

Access this article online

Quick Response Code:



Website:

www.jfcmonline.com

DOI:

10.4103/jfcm.jfcm_323_21

Cost of healthcare rehabilitation services following road traffic injuries: Results from a Level-I trauma center in Saudi Arabia

Suliman Alghnam¹, Meshal M. Alqahtani¹, Hosam A. Alzahrani², Abdulfattah S. Alqahtani³, Ibrahim T. Albabtain^{4,5}, Khalid A. Alsheikh^{4,5}, Mohamed K. Alatwi⁶, Mohamed A. Alkelya⁷

¹Department of Health, Population Health Section, King Abdullah International Medical Research Center, (KAIMRC), King Saud Bin Abdulaziz University for Health Sciences (KSAU HS), ²Department of Physical Therapy, College of Applied Medical Sciences, Taif University, Taif, ³Department of Rehabilitation Sciences, College of Applied Medical Sciences, King Saud University, ⁴Departments of Surgery and Orthopedics, King Abdulaziz Medical City (KAMC), ⁵College of Medicine, King Saud bin Abdulaziz University for Health Sciences, ⁶Department of Physical Medicine and Rehabilitation, King Fahad Medical City (KFMC), ⁷Center for Health Research, Saudi Health Council, Riyadh, Saudi Arabia

Address for correspondence:

Dr. Suliman A. Alghnam,
Department of Health, Population Health Section- King Abdullah International Medical Research Center (KAIMRC), King Saud Bin Abdulaziz University for Health Sciences (KSAU-HS), P.O. Box 22490, Riyadh 11426, Saudi Arabia.
E-mail: ghnams@ngha.med.sa

Received: 26-08-2021

Revised: 27-10-2021

Accepted: 16-11-2021

Published: 19-01-2022

Abstract:

BACKGROUND: Road traffic injuries (RTIs) are the second leading cause of mortality in Saudi Arabia. The high rate of RTIs puts a strain on rehabilitation services. Yet, little is known of the economic burden of nonfatal RTIs and rehabilitation services. This study, therefore, aims to describe the annual rehabilitation costs associated with RTIs at a local trauma center.

MATERIALS AND METHODS: This study was conducted among all the 17 years or older patients hospitalized at King Abdulaziz Medical City in Riyadh following RTIs and required rehabilitation care. We included 299 patients who met the inclusion criteria and were followed for one year after discharge from the index hospital. The data was abstracted through retrospective review of patients' medical records. All rehabilitative services utilized by the healthcare system were recorded. To describe the economic burden, the mean, median, standard deviation, and interquartile range (IQR) were calculated. Total costs were aggregated for all patients to estimate overall costs.

RESULTS: The study population was relatively young (31 years \pm 14.4). The total annual rehabilitation cost of patients was Saudi Riyals (SAR) 6,113,781 (IQR: 20,589.3 – 3,125 = 17,464.3), and the average for each patient was SAR 20,447 (median = 7875). Patients aged 40–59 years and \geq 60 years accounted for the highest average rehabilitation cost of SAR 31,563.99 and 32,639.21, respectively. Rehabilitation visits incurred the highest cost (mean SAR 1,494,124), followed by bed utilization which cost SAR 1,311,972 and radiology examination at SAR 1,032,261. The cost of motorcycle injuries was relatively higher (SAR 44,441.0) than other injury mechanisms.

CONCLUSION: This study underlines the economic burden of rehabilitation services resulting from RTIs. Public health interventions are needed to reduce the burden of RTIs by dealing with their preventable causes and improving road safety measures. These findings may be useful to policymakers and researchers to support and improve rehabilitation services in Saudi Arabia.

Keywords:

Injury, motor vehicle, motorcycle, pedestrian, rehabilitation cost

Introduction

Road traffic injuries (RTIs) are one of the leading causes of injury and mortality globally.^[1] This threat to global health accounts for more than 1.3 million deaths

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: WKHLRPMedknow_reprints@wolterskluwer.com

annually and up to 50 million injuries. The burden represents more than five times the death caused by the 2004 Indian Ocean tsunami, one of the deadliest natural disasters ever known.^[2] Moreover, RTIs are a significant cause of disability, the ninth leading cause for adjusted life years.^[3] The

How to cite this article: Alghnam S, Alqahtani MM, Alzahrani HA, Alqahtani AS, Albabtain IT, Alsheikh KA, *et al.* Cost of healthcare rehabilitation services following road traffic injuries: Results from a Level-I trauma center in Saudi Arabia. *J Fam Community Med* 2022;29:1-7.

burden of RTIs is even more significant in the Eastern Mediterranean Region, of which Saudi Arabia is a part.^[4] As alarming as these road traffic injury (RTI) rates are in the region, experts project that the prevalence of RTI would rise to the second highest cause of disability in the developing world and worldwide.^[5]

In Saudi Arabia, RTIs are the second leading cause of mortality, representing 12% of overall deaths.^[6] In 2016, the country was rated one of the countries with the highest RTIs death rates globally, with an estimated 28 deaths/100,000 population. Fatality rates in developed countries such as the United States (US), United Kingdom (UK), and Australia are lower than 2%, while it is 4.7% in Saudi Arabia.^[3,7] Late in 2016, Saudi Arabia initiated Vision 2030, an ambitious initiative which introduced significant changes in governmental and health sectors.^[8] One of the priorities of the Saudi Vision 2030 was to reduce RTIs to improve population health. Therefore, initiatives adopted to achieve that goal included the implementation of strict traffic safety interventions such as the use of monitoring cameras to (1) reduce over-speeding, (2) reduce the use of mobile phones while driving, and (3) improve compliance with the use of seatbelts. As a result, the latest estimates put the traffic-related mortality rate at 13/100,000, more than half of what it used to be 4 years previously.^[9]

