

## Motorcyclists' safety in Iran: implication of haddon matrix in safe community setting

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### Abstract

**Background:** Three studies were conducted aiming to design specific interventions regarding motorcyclist's safety using Haddon matrix in 14 cities of Iran.

**Methods:** Motorcyclists' fatality data was extracted in 14 cities (5 safe community practicing and 9 safe community non practicing cities) during 2006-2007. As the next step a cross sectional study on Knowledge, Attitude, Practice (KAP) of motorcyclists about helmet was performed. A range of variables relevant to motorcyclists' injury and prevention were developed and organized according to the Haddon matrix. The risky behaviors, including over speeding, acrobatic movement, no helmet or not properly wearing helmet were considered. Data were analyzed with chi-square and ANOVA method using STATA software.

**Results:** The highest mortality rate was revealed in Niriz city (NSC) and the least was reported from Arsanjan city (SC) in Fars Province. In Busher province, the highest death rate was detected in the Busher city (SC) and the least was in the Genaveh city (NSC). In Khorasan, the highest death rate was reported from Torbat-e-hydariyeh city (NSC) and the lowest was from Bardscan (SC). Male drivers of 19-39 years old were the most affected age groups. The rate of helmet usage in overall was 13% while 97% owned a helmet. Embarrassing of wearing helmet was mentioned by 70% of participants as a reason for not wearing helmet. Participants believed that public education and re-enforcement of mandatory helmet law are two important ways to raise the helmet usage.

**Conclusions :**Constant public education in addition to attention to traffic rules are two important factors to promote helmet wearing rate.

**Keywords:** Helmet, Safety, Motorcycle, Iran.

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### Introduction

Injuries to motorcyclists are an important public health concern. Motorcycles' riders have the highest public health burden which is expressed in disability adjusted life years lost. Many countries are facing the problem of a rapidly increasing motorcyclists' fatality (1,13). Motorcycles are considered the most economic form of transportation globally; it becomes more important in developing countries

specifically in south East Asia and Western Pacific region. This is a pressing concern because the motorcycle fleet in Iran is growing rapidly (9,12, 13&15). It can be afforded by many people worldwide. It accounts for high proportion of mortality and fatality compare to other forms of transportation especially in low and middle income countries (13,27). The WHO global report on road safety shows that the highest death rates from the road traffic injuries have

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been recorded in Eastern Mediterranean and African region in the world. It showed that this rate has been raised since the last few years in these regions. Road traffic injuries are not the only public health issue but considered as an economic issue too. It is said that it claims 1-3 percent of gross national product of the countries with more effect on poorer individuals. Data shows that in Iran, the road traffic injuries and deaths claimed almost 5 percent of gross national product and lost about 1,200,000 lives in 2004 (9). Among all the road users, motorcyclists are the most vulnerable groups and provide no protection for its rider and pillion. It has been proved that using a crash helmet prevents fatal and serious head injuries and reduces death by 60% - 75% in motorcycle accidents (15,18).

Many countries have adopted legislation for mandatory use of crash helmet by motorcyclists and pillions (27). In the East Mediterranean region only 20% of the countries have a mandatory helmet law. In Iran motorcyclists are considered the most vulnerable groups among all road users (26). The mortality rate in this group is high and the consequences of the crashes to the riders, pillions and families are tremendous. Three hundred to four hundred thousand lives are lost every year due to motorcycle accidents (26). It is said that community based initiatives could help to promote rate of helmet usage among the motorcyclists at the population level. To ensure active participation of community into public health programs, a safe community concept rose from the last two decades (19,35). The safe community movement has its roots in health-policy developments like new Public Health, the World Health Organization's Health for All strategy, and the Ottawa Charter (36). A safe community is called safe when a concrete multi-sectoral group including private, government, social, educational and economic authorities and their organizations commit to work on injury prevention and safety promotion at the local level in safe community initiative cities

(10).

These series of study were conducted to design specific interventions aiming at motorcyclist's safety using Haddon matrix in 14 cities of Iran.

