are officially responsible for rescue activities particularly in urban areas, but they cannot be present at all crashes. However, EMS ambulances usually don't have enough rescue equipment and in some cases, crash victims are trapped in their cars, resulting in the EMS having to call the fire services to come and cut them out.

Shortcomings in infrastructure

Some participants stated that shortcomings in the infrastructure constitute an important barrier to effective PCM. These include poor urban infrastructure and no satellite navigation (GPS) or well-established telecommunication systems. Suggestions for improvements to infrastructure were put forward but as part of a long-term strategy. These included better urban infrastructure including establishment of GPS and better telecommunications, including an improved emergency telephone service as well as a helicopter ambulance for crowded cities.

(EMS/5) There is not usually a traffic lane reserved for the emergency service, and we are stuck in a traffic jam

Facilitators

Public education campaign

All participants stated that public education plays an important role in effective PCM and considered it should be widely spread. In recent years, many activities and public education campaigns have been implemented by the police, focusing on the primary and secondary prevention of road traffic crashes, but the need for more public education regarding PCM was clearly stressed. It was considered that this should incorporate aspects related to better cooperation of people with the emergency services, basic first aid techniques, the role of the different emergency services in road traffic crashes, and safe victim transportation when ambulances are not available. According to participants, the mass media, especially television, is an important way to convey public health information in the Iranian context. On the other hand, it was strongly felt that, since many people still do not have enough knowledge of first aid, their cooperation should be limited to protecting the crash scene and alerting the emergency services, especially at urban crash sites.

(RT/1) People need to learn that they should leave the crash scene immediately when the ambulance team arrives. (EMS/4) Public education is necessary for first aid, recognizing emergency needs, helping the ambulance arrive faster and leaving the crash location carefully and calmly.

Target-group training

Most participants stated that training of those who arrive initially at the crash scene was another way of improving crash scene management. It was proposed that training should include basic principles of safe rescue, Cardio Pulmonary Resuscitation (CPR), victim triage and safe transportation to medical centres. This group could be made up of professional drivers and people who volunteer their help. Providing a kit of simple equipment and supplies and a special uniform for this group could improve their cooperation.

(RT/2)If we can train some professional public drivers and if we give them a uniform to show that they are responsible for emergency services as well as some supplies, this might improve crash scene management. (PO/2) Such people are often first on the crash scene, arriving sooner than all other organizations, and if they know first aid and preliminary crash scene management, they will be of more help to the victims.

Integrated trauma system

A combination of rescue activities and the introduction of one emergency telephone number were suggested by most participants. Further, better coordination among organizations was regarded as necessary for effective victim management. It was proposed that all EMS ambulances and Red Crescent ambulances should be equipped with rescue equipment and other vital supplies. Moreover, in order to improve victim rescue, staff training was seen as more important than physical equipment, including the number of ambulances and ambulance dispatch sites. One suggestion for interurban roads was the establishment of a collaborative group consisting of ambulance team members, Red Crescent personnel, police officers and Road & Transportation office, which would be more useful in crash black spots. Access to a helicopter ambulance in crowded cities was also regarded as necessary. Both these last two suggestions are currently being implemented in many cities and need to be expanded.

(PO/2) Should a system be formulated to do the tasks of police, firefighters, medical staff and rescue teams, all together? (If so) the provision of services would be much better…(EMS/2) if emergency organizations had a single emergency number for all calls, it could ease coordination and speed up arrival on the crash scene.

6 DISCUSSION

6.1 SOCIO-DEMOGRAPHIC CHARACTERISTICS

The study shows that RTIs are not distributed at random across socio-demographic groups and that there is an association between victim attributes like sex, age, education, occupation or marital status, domicile and category of road-user. In particular, women die above all as car passengers or pedestrians. Those with a low education (illiterate and up to grade eight) tend to die from their injuries slightly more often than others. Vulnerable road-users are over-represented in rural areas. In overall, it may not be possible to completely eliminate these factors or to minimize their intensity and consequences, but it is possible to reduce their severity [17].

Sex differences: International studies reveal that the male-to-female ratio of fatal RTIs worldwide is 2.7:1 [2], which is much lower than the one observed in this study, 5.6:1. Compared to the Eastern Mediterranean Region as a whole, this rate is also higher than the figures in different income countries, 2.5:1 till 3.3:1 [113]. However, country-specific figures indicate an even higher ratio in rural Thailand (9.6:1; [114]) and a lower one in Ghana (1.8:1; [115]). In general this ratio in the region is higher than the world as a whole and even the capital city [116] of Iran. According to participants in study III, women's level of driving activity is lower than men's, e.g. socially they can't or don't want to drive motorcycles and trucks, especially on interurban roads. This may reduce the risk of their injuries and deaths in crashes. There are other reasons that might be due to exposure differences (in amount and in kind of cars) that imply than men are far more on the road than women and for cultural reasons. In the face-to-face interview, participants also pointed out that women are more cautious when driving. This is in line with other studies that show that behavioural differences can also come into play as women are likely to be more careful than men when driving (see also [13, 117]).

Other socio-economic attributes: The mean age of the victims of our study was similar to that of other Iranian studies on RTIs from Kerman [117], Shiraz [118] and Tehran [116]. Moreover, people from the older age group (>65 years) are more than twice as likely to be among the victims as people from the population in general (13.0% vs. 5.1%). As expressed by participants in Study III, Iran has a young population; median age is 24.0 [66], however, this argument needs to be tested using quantitative methods.

Further, comparison of domiciles also showed that there was an over-representation of fatalities among people who lived in rural areas (54.5.0% vs. 41.5%), especially among vulnerable road-users. Since Iran is a middle-income country, it is not surprising to find a high number of RTI deaths in rural areas, especially among vulnerable road-users [2, 11-13, 21]. As many injuries occurred in rural areas, the over-representation of farmers and blue-collar workers does not come as a surprise either, which is in line with other injury studies in Iran [118-120].

6.2 PATTERN OF ROAD-USER DEATH (PAPERS I AND III)

Pedestrians: The WAP region registers a smaller proportion of pedestrian deaths compared with national figures [28] (27% compared to 33%) or with the capital Tehran [121]. This might be explained in part by the region's geographic location: bordering on three countries, cross-border trips by car may be frequent, which may

result in more crashes between cars than between cars and pedestrians. Yet, the proportion of pedestrian deaths is not only less than the rest of Iran [28] but also less than reported figures in other LMICs like India, Pakistan and Nicaragua [2, 25, 104].

As participants in Study III (Paper III) pointed out, generally in recent years there has been a dramatic increase in the motorization in Iran, which is in line with the report produced by the World Bank [67]. The government has also encouraged car and motorcycle ownership by providing loans, resulting in a very large proportion of the population owning motorized vehicles. Focusing on WAP and as expressed by participants, the region on the whole has an old car fleet, and, as expressed earlier, this has caused an incompatibility between new high-speed vehicles and old ones, which can have an adverse effect on road-user safety. The result from Study I also shows that most of the crashes occurred on inter urban roads. These factors might influence the pattern of death towards car riders rather than pedestrians. However, these findings need to be tested using a survey and quantitative approach.

Motorcyclists: Not only the proportion of pedestrians but also that of motorcyclists was lower than for the whole country [8]. In WAP, fatal RTIs sustained as a car rider were twice as high as fatal RTIs as a motorcyclist. Again, the explanation for this can be found in the region's geographic location and its related climate, which is mountainous and usually colder than the rest of country. Winters in the WAP region are typified by sub-zero temperatures and heavy snowfall [67]. This does not mean that injuries as motorcyclists have not increased over time in WAP as they have done in the rest of the country [8, 67], as we have no data to assess this trend.

