

Seat Belt Usage in Injured Car Occupants: Injury Patterns, Severity and Outcome After Two Main Car Accident Mechanisms in Kashan, Iran, 2012

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Background: Road traffic accidents (RTAs) are the main public health problems in Iran. The seat belts, which are vehicle safety devices, are imperative to reduce the risk of severe injuries and mortality.

Objectives: The aim of the study was to evaluate injury patterns, severity and outcome among belted and unbelted car occupants who were injured in car accidents.

Patients and Methods: This cross-sectional prospective study was performed on all car occupants injured in RTAs (n = 822) who were transported to hospital and hospitalized for more than 24 hours from March 2012 to March 2013. Demographic profile of the patients, including age, gender, position in the vehicle, the use of seat belts, type of car crashes, injured body regions, revised trauma score (RTS), Glasgow coma score (GCS), duration of hospital stay and mortality rate were analyzed by descriptive analysis, chi-square and independent t-test. P < 0.05 was considered significant.

Results: A total of 560 patients used seat belts (68.1%). The unbelted occupants were younger (28 years vs. 38 years) and had more frequently sustained head, abdomen and multiple injuries (P = 0.01, P = 0.01 and P = 0.009, respectively). Also, these patients had significantly lower GCS and elongated hospitalization and higher death rate (P = 0.001, P = 0.001 and P = 0.05, respectively). Tendency of severe head trauma and low RTS and death were increased in unbelted occupants in car rollover accident mechanisms (P = 0.001, P = 0.01 and P = 0.008, respectively).

Conclusions: During car crashes, especially car rollover, unbelted occupants are more likely to sustain multiple severe injuries and death. Law enforcement of the seat belt usage for all occupants (front and rear seat) is obligatory to reduce severe injuries sustained as a result of car accidents, especially in vehicles with low safety.

Keywords: Seat Belts; Traffic Accident; Motor Vehicles; Accident Prevention

1. Background

Nearly 27000 people lose their lives in road traffic accidents (RTAs) in Iran, making it a major public health concern (1). The incidence of death resulting from RTAs is 30/100000 in Iran, which in comparison with worldwide incidence, is one of the highest RTAs mortality in the world (2). Although motorcycle accidents were the main RTAs (3), car accidents were more severe and comprised 66% of RTAs mortality in Iran (4). During car accident mechanism, especially car rollover and car collision with other vehicles or with a fixed or stationary object, the car occupants experienced two main destructive crash mechanisms: ejection from vehicle and sudden forward movement to glove compartment and steering wheel, which increases the probability of severe injuries and death (5-7). The seat belt usage as cost-effective protective safety device by car occupants decreases the risk of severe injuries and mortality. The proper usage of seat belts could prevent up to 80% of all car crash fatalities (5).

The unbelted car occupants suffered from more severe injuries and needed more surgical operations (8).

The prevalence of the seat belt usage in different countries varies widely and is largely dependent on the existence and implementation of relevant laws. Based on the report of U.S. Department of Transportation, the seat belt use in the United States in 2013 was 87% (9), whereas this rate for front seat driver in the United Kingdom, Norway and Egypt were 93%, 85% and 70%, respectively (10). The rates of seat belt use in Iran were reported in various studies ranging from 53% to 70.93% (11, 12). On the other hand, during last decade, there was a dramatic increase in car production in Iran. Soori et al. reported considerable increase in car production volume from 6949381 in 2004 to 9945140 in 2007 (13). This jump in car production (which do not usually comply with modern safety standards) without significant road structure improvement has been associated with increased car-related RTA frequencies (14).

This study was designed to compare the complications of RTAs in belted and unbelted car occupants referred to a level II hospital in the central part of Iran.

2. Objectives

The purpose of this study was to evaluate and compare injury patterns, severity and outcome in belted and unbelted car occupants after two main car accident mechanisms (car collision and rollover) in Kashan City, Iran, during March 2012 to March 2013.

