Road safety and road traffic accidents in Saudi Arabia

A systematic review of existing evidence

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ABSTRACT

الأهداف: دراسة الاتجاهات المتغيرة والطرق المتبعة للوقاية من حوادث الطرق في المملكة العربية السعودية خلال العقدين ونصف المنصرمة، بالإضافة إلى تحليل بعض الجوانب المرتبطة بهذه المشكلة ولتي تم التجاوز عنها سابقاً.

الطريقة: لقد اعتمد هذا المقال على جمع المقالات التي تناولت حوادث الطرق في المملكة العربية السعودية حيث قمنا بتحليل كافة الدراسات المنشورة والتي تناولت هذا الموضوع خلال 25 سنة الماضية. أُجريت هذه الدراسة في قسم الأسرة والمجتمع، جامعة طيبة، المدينة المنورة، المملكة العربية السعودية وذلك خلال الفترة من ديسمبر 2013م إلى مايو 2014م.

النتائج: لقد وصلت نسبة حوادث الطرق إلى 83.4% من مجموع الإصابات الرضحية خلال الفترة من 1984–1989، ولم تتم دراسة الاتجاه العام لنسبة هذه الحوادث بعد تلك الفترة. وأشارت نتائج الدراسات بأن أكثر أعضاء الجسم المتأذية قد كانت كلاً من الرأس والرقبة، تبعتها الأطراف السفلية والعلوية وذلك كان مناقضاً لما نُشر سابقاً. وأظهرت تقارير المستشفيات إلى زيادة غير واضحة من الناحية الإحصائية في معدل الوفيات الناتجة عن حوادث الطرق وذلك بنسبة 8%. وقد كان هذا خلاف ما نشرته تقارير المرور عن تدني نسبة حوادث الطرق بصورة واضحة من الناحية الإحصائية بنسبة 27% خلال الفترة من 2005–2010. وكانت السرعة الزائدة من أكثر الأسباب المؤدية لحوادث الطرق حسب ما تضمنته نتائج الدراسات الماضية والجديدة.

الخاتمة: أظهرت الدراسة اختلافاً في نوعية التقارير الصادرة بخصوص حوادث الطرق، ومعايير النتائج العلاجية، والأسباب المؤدية لمثل هذه الحوادث خلال 25 سنة الماضية. وقد اعتمدت الأبحاث المنشورة على تحليل أخطاء السائق من دون النظر إلى الأسباب الأخرى. وعلى كافة المستشفيات من الدرجة الثانية والثالثة وفي جميع المناطق السعودية القيام بوضع أنظمة للترصد الوقائي الإنذاري وذلك لكافة إصابات حوادث الطرق لديها.

Objectives: To identify the changing trends and crucial preventive approaches to road traffic accidents (RTAs) adopted in the Kingdom of Saudi Arabia (KSA) over the last 2.5 decades, and to analyze aspects previously overlooked.

Methods: This systematic review was based on evidence of RTAs in KSA. All articles published during the last 25 years on road traffic accident in KSA were analyzed. This study was carried out from December 2013 to May 2014 in the Department of Family and Community Medicine, Taibah University, Al-Madinah Al-Munawwarah, KSA.

Results: Road traffic accidents accounted for 83.4% of all trauma admissions in 1984-1989, and no such overall trend was studied thereafter. The most frequently injured body regions as reported in the latest studies were head and neck, followed by upper and lower extremities, which was found to be opposite to that of the studies reported earlier. Hospital data showed an 8% non-significant increase in road accident mortalities in contrast to police records of a 27% significant reduction during the years 2005-2010. Excessive speeding was the most common cause reported in all recent and past studies.

Conclusion: Disparity was common in the type of reporting of RTAs, outcome measures, and possible causes over a period of 2.5 decade. All research exclusively looked into the drivers' faults. A sentinel surveillance of road crashes should be kept in place in the secondary and tertiary care hospitals for all regions of KSA.