6.3 INJURY-ORIENTED SYSTEM (PAPER II)

Study II (Paper II) showed that the FMS has more specific information about the characteristics of injury, including victim's socio-demographic background, location of injury on the body, cause of death, vehicle type, place of crash, date of crash, date of death, and specific information about pre-hospital and hospital road-user deaths. This system has now been expanded to cover the whole country. The study showed that in terms of RTI prevention, the FMS is an injury-oriented source, and has the potential to serve as an injury surveillance system. Applying a correction factor to the FMS can provide the opportunity for better estimation of different road-users and the other contributors in terms of injury prevention in the Iranian context. It is also important to note that the FMS has an ongoing data collection covering RTIs and they analyze and interpret data regularly in close collaboration with the police and the Road & Transportation Office. The information is also regularly sent to these organizations, governor and national level of FMS and could potential be used as a basis for planning future interventions.

6.4 COMPLIANCE WITH TRAFFIC LAW (PAPERS I AND III)

The use of seat belts and helmets is compulsory in Iran [28]. These protection measures have considerable bearing on the probability of being severely injured in a traffic crash [13]. However, findings from Study I revealed that the use of these safety measures was very low, which also echoes figures from studies in Tehran [116] and Kerman [117]. This tendency was also pointed out in the face-to-face interview by participants and revealed in the participant observation in Study III. Undeveloped traffic safety

behaviour was also in line with the findings by the World Bank report, which highlighted it as "special drivers' attitude and behaviour"[4].However, as expressed by motorcycle participants in Study III, most of them have difficulties with helmet wearing. Accordingly, the reason for the low rate is due to the substandard quality and lack of comfort of most current motorcycle helmets, in combination with a lack of knowledge and compliance with traffic law. The same arguments are used for the low rate of seat belt use in most old vehicles, which lack standard seat belts. In overall, as other studies found, in order to increase the use of helmets and seat belts, various factors may need to be addressed, some by educational campaigns, others by environmental changes including manufacture, e.g. addressing weather conditions, comfort, and weight for helmet which is in line by other studies in other settings [122]. Moreover, while an educational campaign is essential, it seems that focus needs also to be put on environmental changes. Law enforcement is also essential for monitoring helmet wearing and seat belt use [13], as most of our participants in study III mainly relied on the effect of law enforcement. In addition, as Study I showed, only a few of the fatally injured motorcyclists had a driving licence. This finding also revealed that more enforcement and monitoring should be part of these traffic safety measures.

Behavioural changes among most road-users, especially drivers are important issues. In terms of public education, studies in HICs have revealed that a decrease in crashes due to public education campaigns can occur only if they are clearly targeted on specific forms of behaviour, like seat belt use or helmet wearing [13]. Focusing on enforcement, in a case control study in the capital city of Iran, a project imposing penalties on motorcyclists showed that more rigorous enforcement did not decrease the total incidence of traffic crash injuries, but did lead to a shift to less severe injuries during the enforcement implementation [123]. It seems that the manner of law enforcement is also important to be considered. This, in itself needs more investigation. However, experience from HICs estimated that campaigns combined with increased police enforcement appear to be more effective than campaigns without [13].

A study in Sweden reveals that changing road-user behaviour in terms of increasing the rate of seat belt use, by means of environmental changes rather than education campaigns is more effective. In this area, the study revealed that seat belt reminders in the vehicle led to a significant rise in seat belt use in all cars i.e. those both with and without seat belt reminders [124, 125]. The participants in our study didn't place much emphasis on environmental changes to improve human behaviour, which is far from the experience in successful countries. While Iranian traffic police have made enormous efforts in the fields of both public education and enforcement in different areas in recent years, car manufacturers also need to consider crashworthiness and the various safety technologies more seriously. This is in line with other studies in other settings, that areas for potential intervention include: environmental modification of the infrastructure, greater attention to safety in manufacture [126]as well as the promotion of safe behaviours through legislation and law enforcement [127]. These findings reinforce the view that Iran really does have a problem with road-user safety and the consequences of RTIs.

6.5 TRANSPORT SECTOR (PAPER III)

Participants pointed out that an over-production of new cars combined with a lack of emphasis on safety in their design was an important obstacle. This is also in line with a prediction by the World Bank; a dramatic increase in the number of vehicles on the road, particularly motorcycles, is making the roads far more dangerous [4]. It is well known that as motorization increases, especially in LMICs, there will also be a rapid increase in the number of crashes and injuries [1]. Iran currently has the largest automotive industry in the Middle East and Central Asia and vehicle ownership levels in Iran are significantly higher than in other similar countries [4]. The situation is exacerbated by the very low price of fuel (US$ 0.08/l for gasoline and US$ 0.02/l for diesel) [67]. Moreover, the existence of many old cars in the fleet, combined with inadequacies in the public transport system, leading to a greater use of private vehicles, thus increases the risk of crash and injuries. Roberts et al. argue that the government and the car industry have a major responsibility in road safety, although it is currently much more common for road-users to be held responsible [128]. Research into biomechanics has shown that changes in the design of vehicles could greatly reduce the frequency and severity of injuries [129]. However, despite the current climate not being conducive to such changes, this issue is in serious need of consideration. An alternative plan in our setting, as expressed by participants, would be greater emphasis on speed control.

6.6 KINETIC ENERGY MANAGEMENT (PAPER III)

Speed is almost universally recognized as a major contributory factor to both the occurrence of RTIs and their severity [1]. Accordingly, more rigorously enforced speed limits seem to be a major priority in both the study area and the country as a whole. Furthermore, it is really important to increase public awareness about how high speed contributes to the severity of RTIs, a factor which seems not to be understood completely [1] or not seen as important in society. The forms of behaviour in relation to high-speed driving, as commented on by participants, could be due to: a lack of safety knowledge and traffic law; a sense of urgency and haste among most drivers and the other road-users; inadequate driver training and testing; and insufficient enforcement of traffic and transport regulations. While the improvements within the transport sector and car industries need long-term strategies, it seems that speed management should have more immediate priority to improve road-user safety, prevent RTIs and diminish their severity. Accordingly, better separation of road-users, when speeds exceed 60 km/h, should be considered. In addition, for pedestrian safety, the aim could be restriction of vehicle speeds to 30 km/h or even lower when there are potential dangers between vehicles and pedestrians, especially within cities [2].

6.7 SYSTEM VERSUS INDIVIDUAL APPROACH (PAPERS III AND IV)

In general, there are different approaches to RTI prevention: mainly in terms of the individual and the system approach [57, 130]. Traditionally there is a tendency by researchers and practitioners to look for only one or a few elements [17]. Many studies have focused on factors relating to driver errors, poor vehicles and the road environment instead of examining the reason for injury outcome, which could be found in many studies in LMICs as well as Iran [104, 116, 118, 121, 131-135]. In our study,

most participants focused mainly on human error as the major factor in RTIs. According to the stakeholders in our study, the individual approach is prominent. Despite many activities by most of the organizations and practitioners in this field, most effort is currently directed towards crash prevention, instead of RTI prevention and road-user safety. In contrast, a system approach would be mainly directed towards improvement in road design and crashworthiness as a system [57].The Haddon model [32] with his ten famous strategies broadens the scope for intervention to reduce road crashes and injury in three different phases: pre-crash, crash and post-crash. Furthermore, the Swedish Road Administration Model has examined RTIs using rich data and a system approach [57]. This model considered the interaction between the three components of RTIs to classify fatal car crashes according to safety indicators and fatal outcomes. Of the three components in this model, the road was the one that was most often linked to a fatal outcome [57]. In our qualitative approach, however, most of the gain perceived by participants would concern human factors. This implies that to improve road-user safety in Iran, a change in the attitudes of the Iranian stakeholders is crucial. Accordingly, the goal of all activities should be road-user safety rather than crash prevention even when it comes to RTI prevention.