### Methods

Motorcyclists' fatality data was extracted from forensic medicine department and hospital records in 14 cities during 2006-2007. Data were analyzed using chi-square and ANOVA method (16). As the next step a cross sectional study was performed in the population to assess knowledge, attitude and practice of motorcyclists about helmet wearing. It was partly based on questionnaire and partly based on observation. Data were collected by interviewing motorcyclists' riders in fourteen cities independently. The same method used for data analyzing. Based on the study plan, a qualitative research on motorcyclists was designed in 14 cities (16). A retrospective chart review of motorcyclists' injury and death with the result from the Knowledge, Attitude, Practice (KAP) study of motorcyclists were obtained. A range of variables relevant to motorcyclists' injury research and prevention were developed and organized according to the Haddon matrix (4, 25&30). Haddon matrix is a framework for analyzing injuries based on the host (i.e. the person injured), the agent (i.e. what caused the injury e.g. electrical energy) and the environment (i.e. the physical and social context in which the injury occurred). Analyzing injury in this way helps to develop three approaches to injury prevention which includes behavioral, environmental and policy changes (8,26). Three working groups based on the result of our first and second study were formed in safe community practicing cities. A series of potential interventions were performed for traffic related accidents (28). The risky behaviors, including over speeding, acrobatic movement, no helmet or improperly usage of helmet usage were considered. Training of traffic safety law to the school children and younger kids were achieved. Re-enforcement of manda-

tory crash helmet law was performed by traffic police.

#### *What is a Safe community Model?*

A Safe Community is one which reflects the passion and commitment of people who dream of a society that is free of injury and pain, and who dares to commit to achieve something tangible to realize that dream (29,36). A designated Safe Community is one which believes that safety is a basic right, and views its designation as a public affirmation to create a safer life for all her citizens (36). To become a world designated Safe Community, a community must demonstrate that it has fulfilled 7 indicators (36). In Iran implementations of Safe Community program began on 1997 nationwide; the first city that could fulfill the criteria of becoming a safe community was Kashmar city in Khorasan province. The designation ceremony was coinciding with the 16th international conference on safe community was held in Tehran on June, 2007. Arsanjan city in Fars province became a safe community one year later (10,30,35).

#### *Statistical Analysis*

*Statistical Method:* Initial analysis pro-

duced descriptive statistics for each group. Observational data sheets were checked for consistency. For continuous exposure data of normal distribution, a one way analysis of variance (ANOVA) test was used to analyze the relationship between outcome variables from each of the groups. Kruskal-Wallis test was used for continuous exposure data not normally distributed. Linear (in the case of continuous outcome variables) and logistic (in the case of binary outcome variables) regression methods were used to explore differences between the groups, with adjustment for confounding variables. Frequencies were generated, chi-square test for testing significances between Safe community setting and non safe community setting test was carried out and two sets of data in each category were compared at the P level of 0.05. All statistical analyses were performed using STATA soft ware.

#### **Results**

The predominant group of the participants was male drivers between 15-29 years (Table1). The highest death rate was detected from the Fars province (225/100,000 motorcycles) and the least from the Bushehr province (41.8/100,000 motorcycles). In

Table 1. Number and proportion of registered motorcycles existing in 14 cities in Iran by owner's age group, in practicing safe community cities verses non practicing safe community cities, 2007

| Characteristic        | Safe community groups     |                              |                |
|-----------------------|---------------------------|------------------------------|----------------|
|                       | Safe community practicing | Safe community no practicing | all            |
| Participants, no. (%) | 116520 (51.3%)            | 110540 (48.7%)               | 227060 (100%)  |
| Owners age in years   |                           |                              |                |
| 0-17                  | 0(0)                      | 0(0)                         | 0(0)           |
| 18-29                 | 52434(45%)                | 48195(43.6%)                 | 100629 (44.3%) |
| 30-44                 | 33790(29%)                | 37804(34.2%)                 | 71594 (31.5%)  |
| 45-59                 | 15963(13.7%)              | 12380(11.2%)                 | 28343 (12.5%)  |
| 60 and above          | 14333(12.3%)              | 12161(11%)                   | 26494 (11.6%)  |