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The burden of road traffic accidents (RTA) is a leading cause of all trauma admissions in hospitals worldwide.[1] According to the World Health Report (WHR) in 2010,[2] road traffic injuries (RTI) have been identified as the ninth most common cause of disability adjusted life years (DALYs) lost for all age and gender categories. The World Health Organization (WHO) reported that 1.24 million people were killed on the road, and up to 50 million people were injured worldwide, and the number of road traffic deaths is expected to increase further by 2020.[3,4] Nearly three-quarters of overall road deaths occur in developing countries, although road deaths are common in developed countries. Road traffic fatality in the Kingdom of Saudi Arabia (KSA) accounts for 4.7% of all mortalities, while road traffic fatalities do not exceed 1.7% in Australia, United Kingdom (UK), or United States of America (USA).[5] Similarly, road fatalities in KSA have increased over the last decade from 17.4-24 per 100,000 population compared with 10 in USA, and 5 in UK, where road safety has been taken seriously, and all primary and secondary preventive measures are implemented appropriately.[6] Saudi Arabia was found to have higher number of deaths from RTAs among high income states (accident to death ratio is 32:1 versus 283:1 in USA), and is considered to be the country's main cause of death for 16-30-year-old males.[7] Road injuries are reported to be the most serious in this country with an accident to injury ratio of 8:6, compared with the international ratio of 8:1.[8] The rate of RTA caused by 4-wheeled vehicles is the highest of all worldwide accidents.[9]

Saudi Arabia is a vast country of 2,149,690 km^2, and is the largest Arab state in Western Asia. The Kingdom has been categorized as a high-income nation, and is part of the "Group of Twenty" (G-20) of major economies. It has a total population of approximately 27 million, one-fourth of whom are expatriates, with the highest population density (per km^2) of 101 in Jizan, and 38 in Makkah, and the lowest of 2.8 in Najran, and 3.6 in Al Jawf.[10] In KSA, motor vehicles are the main means of transportation within, and in-between cities. According to a recent estimate, more than 6 million cars are found on the roads of KSA.[11] According to the morbidity and mortality records in the Ministry of Health (MOH) hospitals, 20% of beds are occupied by RTA victims, and 81% of deaths in the hospitals are due to RTIs.[8] Over the past 2 decades, KSA has recorded 86,000 deaths, and 611,000 injuries in RTAs with 7% resulting in permanent disabilities.[12] The economic implications of RTAs estimated in terms of potential productive years life lost (PPYLL) were examined in a study that reported a 31.6% increase in deaths due to RTA among males in 1997-2002 compared with a 1.3% increase in deaths due to RTA among females.[13,14] Road traffic accidents are a major health hazard with 19 killed daily, and 4 injured every hour in KSA. The young and economically productive age groups are the most affected.[9] In industrialized countries, the gross loss due to accidents is 1 ± 2% of the national income, while for KSA, this loss has been estimated to be between 2.2 and 9%.[8,15] The accident or injury reporting system in KSA has been much improved over the last couple of decades. Legislation on seat belt use has been put into practice, along with fully operational speed camera systems in large cities under the control of police departments, and police department record keeping of road mortalities and collisions.[16] This improved reporting system shows a paradoxical rise in the magnitude of the problem over the years. The WHO has identified 5 Road Safety Pillars, namely: road safety management or policy; road infrastructure; safe vehicles; road users' safe behavior; and post-crash care.[17] Driver errors has been mostly reported in different regions of KSA as a cause of RTAs, in addition to some deplorable vehicles, and road conditions. However, post-crash care is largely ignored in all possible direct, or indirect evidence on the subject. There is scarcity of local standardized information on RTAs; therefore, measures for injury related mortality and disability are mostly available, either in popular press articles, police records, or WHO projected estimates. The aim of this study was to identify the changing trends and crucial preventive approaches to RTAs adopted in KSA over the last 2.5 decades, and to analyze aspects previously overlooked. This systematic review was planned to propose a standardized surveillance system for RTAs in KSA. This analysis aims to provide helpful information in limiting the overall incidence of RTAs, and the severity of the resultant injuries in KSA.