3. Patients and Methods

All car occupants injured in RTAs (n = 822) who were hospitalized for more than 24 hours in Shahid-Beheshti Hospital or died after arrival at emergency room were prospectively studied from March 2012 to March 2013. We excluded those who had died at accident scene due to the lack of recorded data. Information about accident scene details, including car accident mechanism, geographic place of crash (city streets, out city roads) and position of injured car occupants were collected by emergency medical services (EMS) personnel. Patients were examined by physicians to obtain other information, such as type of organ injury based on international disease code (ICD) 10, Glasgow coma score (GCS), and vital sign for calculated revised trauma score (RTS). Kashan City is located in central part of Iran near the main north-south road (Freeway 7). Shahid-Beheshti Hospital is the main trauma center admitting 3000 RTA injured patients annually.

Some variables, including sex, age, the car accident mechanism, and place of crash, and position of injured car occupants, type of organ injury, RTS, GCS, total duration of hospitalization, and mortality were studied in

this study. We compared injury patterns and outcome in belted and unbelted patients. Moreover, we compared injury patterns, severity and outcome in two main car accident mechanisms (car rollover and car collision). An informed consent was obtained from all patients.

For statistical analysis, SPSS version 13.0 (SPSS Inc, Chicago, Illinois, USA) software was used to calculate chi-square test and t-test. $P < 0.05$ was considered significant.

4. Results

In this study, 68.1% of the patients had their seat belts fastened during the accident (n = 560). The mean age of the belted patients was higher than unbelted patients ($P \leq 0.001$). Sixty-two percent of males and 82.1% of females used seat belts ($P \leq 0.04$). Front-seat car occupants (driver and passenger) used seat belt more frequently than back-seat passengers ($P = 0.007$) (Table 1). Table 2 shows injury patterns and outcome of injured car occupants, in belted and unbelted patients.

4.1. All Mechanisms

Generally, tendency of head and abdominal injuries were increased in unbelted patients ($P = 0.01$ and 0.01 , respectively). The rates of multiple organ injuries in belted and unbelted patients were 38.7% and 17.8%, respectively ($P = 0.009$). In traumatic brain injured patients, the mean GCS was higher in those who used safety belts ($P = 0.001$). The unbelted patients had a higher hospitalization duration and mortality rate ($P = 0.001$, $P = 0.05$, respectively). Car-rollover mechanisms composed of 50.4 % of all car accident (n = 413), and the rest were car collisions, such as collisions with car, pick-up truck or van and fixed or stationary objects.

Table 1. The Studied Variables for Injured Car Occupants in Those Using Seat Belts Compared to Those not Using Them ^a

Variables	Seat Belt (+) (n = 560)	Seat Belt (-) (n = 263)	Total (n = 823)	P Value
Age group, yr				
0-19	38.9	61.1	12.8	0.001
20-59	70.4	29.6	76.6	
Over 60	86.7	13.3	10.6	
Gender				0.04
Male	62.7	37.3	72.3	
Female	82.1	17.9	27.7	
Car occupant				0.007
Driver	74	26	68.1	
Front seat passenger	65.5	34.4	22.7	
Back seat passenger	30.8	69.2	9.2	
Place of accident				0.58
City streets	70.9	29.1	61	
Out city roads	66.3	33.7	39	

^a Data are presented as %.

Table 2. Injury Patterns and Outcome of Injured Car Occupants in Belted Patients Compared to the Unbelted Patients ^{a,b}