Table 2. Number and proportion of existing registered motorcycles in 14 cities in Iran in safe community practicing Verses safe community non practicing cities, 2007

| province | Number of Motorcyclists   |      | NSC                               |      | Total  |      |
|----------|---------------------------|------|-----------------------------------|------|--------|------|
|          | SC                        | %    |                                   | %    |        | %    |
| Busher   | Busher city               | 44   | Genaveh & Tangestan cities        | 56   | 49060  | 21.6 |
|          | 21520                     | 18.5 | 27540                             | 25   |        |      |
| Khorasan | Kashmar & Bardscan cities | 55.4 | Ferdos & Torbat e Hydarieh cities | 44.6 | 148000 | 65.2 |
|          | 82000                     | 70.3 | 66000                             | 59.7 |        |      |
| Fars     | Arsanjan & Eghlid cities  | 43.4 | Kazeron & Niriz cities            | 56.7 | 30000  | 13.2 |
|          | 13000                     | 11.2 | 17000                             | 15.6 |        |      |
| Total    | 116520                    | 51.3 | 110540                            | 48.7 | 227060 | 100  |

the Fars province, the highest mortality rate was revealed in Niriz city (NSC) (254/100,000 motorcycles) and the least reported from Eghlid city (SC) (122/100,000 motorcycles). In Busher province, the highest death rate was detected from the Busher city (SC) (41.8/100,000 motorcycles) and the least was from the Genaveh city (NSC) (41.7/100,000 motorcycles). In Khorasan province, the highest death rate was reported from the Torbat-e-heydarieh city (NSC) (200/100,000 motorcycles) and the lowest from Bardscan city (SC) (16/100,000 motorcycles) (table 2, 3, 4). About fifty percent of motorcyclists died on scene of crash, 25% died on the way to the hospital and 25% at the emergency room. 73.2% of motorcyclists believed that wearing a helmet is looking funny, 44.4 percent said that it is disturbing, 30 percent mentioned that they feel warm when wearing a helmet and it generate heat particularly in summer time. 36.4 percent said it blocks the hearing, and finally more than 70 percent expressed that the helmet usage is an embarrassing to the riders in

both case and control cities (Table 5). Our finding confirms that 55 percent of the motorcyclists have faced with at least one time accident, 71 percent of them had got some kind of major injuries during the same crash, two motorcycle riders were wearing crash helmet at the time of accident (Table 6).

We also found that most of the motorcyclists have good knowledge about the safety of helmet usage. More than 98 percent of motorcyclists knew that helmet can induce safety, can prevent injury to the head and prevent death. Statistically differences were found between two groups of cities. ( $p < 0.05$ ) (Graph 1). Embarrassing while wearing a helmet was mentioned by many participants. Odds ratio (OR) was calculated for both the groups independently, the odds ratio of the criteria in safe community group versus other group were considered. In two items namely inducing heat and hearing blockage while using helmet, the odds ratio was significant between the two groups. Data showed that the odds for inducing heat was 7.1 (CI: 1.7-29.9) in safe

Table 3. Death rate among the motorcyclists by 100,000 motorcycles in 14 cities in Iran, in practicing safe community cities verses non practicing safe community cities, 2007

| Province | Safe community practicing cities |            | Safe community none practicing cities |            |
|----------|----------------------------------|------------|---------------------------------------|------------|
|          | Cities                           | Death Rate | Cities                                | Death Rate |
| Busher   | Busher city                      | 41.8       | Genaveh city                          | 41.7       |
| Khorasan | Kashmar city                     | 34.2       | Ferdos city                           | 75         |
|          | Bardscan city                    | 16         | Torbat-e heydarieh city               | 200        |
| Fars     | Arsanjan city                    | 225        | Niriz city                            | 254        |
|          | Eghlid city                      | 122        | Kazeron city                          | 95.7       |

Table 4. Number and proportion of motorcyclists' fatality in 14 cities in Iran in practicing safe community cities verses non practicing safe community cities, 2007

| province | Safe community Groups |  | No.(%)   | P-value |
|----------|-----------------------|--|----------|---------|
| Busher   | NSC                   |  | 8(11.8)  | 0.1489  |
|          | SC                    |  | 9(14.8)  |         |
| Khorasan | NSC                   |  | 36(52.1) | 0.1546  |
|          | SC                    |  | 32(52.4) |         |
| Fars     | NSC                   |  | 20(36.1) | 0.1373  |
|          | SC                    |  | 25(32.8) |         |