Methods. The search for related articles for this review was carried out from December 2013 to May 2014, through Google Scholar, PubMed, Scopus, Saudi Medical Literature, Saudi Medbase, and Science Direct using the key terms "road traffic accident", "road traffic injuries", "road fatalities" combined with the term "Saudi Arabia". The search was further complimented by WHO statistics reports, and related reports under the Ministry of Interior (MOI) KSA, and police department websites. All articles published during the last 25 years based on primary or secondary, or both types of data on RTAs in KSA were included. Two authors independently reviewed each article to determine the outcome measures, and those articles not in English language were excluded. A total of 31 articles were retrieved through various search engines. Out of

these, 2 were excluded as they were not in English. This review was reported according to the Meta-analysis of Observational Studies in Epidemiology (MOOSE) guidelines for systematic reviews of observational studies. Cumulative analysis could not be performed, as outcome variables were not homogeneous across these studies. We considered RTA as an exposure, and outcome measures included injuries, death (on arrival, or in the hospital), and disabilities. Ethical approval was obtained from ethical the review committee of the university to conduct this study.

Results. Out of the total 29 articles, 8 were full text focusing on RTA or injuries (**Table 1**), and 21 articles (including 3 full texts) were those where road injuries were implicated as a cause to an event of any other specific interest.

Overall distribution of RTA. The trend of young males affected more than females was mostly reported in all studies over the last 2.5 decades with some variations in the type of estimates among regions, and period of reporting. The overall age-gender-adjusted rate for non-fatal RTIs was 20.7/100 persons/year.[16] The rate for non-fatal RTI was found to be higher in the 10-19 year age group.[16] An audit of RTAs over a one-year period revealed that 16% of the victims were less than 10 years old, and 47% were between 11 and 30 years old.[18] Males had a twice, or greater incidence rate for RTI compared with females.[16] In another study,[18] an even higher male to female ratio of 4:1 was reported, and attributed to the driving laws in KSA. While 50% percent of road injuries among children were observed in pedestrians.[18] The top regions in KSA regarding the occurrence of RTA were found to be Riyadh, Jeddah, Makkah, Madinah, and Qassim.[19,20] Few studies reported the time, season, or month of occurrence of accident. A study conducted in Al-Ahsaa[21] reported that 13.7% of accidents occurred during December (Jummada Thani), predominantly on the last 3 days of the week, while the lowest rate of 6.4% occurred during February. While in Al Qassim, the lowest rate of 5.8% was observed in March.[16] Another study[22] reported that Ramadan is the most common month for accident occurrence during the first 12-24 hours. A study conducted in a Riyadh hospital[14] reported that RTA were the cause in 83.4% of all of the trauma admissions during a 5-year period (1984-1989).

Pattern of reporting RTA. **Table 1** summarizes the findings of the 8 full text articles regarding type of data, place and time of study, year of publication, common cause of accident, outcome, and conclusion, or recommendations. Only 50% (4 out of 8) of the studies used primary data on RTA. The primary data collected in these 4 studies was representative of the cities of Al-Qassim in 2010,[16] Al-Aseer in 2005,[22] Abha in 1989-1994,[23] and Riyadh in 2001.[24] All these studies

Table 1 - Key features of studies (full text) on road traffic accident (RTA) in the Kingdom of Saudi Arabia (KSA) (n=8).

Study, year of publication	Type, year	Sample size	Place of study	Most common identified cause of RTA	Outcome measure	Preventive strategy proposed
Barrimah et al, 2012[16]	Both, 2010	835	Hospitals and PHC in Buraydah, Al-Qassim region	High speed	Type of accident, injury, deaths, health versus police records RTA, non-fatal injury rate	Good surveillance, improvement in quality of data
Khan et al, 2010[22]	Primary, 2005-2006	1513	Armed Forces Hospital Southern Al-Aseer region, KSA	Non use of seat belts	Cause of injuries	Primary prevention of road injuries emphasized
Al-Naami et al, 2010 [20]	Secondary	---	-	Driver errors	Magnitude of RTAs	Establishment of trauma care system
Bendak, 2005[24]	Both, 2001	900	Drivers and FSP in Riyadh	NA	Compliance to seat belt law and types of injuries	Trends in use of seat belts
Elshinnawey et al, 2008[13]	Secondary, 1997-2002	--	Mortality records of MOH and General Statistics Authority, KSA	NA	PYLL	Health education
Ansari et al, 2000[8]	Secondary	--	--	High speed	General and specific causes of RTA economic impact	Use of seat belts, developing RTA database
Qayed, 1998[21]	Secondary, 1994-1995	--	Al-Ahsaa Hospitals and Traffic Department	NA	Injury, deaths, no. of vehicles and accidents and causes	Primary, secondary, and tertiary prevention of road injuries
Batouk et al, 1996[23]	Primary, 1989-1994	303 dead victims	Abha (Al-Aseer region)	NA	Dead on arrival, site of injury, time of accident	Legislation on seat belt and pre-hospital emergency system