Variables	Total				Car Rollover				Car Collision			
	Belted (n = 560)	Unbelted (n = 263)	Total (n = 823)	P Value	Belted (n = 265)	Unbelted (n = 148)	Total (n = 413)	P Value	Belted (n = 294)	Unbelted (n = 116)	Total (n = 410)	P Value
Head	49	71.1	56	0.01	41.2	60	46.5	0.1	57.8	80	65.7	0.05
Chest	9.4	15.6	11.3	0.28	7.8	25	12.7	0.05	11.1	8	10	0.6
Abdomen	5.2	17.8	9.2	0.01	5.9	30	12.7	0.05	4.4	8	5.7	0.5
Pelvic	4.2	4.4	4.3	0.9	3.8	5	4.2	0.8	4.4	4	4.3	0.9
Limb	43.8	37.8	41.8	0.5	39.2	55	43.7	0.2	48.9	24	40	0.04
Multiple	17.7	37.8	24.8	0.009	11.8	55	23.9	0.001	24.4	24	24.3	0.9
RTS	7.5 ± 1	7.2 ± 0.7	7.4 ± 0.8	0.06	7.5 ± 0.9	6.7 ± 1.3	7.3 ± 1.1	0.01	7.6 ± 0.4	7.6 ± 0.3	7.6 ± 0.4	0.6
GCS	14.2 ± 1.8	13 ± 3.2	13.8 ± 2.4	0.001	14.1 ± 2	11.4 ± 4	13.3 ± 2.9	0.00	14.3 ± 1.5	14.3 ± 1.4	14.3 ± 1.5	0.8
Hospital stay, d	4.1 ± 5	8.4 ± 9.4	5.1 ± 7	0.001	4 ± 11.4	12.5 ± 5.7	6.4 ± 8.5	0.001	4.2 ± 4.2	5.1 ± 5.8	4.5 ± 4.8	0.4
Death	2.1	8.9	4.3	0.05	2	20	7	0.008	0.2	2.2	1.4	0.4

^a Abbreviations: GCS, Glasgow coma score; RTS, revised trauma score.

^b Data are presented as % or mean ± SD.

4.2. Car-Rollover Mechanism

A tendency for chest and abdominal injuries was seen in unbelted patients in this mechanism ($P = 0.05$, $P = 0.05$, respectively). Multiple injuries in unbelted and belted patients were 55%, 11.8%, respectively ($P = 0.001$). The mean GCS and RTS in belted patients were higher than unbelted ones ($P = 0.001$, $P = 0.01$, respectively). The unbelted patients had elongated hospitalization time ($P = 0.00$) and these patients are 12.5 folds more likely to die (OR: 12.5, 95%, CI 1.30-120.03). There was a significant difference between the seat belt usage and death in car-rollover mechanism ($P = 0.001$).

4.3. Car-Collision Mechanism

In this mechanism, unbelted patients sustained more frequent head injuries ($P = 0.05$). No significance difference was found between the seat belt usage with injury severity indexes (RTS, GCS) and mortality in this mechanism.

5. Discussion

In our study, we investigated the rate of seat belt usage in traumatically injured car occupants and concluded that 68% of them used this safety device. Seat belt enforcement by police and law fines could lead to increase the use of seat belts in our study and Nabipour et al. with 70.9% (14) compared with Borghebani et al. study that 53% of drivers were fasten seat belts at 2009 (12). Similar to Abu-Zidan et al. study (8) the unbelted patients were significantly younger than the belted ones. In our study, 61 % of the patients under 19 years old didn't have their seat belts fastened. Since young people have more risk-taking traffic behaviors, such as speeding and noncompliance with rules, they are more susceptible to fatal injuries; they need special attention and education (8, 15).

Women, regardless of their occupant position, used seat belts significantly more than men in our study. Nabipour et al. study in Iran 2013 reports the rate of the seat belt usage was significantly higher in female drivers (14). Afukaar et al. study in Ghana 2010 (16), Ipingbemi et al. study in Nigeria 2012 (6) and Ma et al. study in Russia 2012 (17) also report this finding in female drivers. Generally, females are more careful and respect the rules more than their male counterparts (8, 12, 16). Only 30.8 % of back seat passengers used seat belts. This rate in Abu-Zidan et al. study was 1% (8). Unfortunately, the law for back seat restraint is not mandatory law in Iran and lack of safety belts for rear-seat passengers in some types of cars may also explain the low rate of seat belt usage in back seat passengers in this study. Consistent with the previous studies (8, 18, 19), our study shows that the tendency of head and abdominal injuries was increased in unbelted patients and also these patients were more severely injured. In our study, RTS and GCS showed that unbelted patients were more severely injured than the belted ones, as reported with previous studies (8, 18). Allen et al. study (18) reported the hospital admission rate of unbelted car occupants were two folds compared to the belted occupants and unbelted had 25% higher emergency department charges. Also, Abu-Zidan et al. study reported (8) the unbelted patients more frequently needed surgical operation and ICU admission and more hospitalization. Consistent with previous studies (8, 19, 20), our study showed the unbelted patients stayed in hospital twice more than belted ones.