6.8 ORGANIZATIONAL COORDINATION (PAPER III)

As expressed by participants in this study, lack of organizational coordination in relation to road-user safety was an important obstacle. According to WHO, prevention of RTIs is a shared responsibility and needs multi-sector collaboration [2, 17]. Collaboration might take the form of research, information sharing, policy development, advocacy and capacity building. The World Bank also stated that the preparing of a National Transport Strategy (NTS) document was found useful by most governments to help and guide the development of the country's transport system in the medium and long term. In this way an NTS can help to provide a framework for the development of detailed policy and legislation as well as identifying investment priorities [136]. The same lack of coordination as in pre-crash and crash activity was also pronounced in the post-crash event. The World Bank also reports that a lack of coordination between all sectors in the transport chain as well as shortcomings in the capacity of the transport system were the core problems for road safety in Iran [4]. The reason for this could be the lack of an overall agency to coordinate road safety policy and activities. Moreover, the lack of a sustainable plan for RTI prevention along with parallel activities being carried out for some tasks are other reasons. Accordingly a specific agency in the government should be identified to guide and arrange national agency efforts [17]. A movement for safety in the community is another important strategy, which is currently underway in three communities in Iran [137]. The effectiveness of such a movement has been shown in many RTI prevention strategies [17] and needs to be expanded in the study area.

6.9 POST CRASH CIRCUMSTANCES (PAPERS I AND IV)

Around two thirds of deaths in WAP occurred during the pre-hospital phase, which was relatively similar to the country as a whole [28]. Focusing on victims rescue, almost two out of three victims were rescued by laypeople and 11% transported by EMS. This finding is approximately in line with a national survey from 2003, in which 14% of the victims were transported by the EMS and 10% were rescued by trained personnel [8]. Generally, many fatal injuries can be prevented or their severity reduced by adequate pre-hospital trauma care [28, 39, 138]. The in-depth interviews in Study III (Paper IV) as well as participant observation revealed that two main issues should be considered: firstly, a sense of haste and urgency in laypeople's post-crash behaviour and secondly the late arrival of the emergency services, which can affect PCM. Improving PCM and understanding the reason for involvement of untrained laypeople are crucial. The aims of PCM in general are to avoid preventable death and disability, to limit the severity of injury and the suffering caused by it, and to ensure the crash survivor's best possible recovery and reintegration into society [41]. The Study III (Paper IV) highlights significant barriers to the achievement of these aims, including laypeople's involvement, particularly in urban settings, suboptimal pre-hospital services and poor coordination among organizations.

6.10 UNTRAINED LAYPEOPLE'S INVOLVEMENT – EDUCATION (PAPER IV)

One of the most common issues raised by participants in relation to PCM was the interaction of untrained laypeople and their lack of knowledge and skills in handling the situation in general; and the victims in particular. According to WHO [17], the role of laypeople who are present at a crash scene should be: to contact the emergency services; help to put out fires; and take action to secure the crash scene, to control the crowd of onlookers, and apply first aid. It seems that some – but not all – of these WHO recommendations are not fully followed in the study area. More specifically, laypeople extricate – or try to extricate – victims instead of taking action to secure the scene. This might be related in part to the sense of haste and urgency that they also have reported, but also to the late arrival of the emergency services at the scene, which has an adverse effect on the management of the crash scene. This calls for better public information concerning what should best be done by laypeople at the crash scene (including calling the emergency service, and not moving any victims unless trained in doing so). Public education should also emphasize the issue of the emotional behaviour of laypeople and how this can impede the work of ambulance team members. An additional educational aspect to be dealt with is target group training. Studies from LMICs indicate that basic first-aid training for professional drivers (taxi, bus or truck drivers) could help improve PCM as they can often provide care and transportation [44, 139, 140]. This should also apply to the combination of formal training of both paramedics, and basic training for laypeople, and the provision of some basic supplies and equipment which could decrease the mortality rate to an even greater extent [141].

6.11 POOR COORDINATION (PAPERS III AND IV)

Pre-hospital services (i.e. extrication of trapped casualties in road traffic crashes and their transportation) require coordination of rescue activities by different organizations and groups. Without this, extrication becomes slow, frustrating, and may be dangerous for both victims and rescuers [39]. One important reason for this was different emergency numbers throughout the country, all of which are three digit numbers, and this may confuse the member of the public as to which numbers are needed in the case of an emergency situation. This can even result in lack of coordination among organizations. Experience from HICs in the case of emergency services reveals that they usually have one single 3 digit number for the whole country, such as 112 in Sweden and most European countries; 911 in United States of America and Canada; and 000 in Australia [142]. Bazzoli [35] argues that the most important strategies to counteract this problem include broad-based participation of key stakeholders and changes in trauma delivery. Although various parameters can come into play [140], the study participants mainly referred to difficulties in coordination rather than with equipment, staffing and physical resources. An integrated trauma system was suggested by most participants to cover all PCM activities.

6.12 PRE-HOSPITAL SERVICES (PAPER IV)

The vast majority of road traffic deaths in LMICs [143] and in Iran [8, 28] occur in the pre-hospital phase. It has been hypothesized that the reduction in the proportion killed of all those who are involved in RTIs is, at least in part, attributable to an improved provision of emergency medical services [13]. As proposed elsewhere, comprehensive trauma systems [144] should be widely put into place and, according to Zargar et al. [134], they are a must in Iran.

Although rapid improvements in pre-hospital care services have occurred in the country [145], it seems that their administration needs further improvement. Moreover, a holistic and system approach to the trauma system as a whole might be required. It ought to be underlined that, in rural areas, most pre-hospital service problems originate from a lack of ambulance dispatch sites and equipment which leads to the late arrival of the ambulances, a result that is in line with findings from Mock et al. [140, 144]. These all can imply why members of the public get involved at the crash scene and due to lack of their experience can have an adverse effect on the victim management.

6.13 METHODOLOGICAL CONSIDERATIONS

Capture-recapture method (Paper II): Application of the capture-recapture method must be based on valid and reliable data. The FMS is an official source and subject to legal requirements; examination of the fatal cases by the expert physician in this system [87]; and due to close collaboration between the police and the Road &Transportation Offices, we believe that its registers have valid data on fatal RTIs. Moreover, it is one of the most reliable source of mortality data in Iran [28]. On the other hand, the DRS uses death certificates and verbal autopsies for its classification, and there is regular quality control of DRS records each year. In addition, since overlap was high between the two systems, it can be argued that the DRS also has valid data. However, due to multiple data sources for data collection in the DRS and registration by different

personnel, we examined the accuracy of the DRS in Study I. The findings revealed that among 669 recorded cases in the DRS, there was a 4.9% misclassification of cause of death registration, whereby another case of death was found other than the fatal RTIs in DRS. Moreover, Study I also revealed that, among 148 recorded cases in the FMS, the agreement rate between FMS records and the household survey was 100%.

Moreover, for reliable results to be obtained using capture-recapture, four basic prerequisites must be fulfilled [51, 52, 146]. In the current study, we believe this to be the case for the following reasons:

1. *Independence of data sources*. This is the requirement that is regarded as most difficult to meet [92, 96, 98, 101-103], but it seems that it was satisfactorily met in this study. The high degree of overlap between the sources may not be related to positive dependence but, rather, to the severity of the cases, all fatal in this study, and to the well-established routines of death registration in both systems. However, we assumed that deaths reported by hospitals might have a positively dependent role. To verify this, we collected mortality data from all WAP hospitals. As shown in Appendix 9.1, the hospital data and the FMS records yield approximately the same results: 987 (95% CI: 922-1052) cases between hospital and FMS rather than 1018 (95% CI: 985-1051) cases by the DRS and the FMS. Both results were approximately similar, which means that one could argue that the data sources might be independent. However, in practice and as is shown in the table, we considered that some cases of deaths in hospital, could be captured by both the DRS and FMS, but they are not many. For this reason, the corrected estimates should be interpreted with caution and the number of the fatalities might be higher than the results in this study.

2. Same probability of being captured. All members of the population should have the same probability of being captured. It seems that victims in rural areas are more likely to be captured by DRS and fatal victims in urban areas more likely to be captured by the FMS. However, since all districts had one DRS and one FMS, we believe this assumption is met.

3. The population should be closed. We limited the study to one year, and all capture and recapture samples were chosen for the same period. Moreover, there were no considerable changes in the population [70] – such as immigration and emigration, including tribal movements – during the study period. Also, only cases with a designated place of death and residence within WAP were included in the study.

4. *Matching*. We performed a careful comparison of both sources with common variables in order to avoid mistaken matching (with name, sex, age, date of death and place of death as key variables).