PHC - primary health care, FSP - front seat passenger, MOH - Ministry of Health, PYLL - potential productive years life lost, NA - not available

were either based on descriptive design, or narrative review. The outcome measures and the methodology in these studies were diverse, and included the cause of death on arrival (Abha),[23] type of injuries, and a comparison of police records of RTA (Al-Qassim),[16] cause of injury (Al-Aseer),[23] and the compliance to seat belt legislation (Riyadh).[22]

Type of RTI. **Table 2** shows that the most common injuries reported in the primary data from Al Qassim and Abha were of the head and neck during the selected spectrum of years.[16,23] In contrast, data from Riyadh and the Armed Forces Hospital Al Aseer reported a lower number of all types, and particularly, head and neck injuries during 2001-2006.[24] Additionally, according to a 1994 review,[19] the most often injured body regions were the upper and lower extremities, and the head. A study conducted during 1990[25] showed that 14% of the cases of accidental fractures and dislocations were due to RTA. It was reported that 79.2% of patients admitted with spinal injuries between the years 1971 and 1997 had sustained their injuries as a result of a motor vehicle accident.[8] A recent retrospective study in Riyadh[26] also revealed the same trend that 80.1% of traumatic spinal cord injuries resulted from motor vehicle accidents. The cervical cord was the most common site of injury among males, whereas it was upper thoracic spine for females.[25]

Causes of RTA and risk factors. **Table 3** depicts that most of the reviewed studies reported excess speed as the major cause of RTAs, accounting for 43.1% (in 2010),[16] and 29% (in 2006),[22] followed by improper turning in 42%,[16] and violation of regulations in 26.6% of accidents.[22] It was also established by regression analysis in a study that fatal and non-fatal injuries are significantly determined by speeding, particularly at daytime, and head-on collision to affect the magnitude of the accident.[27] In 1996, a study reported that none of the accident victims were wearing seat belts.[20] Non-use of seat belts decreased from 40% in 2000 to 29% in 2006.[22,24] The seat belt use rates are considered low, yet encouraging when compared with its use rates before the enactment of the law.[16]

Tire failure was identified as the cause in 39% of accidents in 1996, and this rate was reduced to 13% in the year 2001.[20,28] It was also concluded that drivers need proper education on how to select, use, and maintain tires.[20,28] During the period from 1991-1997, prolonged exposure to heat, adverse weather conditions, such as precipitation, fog, and dust, in addition to driver errors were identified as the main contributing factors in approximately two-thirds of all RTAs.[29] Hypoglycemia, reported recently in 2010,[30] and alcohol toxicity[31] reported earlier during the period from 1995-1996 were less commonly reported causes of RTA.

Behavior of drivers. It was noted that the dependence on cars for transportation has created a diversity of drivers who are not sufficiently familiar with the local driving rules, and lack the basic skills for safe driving.[28,32] An assessment of the knowledge, attitudes, and practices of male students at the Health Science College in Abha towards road traffic regulations found that more than half of the students had been involved in RTAs; 22%

Table 2 - Types of injuries among traffic crash victims according to studies from Saudi Arabia.

Study	Maxillo-facial/ head and neck	Limb	Trunk	Multiple	Neurologic deficits	Amputation	Deaths among victims
			(%)				
Barrimah et al[16]	(63.1)	(46.0)	(14.1)	-	-	-	-
Bendak[24]	(15.6)	(14.7)	(2.1)	(14.9)	(3.1)	-	-
Batouk et al[23]	(45.0)	(59.0)	(52.0)	-	-	-	Not available

Table 3 - Causes of road traffic accidents as implicated in various years according to studies from Saudi Arabia.