The use of seat belt has obviously reduced the mortality rate from road traffic collisions all over the world (1, 21). Sanaei-Zadeh et al. study in Iran, before the mandatory seat belt law, showed that the head injury due to a lack of the seat belt usage is the main cause of RTAs mortal-

ity (22). In our study, the mortality rate was significantly higher in unbelted patients (8.9%) compared with the belted ones (2.1%). Studies showed the strong negative correlation between the seat belt usage and mortality rate. Unbelted occupants are more likely to be ejected during car accident with 70% rising of mortality chance compared with belted occupants (8, 21).

Car-rollover crashes are responsible for a serious injuries and fatalities compared to other car accident mechanisms (23) that resulted one of three car fatalities (24). Totally, during car-rollover accident mechanisms, one third of car occupants were expelled from the vehicle. One half of car occupants experienced multi-organ injuries that resulted in a 51% mortality rate (25). Funk et al. study report, completely expelled occupants being 91 times more prone to die than nonejected occupants (23). Consistent with previous studies (8, 23, 25), our study showed that the unbelted patients suffer from frequent chest, abdomen and multi-organ injuries and higher injury severity and increased mortality compared to restrained car occupants. The use of seat belts can reduce partial ejection and approximately eliminate complete ejection during car-rollover crashes (23). In addition, the seat belt usage was associated with lower injury severity in nonejected occupants after car-rollover accidents (23).

Although, in contrary to previous studies in Iran that most of them evaluate the rate of safety belt usage and factors affecting this rate in drivers and healthy population, the strength of this study was the evaluation of the rate of safety belt usage and its correlation with injury patterns, severity and outcome in traumatic car occupants, especially in two main car crash mechanisms for the first time in Iran. The authors are aware that this study has some limitations, including some variables such as the presence of airbag, the types of seat belts (lap or three point models), car types (sedan or none sedan), car size and speed that has strongly confounding effect on injury patterns and severity and outcome. In the current study, information at the scene of accidents was gathered by EMS personnel based on national EMS form. Unfortunately, this form has none of these variables and we could not use these variables in the study.

In conclusion, this study found that among car occupants following car crashes, especially car rollover, the unbelted patients are more likely to sustain more frequent and more severe injuries along with elongated hospitalization and raised mortality rates compared to the belted occupants. Law enforcement of the seat belt usage for all occupants (front and rear seat) is obligatory to reduce injury severity of car accidents, especially in vehicles with low safety.

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Authors' Contributions

Mahdi Mohammadzadeh and Azadeh Sadat Mirzadeh were responsible for the study conception and design and Mohammad Paravar performed data collection and Javad Mohammadzadeh preparing the first draft of the manuscript. Soroush Mahdian revised the study draft. Mahdi Mohammadzadeh did the data analysis, made critical revisions to the paper for important intellectual content and supervised the study.