However, comparing DRS, FMS and our survey in Study I and Study II, a critical examination of all available variables and their agreement rate is an important recommendation and implication of this thesis.

Cause of under-reporting in data sources: There were under-reported cases in both sources. Possible reasons for this in the DRS may be case misclassification (as already revealed for 4.9%) and a lack of regular death reports from official sources and health volunteers. Missing cases in the FMS are more likely to occur in rural areas, e.g. when a victim is buried without an official report in the FMS; or death with a tractor in

village, which sometimes is not regarded as a fatal RTI. Cases in the FMS, but not in the DRS, are more likely to occur in urban areas because people there are more aware of and compliant with legal requirements. By contrast, cases not in the FMS but in the DRS are more likely to be from rural areas because of active registration by health houses in this area. The other reason for this might be again due to misclassification of recorded fatal RTIs other than cause of death. In this regard we followed 262 single cases in the FMS and we found 79 recorded fatal RTIs in FMS and not in DRS, as misclassification by DRS, due to means of death being attributed to a cause other than RTIs.

Qualitative approach

***Why grounded theory*:** In most behavioural research endeavours, persons or patients are units of analysis, whereas in GT, the unit of analysis is the incident [89, 147]. The questions that must be asked all the time in GT are "What's going on?" and "What is the main problem of the participants and how are they trying to solve it?" These questions will be answered by the core variable[111].

However, in qualitative research, the validation of the findings is usually judged by their trustworthiness [90, 148]. There are four criteria for trustworthiness: credibility; dependability; conformability; and transferability [148].

Credibility includes activities that increase the probability that credible findings will be produced [149]. It deals with the quality of the research process and refers to how well data collection and the analysis process address the research objective [148]. In order to confirm the credibility of the findings, the researcher will share the outcome with the participants. If the participants recognize the findings to be true to their experience, then credibility has been established [148]. In this research project, all the new categories and sub-categories in the future interviews were discussed with participants for validation. The data also were validated using constant comparison analysis, as a means of returning to the data in order to verify and develop the categories further [90]. Moreover, in the data collection and data analysis process, a peer debriefing was carried out and the research team agreed with the data analysis process. Triangulation, including participant observational, document and literature review as well as movie coding was added in data generation. In addition all data collection and analysis were carried out in the thesis author's native language to avoid any misunderstanding between researcher and participants.

Dependability is a criterion of neutrality. The question to ask is, "How dependable are these results". Accordingly, it refers to how well the study processes can be audited [148]. In order to meet this criterion, all interviews were recorded verbatim and could easily be transcribed in Study III (Papers III and IV). Responsibilities for transcript review, the coding process, categorization, and the selection of data illustrations were well defined and consistent with the respective analytic techniques.

Conformability/audibility [150]. The way the researcher confirms the findings is by leaving an audit trail (which was not addressed in the original grant application). The audit trail consists of raw data, memorandums, communications, thought processes, etc. The purpose of the audit trail is to document decisions made.

Transferability/fittingness refers to the likelihood that the findings will have meaning outside the study situation. The expectation for determining whether the findings fit or are transferable rests with potential users of the finding and not with the researchers [150, 151]. In qualitative research, authors can offer suggestions about transferability but the reader must decide if the setting of the study is sufficiently similar for its findings to be transferable to their won context [152]. By trying to describe the study settings carefully in Study III, the reader can judge to what extent the findings are also applicable to other settings in Iran or elsewhere. It is important to note that some participants in this study, at both the regional and national level, believed that the same barriers could be found in most parts of the country. Moreover, transferability also refers to the extent to which findings can be transferred to other settings and groups, i.e. the generalizability of the results. However, this is less a concern for this study since it was mainly focussed on WAP.

Strengths and limitations of the thesis

Studies I and II focus only on mortality. The main aim of current policy in Iran is to reduce RTI mortality, and mortality data are available in well-established register systems in the country. However, in the stakeholder study, the focus was mainly on prevention of both morbidity and mortality of RTIs.

Further, in the data at hand, we focused on cases where people both resided and died in the WAP region. This implies that we have an underestimation of the number of people from WAP dying on the roads. However, deaths occurring outside WPA were quite few (estimated at 4.3% of total RTI deaths).

Recall bias: in Paper I each interview was conducted between four to sixteen months after the crash occurrence (eleven months on average). Although recall bias might have been a problem, however, most questions in this study dealt with subjects that were rather easy to answer for family members and not subject to much recall bias [153]. Focusing on the pre-hospital information, interviewees may have been affected by recall bias. It is important to note that according to the culture base in the study area, family members are very sensitive about crash deaths and the reliability of the findings is deemed to be high.

Desirability bias: Data provided by family members in Paper I on helmet wearing and seatbelt use at the time of crash may be somewhat less reliable and affected by desirability bias. It is possible that these protective measures were over-reported by family members. However, in order to try and compensate for that, the interviewers made every effort to help the family members to answer the questions.

Selection bias: Study I relied on the records in the DRS as the base. At the time of conducting the study, due to the feasibility and completeness of DRS, we relied on record on this source. Findings in Study II showed that there were under-reported cases in DRS. However, in Study I we didn't calculate the rate and it is possible that the pattern obtained is not distributed randomly.

The strength of the thesis is the high response rate of the family members interviewed (Paper I) combined with the accuracy of the data gathered as a result of the care taken during data collection (e.g. active follow-up, trained health workers, limited number of

questions, and guarantee of confidentiality). Focusing on capture-recapture method, study II, the second study is more cost effective [94]. Focusing on study III, employing GT method with different data sources, it was possible to generate rich data in relation to RTIs prevention with different stakeholders, road users, and victims of RTIs as well as document review and participant observation to increase the validity of the findings.

7 CONCLUSION AND SOME POLICY IMPLICATIONS

The thesis shows that the pattern of fatal RTIs in WAP differs somewhat from other similar LMICs. Whereas men are over-represented in all categories, women die above all as car passengers or pedestrians. It seems more attention should be paid to vulnerable road-users, young people, the over-65s and those living in rural areas. Moreover, the burden of the fatal RTI in the WAP is higher than records in the current data sources, roughly 1.53 higher than both DRS and FMS. The latter is an injury-oriented source and adding a correction factor generated by capture-recapture method can provide a more accurate trend estimate for policy-makers. However, cooperation between the two systems would facilitate surveillance of RTIs.

Iran has one of the highest mortality and morbidity rates from RTIs in the world and currently many crash prevention activities have been launched in the country. According to the study participants, the major barriers were identified as human factors, and efforts to change human behaviour could focus on public education campaigns and stricter law enforcement. However, currently, there is a gap in the knowledge of and attitude towards RTI-prevention activities. The stakeholders' paradigm needs to change and all activities should have road-user safety as the goal. A lead agency for organizational coordination and tracking of all preventive activities is crucial. As other RTI prevention models have shown, a system approach on the interaction between road users, the road infrastructure and vehicles is important to be addressed. Among current interventions most focus should be put on speed management. Considering the new national policy, short-, medium- and long-term strategies are required to promote RTI prevention.

In the post-crash event, important barriers to effective PCM included the involvement of laypeople, insufficient pre-hospital services and poor coordination among organizations. Again all events originated from a lack of system approach on road users' safety, herein victims. However, public education campaigns and target group training need to be considered. The education should cover the role of emergency services in crash site management, first aid, better cooperation with emergency services members, and preliminary management of the crash scene before arrival of the ambulance, triage of the victims and their safe transportation is crucial. Furthermore, instead of different pre-hospital services, an integrated trauma system should be considered to cover all emergency activities. Moreover, improvements in pre-hospital care, the upgrading and improvement of physical resources, human resources as well as improvements to telecommunication systems need to be considered.

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9 APPENDIX

Regarding independency of data sources, as the most important assumption in capture recapture method, data from all public and private hospitals in the province had collected separately and a capture recapture method employed using FMS and hospitals. Table 9.1 presents a comparison between DRS – FMS and hospital – FMS. Using the DRS and the FMS and applying the capture-recapture formula gave a total number of 1018 deaths in the province, while using hospital and FMS showed 987 deaths.