Table 5. Reasons expressed by the motorcyclists for not wearing helmet in both groups

| Excuses made by motorcyclists | ALL  |         |              | Safe community practicing |         |              | Safe community no practicing |         |              |
|-------------------------------|------|---------|--------------|---------------------------|---------|--------------|------------------------------|---------|--------------|
|                               | No.  | percent | 95percent CI | No.                       | percent | 95percent CI | No.                          | percent | 95percent CI |
| disturbing                    | 1034 | 38.4    | 36.3-40.5    | 664                       | 64.2    | 61.8-68.4    | 370                          | 35.8    | 33.9-38.1    |
| Embarrassing                  | 253  | 9.4     | 7.7-11.6     | 130                       | 51.4    | 49.0-53.4    | 123                          | 48.6    | 36.1-53.9    |
| Forgetfulness                 | 833  | 30.9    | 28.4-33.0    | 544                       | 54.5    | 51.7-58.3    | 379                          | 45.5    | 40.9-64.7    |
| Block Hearing                 | 183  | 6.8     | 4.1-12.9     | 83                        | 45.4    | 38.4-52.5    | 100                          | 54.6    | 50.8-59.2    |

Table 6. Motorcyclists' accident and its consequences in 14 cities of IR Iran by safe community group, 2006

| Outcome   | Safe community Group | No.  | ANOVA or K-W test <sup>b</sup><br>P-value |
|---|----------------------|------|---|
| Motorcyclists faced with accident                   | NSC                  | 2500 | < 0.0001*                                 |
|   | SC                   | 3501 |   |
| Sustaining multiple injuries when accident happened | NSC                  | 3512 | < 0.0001*                                 |
|   | SC                   | 3256 |   |
| Wearing helmet when accident happened               | NSC                  | 2    | 0.1373                                    |
|   | SC                   | 0    |   |

Table 7. Crude odds ratio and age-adjusted odds ratio in 14 cities in Iran, 2006

| Attitude of motorcyclists for helmet usage | Crude OR        |              |         | Age-adjusted OR |              |             |
|--|-----------------|--------------|---------|-----------------|--------------|-------------|
|  | OR <sup>a</sup> | 95percent CI | P-value | OR              | 95percent CI | P for model |
| Safe community practicing                  |                 |              |         |                 |              |             |
| Looking funny                              | 1.23            | 0.8-1.9      | -       | 1.17            | 0.7-1.9      | -           |
| Disturbing                                 | 0.47            | 0.3-0.8      | *       | 0.46            | 0.3-0.7      | *           |
| Generate hotness                           | 7.10            | 1.7-29.9     | *       | 7.11            | 1.7-29.9     | *           |
| Hearing Blockage                           | 0.69            | 0.4-1.1      | -       | 0.65            | 0.4-1.0      | -           |
| Embarrassing                               | 0.78            | 0.4-1.3      | -       | 0.75            | 0.4-1.3      | -           |

<sup>a</sup>OR is the odds ratio for attitude factors of motorcyclists in safe community practicing toward safe community no practicing

Table 8. Recommendations were made by motorcyclists for promoting helmet usage by safe community group in 14 location of Iran 2006

| Excuses made by motorcyclists | All  |         | SC   |         | NSC  |         |
|-------------------------------|------|---------|------|---------|------|---------|
|                               | No.  | percent | No.  | percent | No.  | percent |
| New legislation               | 1212 | 11.2    | 662  | 12.6    | 550  | 9.8     |
| Public Education              | 8041 | 74      | 4031 | 76.5    | 4010 | 71.6    |
| Less price                    | 2548 | 39      | 1340 | 44.1    | 12.8 | 46.2    |
| Suitable design               | 183  | 6.8     | 83   | 45.4    | 100  | 54.6    |
| Law enforcement               | 7820 | 71.8    | 3782 | 71.7    | 4038 | 2       |

community practicing cities and the odds for hearing blockage was 0.65 (CI: 0.4-1.0) in safe community non practicing cities after age adjustment (Table 7).

About 50% of the motorcyclists had a registration number fixed on their motorcycle, about 13 percent had worn helmet, about 6 percent were using the motorcycle as a vehicle to carry loads and 4.5 percent had used other safety devices rather than helmet on the motor cycle, such as crash guard. About 50 percent of the motorcyclists had obtained valid driving license in both group of the cities. About 13 percent of motorcyclists were carrying more than one pillion (Graph 2). Finally participants were asked about the potential ways to improve safety among the motorcyclists with emphasize on helmet usage. They expressed on public education and necessity reinforcement of mandatory helmet law as the priority. Re-designing helmets suitable for local climates with better ventilation to overcome the hotness which is generated

by the helmet was mentioned by many of the motorcyclists. Access to the low priced helmets affordable to the public was the last recommendation which proposed by 46 percent of the participants (Table 8).