References

1. Soori H, Nasermoadei A, Ainy E, Hassani SA, Mehmandar MR. Association between mandatory seatbelt laws and road traffic injuries in Iran. *Southeast Asian J Trop Med Public Health*. 2011;**42**(6):1540-5.
2. Ali M, Haidar N, Ali MM, Maryam A. Determinants of seat belt use among drivers in Sabzevar, Iran: a comparison of theory of planned behavior and health belief model. *Traffic Inj Prev*. 2011;**12**(1):104-9.
3. Adib-Hajbaghery M, Maghaminejad F. Epidemiology of patients with multiple trauma and the quality of their prehospital respiration management in kashan, iran: six months assessment. *Arch Trauma Res*. 2014;**3**(2).
4. Mohammadi G. Road traffic crash injuries and fatalities in the city of Kerman, Iran. *Int J Inj Contr Saf Promot*. 2013;**20**(2):184-91.
5. Cummings P. Association of seat belt use with death: a comparison of estimates based on data from police and estimates based on data from trained crash investigators. *Inj Prev*. 2002;**8**(4):338-41.
6. Ipingbemi O. The rate of compliance to seat belt usage among automobile drivers on three categories of roads in Nigeria: an observational survey. *Int J Inj Contr Saf Promot*. 2012;**19**(1):3-8.
7. Abbas AK, Hefny AF, Abu-Zidan FM. Seatbelt compliance and mortality in the Gulf Cooperation Council countries in comparison with other high-income countries. *Ann Saudi Med*. 2011;**31**(4):347-50.
8. Abu-Zidan FM, Abbas AK, Hefny AF, Eid HO, Grivna M. Effects of seat belt usage on injury pattern and outcome of vehicle occupants after road traffic collisions: prospective study. *World J Surg*. 2012;**36**(2):255-9.
9. National Highway Traffic Safety Administration. *Traffic safety facts*. Washington, DC: NHTSA; 2013.
10. World Health Organization. *Seat-belts and child restraints: A road safety manual for decision-makers and practitioners*. London: WHO; 2009.
11. Hodson-Walker NJ. The value of safety belts: a review. *Can Med Assoc J*. 1970;**102**(4):391-3.
12. Borghebani R, Dehahgni L, Khanjani N. The rate of safety belt use and some of its related factors among Kerman, Iran car drivers. *Payesh*. 2013;**12**(2):159-65.
13. Soori H, Royanian M, Zali AR, Movahedinejad A. Road traffic injuries in Iran: the role of interventions implemented by traffic police. *Traffic Inj Prev*. 2009;**10**(4):375-8.
14. Nabipour AR, Khanjani N, Soltani Z, Akbari M. The rate of seat belt use and its related factors among car drivers in Tehran, Iran after imposing new regulations. *Int J Inj Contr Saf Promot*. 2014;**21**(4):348-54.
15. Fakharian E, Mohammadzadeh M, Behdad S, Babamohammadi A, Mirzadeh AS, Mohammadzadeh J. A seven-year study on head injuries in infants, Iran—the changing pattern. *Chin J Traumatol*. 2014;**17**(3):153-6.
16. Afukaar FK, Damsere-Derry J, Ackaah W. Observed seat belt use in Kumasi Metropolis, Ghana. *J Prev Interv Community*. 2010;**38**(4):280-9.
17. Ma S, Tran N, Klyavin VE, Zambon F, Hatcher KW, Hyder AA. Seat belt and child seat use in Lipetskaya Oblast, Russia: frequencies, attitudes, and perceptions. *Traffic Inj Prev*. 2012;**13** Suppl 1:76-81.
18. Allen S, Zhu S, Sauter C, Layde P, Hargarten S. A comprehensive statewide analysis of seatbelt non-use with injury and

- hospital admissions: new data, old problem. *Acad Emerg Med.* 2006;**13**(4):427-34.
19. Houston DJ, Richardson LE, Jr. Traffic safety and the switch to a primary seat belt law: the California experience. *Accid Anal Prev.* 2002;**34**(6):743-51.
 20. Bener A, Al Humoud SM, Price P, Azhar A, Khalid MK, Rysavy M, et al. The effect of seatbelt legislation on hospital admissions with road traffic injuries in an oil-rich, fast-developing country. *Int J Inj Contr Saf Promot.* 2007;**14**(2):103-7.
 21. Abbas AK, Hefny AF, Abu-Zidan FM. Seatbelts and road traffic collision injuries. *World J Emerg Surg.* 2011;**6**(1):18.
 22. Sanaei-Zadeh H, Vahabi R, Nazparvar B, 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.
 23. Funk JR, Cormier JM, Manoogian SJ. Comparison of risk factors for cervical spine, head, serious, and fatal injury in rollover crashes. *Accid Anal Prev.* 2012;**45**:67-74.
 24. Grzebieta RH, Young D, McIntosh A, Bambach MR, Fréchède B, Tan G, et al. Rollover crashworthiness: the final frontier for vehicle passive safety. *J Australas Coll Road Saf.* 2008;**19**(2):29-38.
 25. Frechede B, McIntosh AS, Grzebieta R, Bambach MR. Characteristics of single vehicle rollover fatalities in three Australian states (2000-2007). *Accid Anal Prev.* 2011;**43**(3):804-12.

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