Table 9.1: Estimation of number of fatal RTIs by comparison between DRS – FMS and Hospital – FMS to show independence of data sources

	Cases Reported in the DRS				**Cases Reported in Hospitals**			
		Yes	**No**	**Total**		**Yes**	**No**	**Total**
Cases Reported in the FMS	**Yes**	**437**	**228**	**665**	**Yes**	**198**	**467**	**665**
	No	**232**	**121**		**No**	**96**	**226**	
	Total	**669**		**1018**	**Total**	**294**		**987**

10 REFERENCES

1. Global Road Safety Partnership, **Speed management: a road safety manual for decision-makers and practitioners**. 2008, Geneva: Global Road Safety Partnership.
2. Peden, M., Scurfield, R., Sleet, D., Mohan, D., Hyder, A., Jarawan, E., and Mathers, C., (edi). **World Report on Road Traffic Injury Prevention**. 2004, Geneva: World Health Organization.
3. Management and Planning Organization, **The Forth Planning Law of Economic, Social and Cultural Development of Islamic Republic of Iran (In Persian)**. 2004, Tehran.
4. World Bank, *Islamic Republic of Iran. Transport sector review and strategy note*. 2005: Washington DC.
5. Mohan, D., **Traffic safety and city structure: lessons for the future.** *Salud Publica Mex*, 2008. **50 Suppl 1**: S93-100.
6. World Health Organization, **A 5-year WHO strategy for road traffic injury prevention**. 2001, Geneva: World Health Organization.
7. World Health Organization. **Global Burden of Disease Estimates, Death and DALY estimates for 2002 by cause for WHO Member States**. 2004 [Cited 6 August 2008]; Available from: http://www.who.int/healthinfo/global_burden_disease/en/index.html
8. Naghavi, M., Jafari, N., Alaeddin, F., and Akbari, M., **Injury Epidemiology caused by external cause of injury in the Islamic Republic of Iran (In Persian)**. 2004, Tehran: Bageh Rezvan.
9. World Health Organization. **10 facts on injuries and violence**. 2008 [Cited 2009 19 March]; Available from: http://www.who.int/features/factfiles/injuries/en/index.html
10. Laflamme, L., Svanström, L., and L., S., **Safety Promotion Research**. 2000, Stockholm: Karolinska Institutet.
11. Laflamme, L. and Vaez, M., **Car crash and injury among young drivers: contribution of social, circumstantial and car attributes.** *Int J Inj Contr Saf Promot*, 2007. **14**(1): 5-10.
12. Laflamme, L. and Diderichsen, F., **Social differences in traffic injury risks in childhood and youth--a literature review and a research agenda.** *Inj Prev*, 2000. **6**(4): 293-8.
13. Elvik, R. and Vaa, T., **Handbook of road safety measures**. 2004, Amsterdam Elsevier.
14. Hasselberg, M., *The social patterning of road traffic injuries during childhood and youth: National longitudinal register-based studies* in *Department of Public Health Sciences*. 2004, Karolinska Institutet: Stockholm.
15. Evans, G.W., **The environment of childhood poverty.** *Am Psychol*, 2004. **59**(2): 77-92.
16. Peden, M., McGee, K., and Sharma, G. **The injury chart book: a graphical overview of the global burden of injuries**. 2002 [Cited 2008 Maty 12]; Available from:

17. Mohan, D., Tiwari, G., Meleckidzedeck, K., and Fredrick, M.N., **Road traffic injury prevention training manual**. 2006, Geneva: World Health Organization and Indian Institute of Technlogy Delhi.
18. Murray, C.J.L. and Lopez, A.D., **The global burden of disease: a comprehensive assessment of mortality and disability from diseases, injuries, and risk factors in 1990 and projected to 2020**. (eds). ed. 1996, Boston: Harvard School of Public Health.
19. Kopits, E. and Cropper, M., **Traffic fatalities and economic growth**. 2003, Washington DC: The World Bank (Policy Research Working Paper No. 3035).
20. Toroyan, T. and Peden, M.e., **Youth and road safety**. 2007, Geneva: World Health Organization.
21. Cubbin, C. and Smith, G.S., **Socioeconomic inequalities in injury: critical issues in design and analysis.** *Annu Rev Public Health*, 2002. **23**: 349-75.
22. Engstrom, K., Diderichsen, F., and Laflamme, L., **Socioeconomic differences in injury risks in childhood and adolescence: a nation-wide study of intentional and unintentional injuries in Sweden.** *Inj Prev*, 2002. **8**(2): 137-42.
23. Tiwari, G., Mohan, D., and Fazio, J., **Conflict analysis for prediction of fatal crash locations in mixed traffic streams.** *Accid Anal Prev*, 1998. **30**(2): 207-15.
24. Nantulya, V.M. and Reich, M.R., **Equity dimensions of road traffic injuries in low- and middle-income countries.** *Inj Control Saf Promot*, 2003. **10**(1-2): 13-20.
25. Razzak, J., *The Potential of Ambulance Records for a Road Traffic Safety Agenda in Low-Income Cities. Studies from Karachi, Pakistan.*, in *Department of Public Health Sciences*. 2005, Karolinska Institutet: Stockholm.
26. Mohan, D. and Tiwari, G., **Road safety in low income countries: issues and concerns. In: Reflections on the transfer of traffic safety knowledge to motorising nations**. 1998, Melbourne: Global Traffic Safety Trust.
27. Mohan, D., **Traffic safety and health in Indian cities.** *Journal of Transport and Infrastructure*, 2002(9): 79-92.
28. Montazeri, A., **Road-traffic-related mortality in Iran: a descriptive study.** *Public Health*, 2004. **118**(2): 110-3.
29. SIKA. **Road traffic injuries**. 1998 [Cited 2009 April 20]; Available from: http://www.sika-institute.se/Templates/FileInfo.aspx?filepath=/Doclib/Import/100/olyckor1998.xls
30. Welander, G., Svanstrom, L., and Eckman, R., **Safety Promotion: An Introduction**. 2000, Stockholm: Krolinska Institutet, Department of Public Health Sciences, Division of Social Medicine.
31. Popay et. al. **Safety promotion at the local level - safe community interventions**. 1993 [Cited 2008 May 16]; Available from: http://www.phs.ki.se/csp/lectur/evidbase/11_1.htm
32. Haddon, W., Suchman, E., and Kline, D., **Accident Research: Methods and Approaches**. 1964, New York: Harper and Row.
33. Haddon, J.W., **Advances in the epidemiology of injuries as a basis for public policy.** *Public Health Report*, 1980. **95**: 411-421.