Following convening safe community committee in 5 safe community cities, three priority strategies related to Motorcyclists' safety were adopted (Table 9) as follows:

1. To enhance direct services to the victims and support and training to the caregivers,
2. To promote a campaign aiming to public awareness and community sensitization,
3. To enforce rules and regulations within the framework of support.

The main tasks achieved by the safe community committees at the local level are:

1. Every inter disciplinary member have commitment to the safe community and report back to the committee regularly.
2. Issuing official notices for the inter



Table 9. Haddon Matrix for Motorcyclists' safety

|            | Host   | Agent  | Road environment   |
|------------|--|--|--|
| Pre-event  | Increasing safety culture by educating this group.<br>Providing safety environment for them, Training of traffic safety rules to the student, Training younger kids for bicycle safety and helmet use, Enforcement of traffic police for safety belt and crash helmet and over speed | -poorly designed helmet which is not suitable for the climate of Iran.<br>-Routin Motorcycle safety inspection                                     | Bad quality of roads particularly rural roads and tropical climate<br>Clear road signs and signals   |
| Event      | -Wear fastened helmet<br>- Education to the family and young individual by local media   | Good quality, well-fitting helmet<br>Leg guards on cycle<br>Heavy boots and clothing,<br>To look for any failure in breaking system and suspension | Energy absorbing barriers<br>Roadsides clear of fixed obstructions<br>Guardrail along cliff enforcement of over speeding law and checking for driving license and other document to control less than 18 years old individual driving. |
| Post-event | Rehabilitation   | First aid kit<br>Emergency radio   | Communication network<br>Transportation network<br>Emergency services  |

disciplinary members of the committee and determining the duties of each members based on the instructions

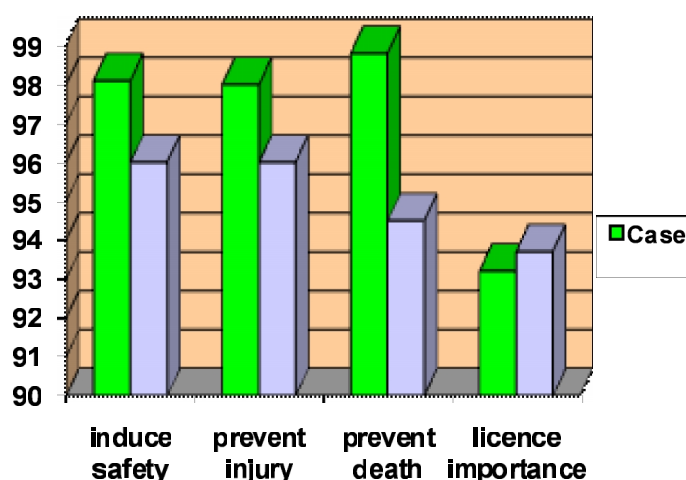
3. Holding sessions in order to design operational plans for prevention of injuries in the city area.

4. Each inter disciplinary committee member should agreed upon the time table for planned activities regarding the safety promotion and injury prevention among motorcyclists.

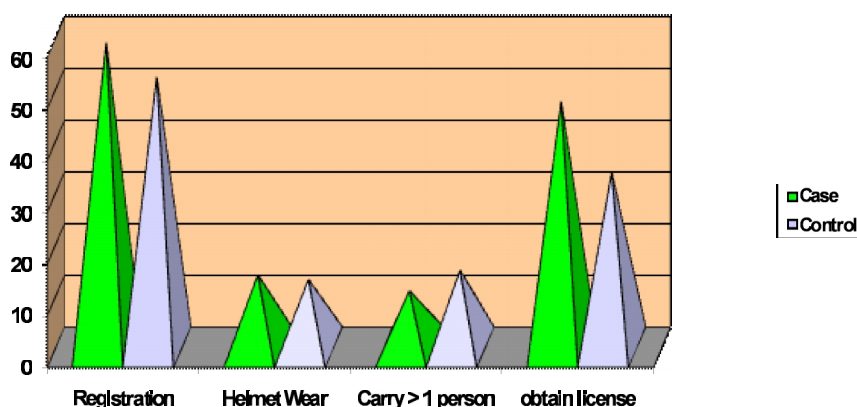
### Discussions

In Many studies including sixty one observational studies which were performed worldwide the results in terms of motorcyclists' death and injury were the same (34). In all studies motorcycle helmet found to reduce head injury in motorcyclists' crash. It is estimated that helmet reduces the risk of death by 42%. In some articles helmet show to reduce risk of head injury by 69% (2,9,27) . Motorcycle injuries are mainly sustained by young adults, leaving burden to individuals and society (31,32) .Traffic related accidents affect lives of thousands individuals in active age range (adolescents and young adults aged 15 to 44 years), representing a serious socioeconomic and public health impact (5,7,13). In our study most of the motorcyclists were using the motorcycle as the only source of the family in-