Study	Drivers' faults					Vehicle's condition	Environmental conditions
	Excess speed	Violation of rules	Non use of seat belts	Substance abuse	Improper turning, or stopping	Tire condition	Increased number of vehicles
					(%)		
Central Department of Statistics and Information[16]	43.1	1.7	-	0.0	42.2	12.2	12.2
Al-Naami et al[20]	65.0	50.0	-	-	-		
Kahn et al[22]	29.0	26.6 had no license	29.2	-	-	-	-
Bendak[24]	-	-	40.0	-	-	-	-
Ansari et al[8]	65.0	65.0	-	-	-	20.0	20.0
Batoul et al[23]	70.0	12.0	-	-	1.8		

of these had been injured, and 13% in these RTAs were admitted to a hospital.[33] Knowledge of road traffic regulations were moderate to high in more than 75% of these students, and more than 90% of them believed in the importance of the use of seat belts. More than 75% of the participants mentioned that they had problems with the use of seat belts, the most common of which were forgetfulness, and anxiety.[33] The knowledge and behavior regarding traffic regulations were also assessed in a sample of drivers from Dammam, Al-Khobar, Qateef, and Jubail.[32] The study found that 52% of the sample had been involved in previous RTAs; 75% were seat belt compliant, and 60% used mobile phones while driving. The drivers' knowledge regarding road traffic regulations and risks did not match their behavior.[32]

Complications of RTA. It was reported that 86.9% of the upper limb, and 52.9% of the total lower limb amputations were performed on victims of RTA.[34] It was reported that between 1971 and 1997, 564,762 people died, or were injured in RTAs; out of this population, 11.8% were reported to be dead on the spot.[30] In a study in Abha,[23] it was recorded that RTA was the cause in 53.8% of patients who were dead on arrival (DOA) at the hospital from 1989-1994. Whereas, the fatalities was reported to be reduced in 1999-2010 from 29-16% among pedestrians.[35,36] A disparity of findings between police registration records and hospital data was noted in a study in Al Qassim.[16] The police records confirmed a significant reduction of 27% in road mortalities from 2005-2010, in contrast to hospital data showing 8% non-significant increase in such mortalities.[16]

Discussion. The evidence sufficiently supports that the action plans in KSA so far have mostly focused on the prevention of RTIs rather than RTAs, including seat belt laws, Saher system, emergency medical rescue services, and the role of the police in the documentation of RTAs. While the international recommendations emphasize on developing institutional framework, safer roads and vehicles, proper surveillance or data system, safer road users, and post-crash care.

It was revealed that the distribution of RTAs in terms of place and time varied widely among the reviewed studies, but cumulatively RTAs were common in cities of religious mass gatherings during the peak month of Ramadan.[21,22] This may be related to a lack of patience among drivers due to fasting and increased traffic. However, in other cities, accidents were clustered in December and May,[16,22] probably reflecting anxiety among drivers complying with diverse schedules due to examinations in schools and colleges during those months.

A Korean study[37] reported that the incidence of injuries increased sharply when the temperature decreased below freezing point in winter. Young males were found to be affected more than females in all studies with an increased ratio of 4:1 found in past studies, and relatively low ratio of 2:1 in lately reported ones.[16,19] Gender difference in our country is self-explanatory for prevailing driving laws and local customs. Young age was more affected as the youth in KSA consider car driving as an entertainment for themselves, as other alternatives are barely available, or opted for, such as, amusement parks or gyms, or sport arenas, and others. Accidents in residential areas could be more frequent among youth where they drive illegally for small distances along narrow roads at high speed. This behavior of the youth reflects the absence of formal training in driving, inadequate sport facilities, and lack of control by the parents. In another study,[39] biomarkers of cortisol was studied, and found to be associated with teenaged-driving risk, and necessitated the development of personalized intervention approaches.