34. Runyan, C.W., **Using the Haddon matrix: introducing the third dimension.** *Injury Prevention*, 1998. **4**: 302-307.
35. Bazzoli, G.J., **Community-based trauma system development: key barriers and facilitating factors.** *J Trauma*, 1999. **47**(Suppl 3): S22-4.
36. Bossaert, L.L., **The complexity of comparing different EMS systems--a survey of EMS systems in Europe.** *Ann Emerg Med*, 1993. **22**(1): 99-102.
37. Carney, C.J., **Prehospital care--a UK perspective.** *Br Med Bull*, 1999. **55**(4): 757-66.
38. Chawla, R., **Need for trauma care programmes in developing countries.** *Bull World Health Organ*, 1999. **77**(11): 948-9.
39. Coats, T.J. and Davies, G., **Prehospital care for road traffic casualties.** *Bmj*, 2002. **324**(7346): 1135-8.
40. Henriksson, E., Ostrom, M., and Eriksson, A., **Preventability of vehicle-related fatalities.** *Accid Anal Prev*, 2001. **33**(4): 467-75.
41. Peden, M., Scurfield, R., Sleet, D., Mohan, D., Hyder, A., Jarawan, E., and Mathers, C., (edi). **World Report on Road Traffic Injury Prevention**. Vol. 1st ed. 2004, Geneva: World Health Organization.
42. von Elm, E., **Prehospital emergency care and the global road safety crisis.** *JAMA*, 2004. **292**(8): 923.
43. Kobusingye, O.C., Hyder, A.A., Bishai, D., Hicks, E.R., Mock, C., and Joshipura, M., **Emergency medical systems in low- and middle-income countries: recommendations for action.** *Bull World Health Organ*, 2005. **83**(8): 626-31.
44. Mock, C.N., Tiska, M., Adu-Ampofo, M., and Boakye, G., **Improvements in prehospital trauma care in an African country with no formal emergency medical services.** *J Trauma*, 2002. **53**(1): 90-7.
45. Podolsky, S., Baraff, L.J., Simon, R.R., Hoffman, J.R., Larmon, B., and Ablon, W., **Efficacy of cervical spine immobilization methods.** *J Trauma*, 1983. **23**(6): 461-5.
46. Cloward, R.B., **Acute cervical spine injuries.** *Clin Symp*, 1980. **32**(1): 1-32.
47. Wilmink, A.B., Samra, G.S., Watson, L.M., and Wilson, A.W., **Vehicle entrapment rescue and pre-hospital trauma care.** *Injury*, 1996. **27**(1): 21-5.
48. Holder, Y., Peden, M., Krug, E., Lund, J., Gururaj, G., and Kobusingye, O.E., **Injury Surveillance Guidelines**. 2001, Geneva: World Health Organization.
49. Berklman, R.L., Stroup, D.F., Buehler, J.W.,, **Public Health Surveillance**. 1997, New York: Oxford University Press, Oxford.
50. Oxford University, **Monitoring the Health of Pupations: Statistical Principles and Methods for Public Health Surveillance**. 2004, New York: Oxford University Press.
51. Hook, E.B. and Regal, R.R., **Capture-recapture methods in epidemiology: methods and limitations.** *Epidemiol Rev*, 1995. **17**(2): 243-64.
52. Wittes, J. and Sidel, V.W., **A generalization of the simple capture-recapture model with applications to epidemiological research.** *J Chronic Dis*, 1968. **21**(5): 287-301.
53. Report of an Inter country Consultation WHO-SEARO. **Surveillance of Major Noncommunicable Diseases in the South-East Asia**. 2000 [Cited 2005 April 20]; Available from: http://w3.whosea.org/LinkFiles/Reports_and_Publications_NCD-48.pdf

54. Larkins, B.M., Worrall, L.E., and Hickson, L.M., **Stakeholder opinion of functional communication activities following traumatic brain injury.** *Brain Inj*, 2004. **18**(7): 691-706.
55. Tingvall, C. and Haworth, N. **Vision Zero: an ethical approach to safety and mobility. [Paper presented to the 6th Institute of Transport Engineers International Conference on Road Safety and Traffic Enforcement: Beyond 2000, Melbourne, 6–7 September 1999] (http://www.general.monash. du.au/MUARC/viszero.htm, accessed 30 October 2003).** [Cited 2007 March 15]; Available from: http://www.monash.edu.au/muarc/reports/papers/visionzero.html
56. European Transport Safety Council, **Risk assessment and target setting in EU transport programmes**. 2003, Brussels.
57. Stigson, H., Krafft, M., and Tingvall, C., **Use of fatal real-life crashes to analyze a safe road transport system model, including the road user, the vehicle, and the road.** *Traffic Inj Prev*, 2008. **9**(5): 463-71.
58. Emami, A. and Mazaheri, M., **Difficulties in Recruiting Participants for Reserarch Study on Immigrant Dementia Caregiver: Challenges in Conducting Research with a Culturally Diverse Population.** *Journal of Immigrant & Refugee Studies*, 2007. **5**(4).
59. Sakineh, M.A., Wahlstrom, R., Vahidi, R., Nikniaz, A., Marions, L., and Johansson, A., **Barriers to high-quality primary reproductive health services in an urban area of Iran: views of public health providers.** *Midwifery*, 2008.
60. Sorbye, S. and Ytterstad, B., **[The vision of zero traffic accidents in Norway].** *Tidsskr Nor Laegeforen*, 1999. **119**(11): 1633-4.
61. The Swedish Institute on www.sweden.se - The official gateway to Sweden. **Sweden's road safety vision catches on**. 2007 [Cited 2009 April 20]; Available from: http://www.sweden.se/eng/Home/Work-live/Government-politics/Reading/Road-safety/
62. The World Bank. **Data & Statistics-Country Groups**. 2009 [Cited 2009 April 14]; Available from: http://web.worldbank.org/WBSITE/EXTERNAL/DATASTATISTICS/0,,contentMDK:20421402~pagePK:64133150~piPK:64133175~theSitePK:239419,00.html
63. The State of the World's Children 2009. **GNI per capita**. 2009 [Cited 2009 April 14]; Available from: http://data.un.org/Data.aspx?q=GNI+per+capita+Iran&d=SNAAMA&f=grID%3a103%3bcurrID%3aUSD%3bpcFlag%3a1%3bcrID%3a364
64. United Nations-Department of economic and social affair-population division. World population prospect. The 2006 revision, p.d. [Cited 2009 12 March]; Available from: http://esa.un.org/unpp/p2k0data.asp
65. United Nations- Department of economic & social affair- Population division. **World population prospects: The 2006 revision, population database** 20 Sep 2007[Cited 2009 5 Jan]; Available from: http://esa.un.org/unpp/index.asp?panel=2
66. Vice-Presidency for Strategic Planning and Supervision: Statistical center of Iran, **The results of Population & Housing Census 2006 : The whole country (In Persian).** 2007.

67. Bhalla, K., Shahraz, S., Naghavi, M., Bartels, D., and Murray, C., *Road Traffic Injuries in Iran*. 2008, Harvard University Initiative for Global Health Road Traffic Injury Metrics Group.
68. Naghavi, M., **Health transition in Iran (in Persian).** *Iranian Journal of Epidemiology*, 2006. **1**(3): 13-25.
69. Vice-Presidency for Strategic Planning and Supervision: Statistical center of Iran, **The results of Population & Housing Census 2006 : The whole country (In Persian)**. 2007.
70. Statistical Center of Iran. **National Portal of Statistics**. 2003 [Cited 2007 March 23]; Available from: http://www.sci.org.ir/portal/faces/public/sci_en/sci_en.Glance/sci_en.trans
71. World Health Organization-Regional Office for the Eastern Mediterranean. **Country profile: About Islamic Republic of Iran**. [Cited 2009 March 10]; Available from: http://www.emro.who.int/iran/countryprofile.htm
72. The World Bank- Country Classification. **Data & Statistics-Country Groups**. 2009 [Cited 2009 April 18]; Available from: http://web.worldbank.org/WBSITE/EXTERNAL/DATASTATISTICS/0,,contentMDK:20421402~pagePK:64133150~piPK:64133175~theSitePK:239419,00.html
73. Wikipedia- the free Encyclopedia. **Silk Road**. [Cited 2009 April 9]; Available from: http://en.wikipedia.org/wiki/Silk_Road
74. Mazraati, M., **Oil demand modeling in Iran's transportation sector: A logistic model of vehicle ownership.** *Quarterly Energy Economics Journal*, 2006. **2**(8).
75. Statistical Center of Iran. 2008 [Cited 2009 18 February]; Available from: http://eamar.sci.org.ir/
76. Mather, D., Mather, Y., and Tamjidi, M., **Making cars in Iran: Working for Iran Khodro.** *Critique*, 2007. **35**(1): 9-21.
77. Shadpour, H. **Review of health information systems (HIS) in selected countries. The Islamic Republic of Iran** 2001 [Cited; Available from: http://64.233.183.104/search?q=cache:Id27kb7B-LAJ:www.who.int/entity/healthmetrics/library/en/iran_05apr.doc+%22The+PHC+experience+in+Iran%22&hl=sv
78. Abbasi-Shavazi, M.J. **preliminary notes on trends and emerging issues of mortality in Iran**. 2004 [Cited 2005 25 March]; Available from: http://www.unescap.org/esid/psis/meetings/health_mortality_sep_2004/H_M_report.pdf
79. Asadi-Lari, M., Sayyari, A.A., Akbari, M.E., and Gray, D., **Public health improvement in Iran--lessons from the last 20 years.** *Public Health*, 2004. **118**(6): 395-402.
80. Mohammadi, R., *Epidemiology and prevention of home related injuries in the Islamic Republic of Iran*, in *Department of Public Health Sciences*. 2005, Karolinska Institutet: Stockholm.
81. Mohammadi, R., Ekman, R., Svanstrom, L., and Gooya, M.M., **Rationales for home safety promotion in the Iranian primary healthcare system: results from a pilot study.** *Public Health*, 2006. **120**(1): 58-64.
82. Naghavi, M., **Mortality pattern in 23 provinces - 2003 (In Farsi)**. 2006: The Iranian Ministry of Health & Medical Education - Deputy of Health.