come. Most of them were the breadwinner to the family. A study revealed that how big is the pain of losing a bread winner is especially at the first years of driving experience and how much the gap is widen in term of socio-economic differences at this stage (20,21,24). These findings might be transferable to other countries where the motorcycle injuries have a higher prevalence rate (22). In our study, we did not measure the years of experience of motorcyclists but most of them used the motorcycle as the only vehicle of source of income for the family. In another study which was performed in Sweden with a community based design, the effect of an organizational program on prevention of traffic related accidents was measured (6,17) the results showed a 50% reduction in the relative risk for moderate and mild injuries. Pedestrians, cyclists, and motorcyclists were the persons who most benefited from the program. Non practicing safe communities in the khorasan province are Ferdos city & Torbat-e-Hydarieh city, death rate of motorcyclists (53%) were high. The same picture was detected in Fars province. Arsanjan city and Eghlid city are two cities that the safe community model is practicing since many years. The Arsanjan was designated as an international safe community on 2008 (36). Effect of the safe communi-



GRAPH 1. Knowledge of motorcyclists in 14 location of Iran by safe community group, 2006



GRAPH 2. Behavior of motorcyclists in 14 location of Iran by safe community group, 2006

ties to the motorcyclists' death was positive in these two cities in comparison to other cities of the province in which the safe community model was not practicing. They were Kazeron city and Niriz city (44.5% vs. 55.5%).

The story is slightly different in Bushehr province. First of all the Bushehr city is cited at the northern border of the Persian Gulf in south of Iran; it is considered as the oldest port in Iran. It is also the capital city of the Buser province. Due to the high number of immigration, the population age and sex composition turns over rapidly. The population density is high too. These criteria make the city unique within the province. The safe community program started very early in the city but due to many factors, the program did not run well. The positive effect of the safe community model to

the death rate of motorcyclists could not be demonstrated and in some instances we concluded a negative effect. Statistically no differences were detected between Safe community practicing cities and non practicing safe community in Buser province in terms of fatality from motorcycle accident. In Fars province, number of death from motorcycle accident is slightly more in safe community than in non practicing safe community. This may be as a result of better data gathering system in the former than the later. But statistically this finding was not significant. The situation is slightly deviated in Khorasan province. The safe community practicing cities are safer than the non practicing safe community for motorcyclists. After testing we did not find any statistically significant differences between these two settings. These findings and other

similar findings may say common sentences that motorcyclists' safety was not the main priority of the community in safe community settings, but as a subsidiary outcome to the main activities of road traffic safety (8,10). Factors related to the individual level, remain by far the main determinants in injury severity. Law enforcement and, above all, building the perception of safety would be advantages for these type of injuries (6,8,24).

When planning programs for motorcycle injury prevention, timing and groups should be taken into account. Effective alliances including public and private partnerships are needed to link the fields of public health, health care, transportation, law enforcement, engineering, and education (6,18). It has been shown that devices such as protective clothing for leg and forearm, reflectors, and side air bags are just some of the aspects that should be considered (3,19,23). But our study revealed that law enforcement was the main item mentioned by motorcyclists to promote helmet usage among them. Since most of the motorcyclists were the bread winner to the family, motorcycles' accessory safety devices such as air bag could not be considered in our society.

Almost in all studies dealing with motorcyclists' characteristics including attitudes, knowledge and behaviors, the similar findings were detected. The majority of motorcycle riders involved in road accidents were young males, particularly under 20 years, who generally tend to adopt risky attitudes and behaviors having an increased risk of injury compared with older drivers (14,24).

### Limitations

Seasonal and time variation for helmet wearing rate were not considered in this study

### Conclusions

Although the knowledge of motorcyclists about the importance of helmet usage was very high and about 50 percent of them believed that using helmet results in safety

but only 13% of the motorcyclists actually used a helmet. The situation was better in Safe community practicing cities compare to non practicing safe community cities. This finding suggests two priorities for promoting helmet usage among motorcyclists: constant public education, campaigning for motorcyclists' safety improvement of rescue services and re enforcement of mandatory helmet law.

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