We noted that the most common reported site of injuries in recent studies were the head and neck, limbs, and trunk in contrast to previous studies where limb and trunk injuries were more common than the head and neck. Some studies reported injury per individual regions, or parts of body, and others as multiple parts. Complications of road injuries, such as amputations, neurological deficit, and others were noted in hospital audits, and not as part of follow-up for road injuries, therefore, those indirect studies[16,35] and their chance findings will not add much to the understanding of the problems of RTA.[16,35] In many international studies, time-series analysis using an "autoregressive integrated moving average" model has been carried out to predict mortality out of road casualties,[40] and thus, also assessed the implementation of an intervention parameter like demerit point scoring, or road crash victim information system. It was concluded that factors affecting the occurrence of accidents were not necessarily predictors of outcome severity.[41,42] Similarly, the causes of accidents were described in some of the reviewed articles by different methods, such as the opinion of the drivers, the reflected opinion of potential drivers, and evidence of the victims.[16,26,32,33,38] As a result of the enactment of the seat belt law, in accordance with suggestions from these studies, a significant drop in certain types of injuries was observed. Likewise, we identified discrepancies in some vital statistics, such as, mortality rates between sources of data as noticed by other investigators as well.[16,45] In all of these studies, the causes were focused around drivers' fault, road and

vehicle conditions, either alone, or as multitude. The evidence was not found in local studies on data systems, or post-crash care, or implementation of widespread primary preventive strategies, and so forth.

Our review of all aspects of reported RTAs, allows us to propose the neglected areas in prevention of RTAs, such as young drivers' behavior, and lack of focus on post-crash care, including both pre-hospital and hospital care. This surveillance system approach along with a few suggested interventions to modify the behavior of young drivers would prevent both RTAs and resultant injuries. The WHR on prevention of injury has identified separate risk factors for road crash, road injuries, and post-crash care.[43] In Romania, it was proposed in a study that national road safety strategies should be in line with the European Union objectives, with needs to be concentrated around national priorities and objectives.[44] An Italian[45] and a local study[20] emphasized that an effective prevention policy of frequency of accidents, mortality, and disability should be based on drivers' safety education, structural interventions, targeted road controls, and law enforcement. We therefore suggest developing an active surveillance system in the emergency rooms of hospitals across KSA as a measure of post-crash hospital care. This will help in better understanding the factors and processes of road crashes in our region, and relevant programs in the future can be offered to limit the problem at large.

In this context, an advocacy plan for primary prevention of the risks of RTAs should be initiated to modify the behavior of young drivers, particularly, through mass media campaigns. This can be achieved by distributing health messages at points of care, such as shopping malls, and schools. Moreover, efforts can be strengthened by strict reinforcement of laws in residential areas, and also providing alternate options for entertainment by building health fitness, or sport facilities, or amusement parks in the communities. Simultaneously secondary and tertiary prevention should be ensured through a standard surveillance system in all hospitals, recognizable as the hospital component of post-crash care. For pre-hospital care components, communities need to be trained in first response care, to mitigate the delay and complications of RTAs.[43]

The use of reliable Geographical Information Systems (GIS) should also be used as an aid in identifying the problem sites and risk factors for the accidents, and launching relevant interventions in those areas.[46] That is how we hope to address the issue of RTAs, both from its public health, and as well as, social equity aspects.

Limitations. Underreporting and disorganized data are considered to be the major limitations of RTA data. The data quality was found to be inconsistent and the injury severity score was not calculated in any of the included studies. Many of the data sources that reported fatalities due to RTI do not follow the internationally recommended definition of a road traffic fatality, which include a 30-day follow-up period. This resulted in great underrepresentation of the number of deaths resulting from RTI in KSA. Due to the above constraints, meta-analysis could not be performed to estimate the size effects.

In conclusion, the results of this review article clearly highlighted an indiscriminate description and explanations for RTAs in KSA due to the absence of emergency room-based injury surveillance systems. There were inherent gaps in the data presented due to the lack of adequate and uniform information from a variety of sources. A sentinel surveillance of road crashes should be kept in place in the secondary and tertiary care hospitals for all regions of KSA. This will help in developing a standardized data system for identification of the core factors and strategies to cope with the problem. Accordingly, road safety may be improved in the future by an advocacy of relevant primary preventive strategies in the population.

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