83. Forjuoh, S.N., **Traffic-related injury prevention interventions for low-income countries.** *Inj Control Saf Promot*, 2003. **10**(1-2): 109-18.
84. Wikipedia- the free Encyclopedia. **West Azarbaijan Province**. [Cited 2009 April 9]; Available from: http://en.wikipedia.org/wiki/West_Azarbaijan_Province
85. Statistical Center Of Iran. **Population and land**. 2009 [Cited 2009 May 12]; Available from: http://www.sci.org.ir/content/userfiles/_sci/sci/SEL/f13/13.11.html
86. Khosravi, A., Taylor, R., Naghavi, M., and Lopez, A.D., **Differential mortality in Iran.** *Popul Health Metr*, 2007. **5**: 7.
87. Sanaei Zadeh, H., **Modern forensic medicine and the medico-legal system in Iran.** *J Clin Forensic Med*, 2002. **9**(1): 12-4.
88. Naghavi, M., **The figure of death in eighteen Iranian Province**. 1 ed. 2001, Tehran: Tandis.
89. Corbin, A. and Strauss, J., **Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory**. 3 ed. 2008, USA: Sage Publications.
90. Strauss, A. and Corbin, J., **Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory**. 2 ed. 1998, Thousand Oaks, USA: Sage Publications.
91. Pettersson, K.O., Johansson, E., Pelembe Mde, F., Dgedge, C., and Christensson, K., **Mozambican midwives' views on barriers to quality perinatal care.** *Health Care Women Int*, 2006. **27**(2): 145-68.
92. Roberts, I. and Scragg, R., **Application of capture-recapture methodology to estimate the completeness of child injury surveillance.** *J Paediatr Child Health*, 1994. **30**(6): 513-4.
93. McCarty, D.J., Tull, E.S., Moy, C.S., Kwoh, C.K., and LaPorte, R.E., **Ascertainment corrected rates: applications of capture-recapture methods.** *Int J Epidemiol*, 1993. **22**(3): 559-65.
94. Hook, E.B. and Regal, R.R., **Capture-recapture methods.** *Lancet*, 1992. **339**(8795): 742.
95. Wittes, J.T., Colton, T., and Sidel, V.W., **Capture-recapture methods for assessing the completeness of case ascertainment when using multiple information sources.** *J Chronic Dis*, 1974. **27**(1): 25-36.
96. Stephen, C., **Capture-recapture methods in epidemiological studies.** *Infect Control Hosp Epidemiol*, 1996. **17**(4): 262-6.
97. Morrison, A. and Stone, D.H., **Capture-recapture: a useful methodological tool for counting traffic related injuries?** *Inj Prev*, 2000. **6**(4): 299-304.
98. Jarvis, S.N., Lowe, P.J., Avery, A., Levene, S., and Cormack, R.M., **Children are not goldfish--mark/recapture techniques and their application to injury data.** *Inj Prev*, 2000. **6**(1): 46-50.
99. LaPorte, R.E., Dearwater, S.R., Chang, Y.F., Songer, T.J., Aaron, D.J., Anderson, R.L., and Olsen, T., **Efficiency and accuracy of disease monitoring systems: application of capture-recapture methods to injury monitoring.** *Am J Epidemiol*, 1995. **142**(10): 1069-77.
100. Chiu, W.T., Dearwater, S.R., McCarty, D.J., Songer, T.J., and LaPorte, R.E., **Establishment of accurate incidence rates for head and spinal cord injuries**

in developing and developed countries: a capture-recapture approach. *J Trauma*, 1993. **35**(2): 206-11.

101. Meuleners, L.B., Lee, A.H., Cercarelli, L.R., and Legge, M., **Estimating crashes involving heavy vehicles in Western Australia, 1999-2000: a capture-recapture method.** *Accid Anal Prev*, 2006. **38**(1): 170-4.
102. Razzak, J.A. and Luby, S.P., **Estimating deaths and injuries due to road traffic accidents in Karachi, Pakistan, through the capture-recapture method.** *Int J Epidemiol*, 1998. **27**(5): 866-70.
103. Van, H.T., Singhasivanon, P., Kaewkungwal, J., Suriyawongpaisal, P., and Khai, L.H., **Estimation of non-fatal road traffic injuries in Thai Nguyen, Vietnam using capture-recapture method.** *Southeast Asian J Trop Med Public Health*, 2006. **37**(2): 405-11.
104. Tercero, F. and Andersson, R., **Measuring transport injuries in a developing country: an application of the capture-recapture method.** *Accid Anal Prev*, 2004. **36**(1): 13-20.
105. Schootman, M., Harlan, M., and Fuortes, L., **Use of the capture-recapture method to estimate severe traumatic brain injury rates.** *J Trauma*, 2000. **48**(1): 70-5.
106. Kullgren, A., Lie, A., and Tingvall, C., **Photogrammetry for documentation of vehicle deformations--a tool in a system for advanced accident data collection.** *Accid Anal Prev*, 1994. **26**(1): 99-106.
107. Dhillon, P.K., Lightstone, A.S., Peek-Asa, C., and Kraus, J.F., **Assessment of hospital and police ascertainment of automobile versus childhood pedestrian and bicyclist collisions.** *Accid Anal Prev*, 2001. **33**(4): 529-37.
108. Aptel, I., Salmi, L.R., Masson, F., Bourde, A., Henrion, G., and Erny, P., **Road accident statistics: discrepancies between police and hospital data in a French island.** *Accid Anal Prev*, 1999. **31**(1-2): 101-8.
109. Amoros, E., Martin, J.L., and Laumon, B., **Estimating non-fatal road casualties in a large French county, using the capture-recapture method.** *Accid Anal Prev*, 2007. **39**(3): 483-90.
110. Ismail, A.A., Beeching, N.J., Gill, G.V., and Bellis, M.A., **Capture-recapture-adjusted prevalence rates of type 2 diabetes are related to social deprivation.** *QJM*, 1999. **92**(12): 707-10.
111. Streubert, H.J. and Carpenter, D.R., **Qualitative Research in Nursing: Advancing the Humanistic Imperative**. 2007, Lippincott: Williams & Wilkins.
112. Ministry of Health and Medical Education, *Official letter*. 2 August 2005 Num. P, 391, Undersecretary for Research and Technology: Tehran, Iran.
113. World Health Organization-Eastern Mediterranean Region. **Violence, Injuries and Disability**. 2002 [Cited 2009 March 20]; Available from: http://www.emro.who.int/vip/roadtrafficinjuries-regionaldata.htm#Section4
114. Swaddiwudhipong, W., Nguntra, P., Mahasakpan, P., Koonchote, S., and Tantriratna, G., **Epidemiologic characteristics of drivers, vehicles, pedestrians and road environments involved in road traffic injuries in rural Thailand.** *Southeast Asian J Trop Med Public Health*, 1994. **25**(1): 37-44.
115. Mock, C.N., Forjuoh, S.N., and Rivara, F.P., **Epidemiology of transport-related injuries in Ghana.** *Accid Anal Prev*, 1999. **31**(4): 359-70.

116. Roudsari, B.S., Sharzei, K., and Zargar, M., **Sex and age distribution in transport-related injuries in Tehran.** *Accid Anal Prev*, 2004. **36**(3): 391-8.
117. Mohammadi, G., **The pattern of fatalities by age, seat belt usage and time of day on road accidents.** *Int J Inj Contr Saf Promot*, 2008: 1-7.
118. Soroush, A.R., Ghahri-Saremi, S., Rambod, M., Malek-Hosseini, S.A., Nick-Eghbal, S., and Khaji, A., **Pattern of injury in Shiraz.** *Chin J Traumatol*, 2008. **11**(1): 8-12.
119. Rezapur-Shahkolai, F., Naghavi, M., Shokouhi, M., and Laflamme, L., **Unintentional injuries in the rural population of Twiserkan, Iran. A cross-sectional study on their incidence, characteristics and preventability.** *BMC Public Health*, 2008. **8**(1): 269.
120. Soori, H. and Naghavi, M., **Deaths from unintentional injuries in rural areas of the Islamic Republic of Iran.** *East Mediterr Health J*, 1999. **5**(1): 55-60.
121. Sanaei-Zadeh, H., Vahabi, R., Nazparvar, B., and Amoei, M., **An epidemiological study and determination of causes of traffic accident-related deaths in Tehran, Iran (during 2000-2001).** *J Clin Forensic Med*, 2002. **9**(2): 74-7.
122. Skalkidou, A., Petridou, E., Papadopoulos, F.C., Dessypris, N., and Trichopoulos, D., **Factors affecting motorcycle helmet use in the population of Greater Athens, Greece.** *Inj Prev*, 1999. **5**(4): 264-7.
123. Younesian, M., Moradi, A., Khalaji, A., Mesdaghi Nia, A.R., and Zargr, M., **Evaluation of the effect of offender motorcyclists' penalty enforcement project on the incidence of road traffic accident injuries in Tehran (In Persian).** *Payesh*, 2007. **6**(1): 19-26.
124. Lie, A., Krafft, M., Kullgren, A., and Tingvall, C., **Intelligent seat belt reminders-do they change driver seat belt use in Europe?** *Traffic Inj Prev*, 2008. **9**(5): 446-9.
125. Krafft, M., Kullgren, A., Lie, A., and Tingvall, C., **The use of seat belts in cars with smart seat belt reminders--results of an observational study.** *Traffic Inj Prev*, 2006. **7**(2): 125-9.
126. Kullgren, A., Krafft, M., Nygren, A., and Tingvall, C., **Neck injuries in frontal impacts: influence of crash pulse characteristics on injury risk.** *Accid Anal Prev*, 2000. **32**(2): 197-205.
127. Mock, C., Quansah, R., Krishnan, R., Arreola-Risa, C., and Rivara, F., **Strengthening the prevention and care of injuries worldwide.** *Lancet*, 2004. **363**(9427): 2172-9.
128. Roberts, I., Mohan, D., and Abbasi, K., **War on the roads.** *Bmj*, 2002. **324**(7346): 1107-8.
129. Crandall, J.R., Bhalla, K.S., and Madeley, N.J., **Designing road vehicles for pedestrian protection.** *BMJ*, 2002. **324**(7346): 1145-8.
130. Bedard, M., Guyatt, G.H., Stones, M.J., and Hirdes, J.P., **The independent contribution of driver, crash, and vehicle characteristics to driver fatalities.** *Accid Anal Prev*, 2002. **34**(6): 717-27.
131. Zargar, M., Khaji, A., Karbakhsh, M., and Zarei, M.R., **Epidemiology study of facial injuries during a 13 month of trauma registry in Tehran.** *Indian J Med Sci*, 2004. **58**(3): 109-14.
132. Taher, A.A., **Ocular injuries in 367 patients with middle and upper third facial trauma: experience in Tehran.** *J Craniofac Surg*, 1996. **7**(2): 117-21.

133. Akbari, M.E., Naghavi, M., and Soori, H., **Epidemiology of deaths from injuries in the Islamic Republic of Iran.** *East Mediterr Health J*, 2006. **12**(3-4): 382-90.
134. Zargar, M., Modaghegh, M.H., and Rezaishiraz, H., **Urban injuries in Tehran: demography of trauma patients and evaluation of trauma care.** *Injury*, 2001. **32**(8): 613-7.
135. Razzak, J.A., Luby, S.P., Laflamme, L., and Chotani, H., **Injuries among children in Karachi, Pakistan--what, where and how.** *Public Health*, 2004. **118**(2): 114-20.
136. The World Bank. **National Transport Strategies**. 2008 [Cited 2009 April17]; Available from: http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTTRANSPORT/EXTTES/0,,contentMDK:20513307~menuPK:1165231~pagePK:148956~piPK:216618~theSitePK:338532,00.html
137. World Health Organization. **Safe Communities**. 2008 [Cited 2009 March 20]; Available from: http://www.phs.ki.se/csp/safecom/arsanjan.htm
138. Bazzoli, G.J., **Community-based trauma system development: key barriers and facilitating factors.** *J Trauma*, 1999. **47**(3 Suppl): S22-4.
139. Tiska, M.A., Adu-Ampofo, M., Boakye, G., Tuuli, L., and Mock, C.N., **A model of prehospital trauma training for lay persons devised in Africa.** *Emerg Med J*, 2004. **21**(2): 237-9.
140. Mock, C., Arreola-Risa, C., and Quansah, R., **Strengthening care for injured persons in less developed countries: a case study of Ghana and Mexico.** *Inj Control Saf Promot*, 2003. **10**(1-2): 45-51.
141. Husum, H., Gilbert, M., Wisborg, T., Van Heng, Y., and Murad, M., **Rural prehospital trauma systems improve trauma outcome in low-income countries: a prospective study from North Iraq and Cambodia.** *J Trauma*, 2003. **54**(6): 1188-96.
142. Wikipedia- the free Encyclopedia. **Emergency telephone number**. [Cited 2009 April 9]; Available from: http://en.wikipedia.org/wiki/Emergency_telephone_number
143. Mock, C.N., Jurkovich, G.J., nii-Amon-Kotei, D., Arreola-Risa, C., and Maier, R.V., **Trauma mortality patterns in three nations at different economic levels: implications for global trauma system development.** *J Trauma*, 1998. **44**(5): 804-12; discussion 812-4.
144. Mock, C., Kobusingye, O., Joshipura, M., Nguyen, S., and Arreola-Risa, C., **Strengthening trauma and critical care globally.** *Curr Opin Crit Care*, 2005. **11**(6): 568-75.
145. Zargar, M., Khaji, A., and Karbakhsh, M., **Pattern of motorcycle-related injuries in Tehran, 1999 to 2000: a study in 6 hospitals.** *East Mediterr Health J*, 2006. **12**(1-2): 81-7.
146. Ismail AA, B.N., Gill GV, Bellis MA., **How many data sources are needed to determine diabetes prevalence by capture-recapture?** *Int J Epidemiol.*, 2000. **29**(3): 536-41.
147. Glaser, B. and Strauss, A., **Discovery of Grounded Theory. Strategies for Qualitative Research**. 3 ed. 1967: Sociology.

148. Graneheim, U.H. and Lundman, B., **Qualitative content analysis in nursing research: concepts, procedures and measures to achieve trustworthiness.** *Nurse Educ Today*, 2004. **24**(2): 105-12.
149. Streubert Helen, J. and R., C.D., **Qualitative Research in Nursing: Advancing the Humanistic Imperative**. 3 ed. 2003: Lippincott Williams & Wilkins.
150. Streubert, H.J. and Carpenter, D.R., **Qualitative Research in Nursing: Advancing the Humanistic Imperative**. 2 ed. 1999, Philadelphia: Lippincott.
151. Lincoln, Y., & Guba, E.,, **Naturalistic inquiry. Beverly Hills, CA**. 1985: Sage Publications.
152. Kuper, A., Lingard, L., and Levinson, W., **Critically appraising qualitative research.** *BMJ*, 2008. **337**: a1035.
153. Mock, C., Acheampong, F., Adjei, S., and Koepsell, T., **The effect of recall on estimation of incidence rates for injury in Ghana.** *Int J Epidemiol*, 1999. **28**(4): 750-5.