Similar to what had been observed in developed countries, a reduction in trauma mortality may lead to an increased burden of nonfatal injuries.^[10] This is because severely injured patients, who survive death, may sustain temporary or permanent disabilities. Consequently, they may require intensive follow-ups to regain prior levels of health or cope with existing disabilities. This burden is exacerbated if the treated individuals are young, as in the case of Saudi Arabia. In fact, 40% of all reported disabilities resulting from RTIs in 2016 were of those aged between 10 and 24 years.^[11] Therefore, this high prevalence of RTIs in the young population can significantly impact population health and prosperity.^[12]

The high rate of RTIs in Saudi Arabia is likely to be associated with high demand for rehabilitation services. More than 1.5 million individuals seek medical care after injuries every year.^[13] Furthermore, Al-Zamanan *et al.*, reported that RTIs are the primary cause of disability in young adults.^[14] Permanent disabilities over the past two decades are estimated at around 7% of overall injuries resulting from RTIs in Saudi Arabia.^[15] As a result, patients who have disabilities as a result of injuries sustained in severe RTIs create considerable demand for health and rehabilitation services.^[16] Victims are likely to need rehabilitation services that are not limited to physical therapy and occupational therapy^[17] but which

also involve professionals from multiple disciplines, including orthopedics, neurosurgery, general surgery, prosthetics/orthotics, psychology, and speech therapy.^[18]

RTIs have adverse health and economic consequences. These explored extensively in developed countries, have helped to further plans for primary and secondary prevention.^[19,20] However, the actual economic cost is difficult to estimate because it involves various components such as property damage, medical treatment, rehabilitation services, and the loss of productivity owing to disability or absenteeism.^[21] Little is known about specific components of the overall economic burden. One recent study estimated the annual cost of RTIs of hospitalized patients as 77,657 Saudi Riyals (SAR) on average. However, the study focused only on the initial medical encounter without rehabilitation costs after the initial hospitalization.^[22]

Estimates from other countries of annual rehabilitation costs of RTI patients can inform efforts to reduce their economic burden. An extensive report published by the US National Highway Traffic Safety Administration estimated that in the year 2000, around \$128 million (480 million SAR) was spent on inpatient rehabilitation for RTIs.^[23] Although the economic costs attributed to RTIs put the total costs between four to eight billion SAR, an estimated cost of rehabilitation services for RTI patients in Saudi Arabia has not yet been made.^[24] Understanding the cost of rehabilitation services will facilitate quantifying the burden of nonfatal RTIs, which will then inform public health initiatives and traffic safety interventions under Vision 2030.^[25] Therefore, this study's aim was to estimate the annual rehabilitation services costs associated with RTIs in Saudi Arabia.

Materials and Methods

This was a retrospective chart review study conducted at King Abdulaziz Medical City (KAMC) in Riyadh, Saudi Arabia. KAMC has a capacity of over 1501 beds and another 132 beds in the emergency department. The hospital is one of the country's most advanced and specialized trauma centers, which serves mainly the eastern part of Riyadh's metropolitan area. KAMC's capacity and standards make it comparable to a Level-I trauma center in the US.^[26]

The study utilized the hospital's trauma registry to identify the study population. This registry records traumatic injuries admitted to the hospital for at least 24 h and those who died before reaching the hospital. The study included patients aged 17 years and older who were admitted following RTIs requiring any rehabilitation care. We defined rehabilitation services as those related to any medical care that aims to regain health status

prior to the injury (secondary prevention). These services include, but not limited to, physiatrist consultation, acute inpatient and outpatient physiotherapy and occupational therapy. Patients who had RTIs between 2017 and 2018 were included. Upon reviewing the registry data, 299 patients met the inclusion criteria and were covered in the analysis. We retrospectively followed each patient from discharge from the index hospitalization for 1 year, documenting subsequent healthcare utilization of rehabilitative services.

Trained research coordinators recorded data regarding demographics, injury details, length of stay, medical investigations and interventions (laboratory tests, radiology exams, medications, healthcare providers' visits, physiotherapy, occupational therapy, physiatrist consultation, prosthetics and orthotics, restorative surgeries for rehabilitation), and health outcomes for all those who met the inclusion criteria. In addition, the recorded data included measures for injury severity such as Glasgow Coma Scale (GCS) and Injury Severity Scale (ISS). GCS is a measurement standard of the level of consciousness of injured patients.^[27] ISS is an anatomical measurement of the severity of the injury characterizing the trauma patients with multiple injuries.^[28]

Pricing for healthcare expenditure was obtained from three sources. First, the cost of radiology examinations, laboratory tests, healthcare providers' visits, rehabilitation services, and restorative surgeries for rehabilitation were obtained from the pricing list of the KAMC hospital's business center. Second, the cost of medications was calculated from the Saudi Food and Drug Authority. Third, the cost of prosthetics and orthotics was taken from three local rehabilitation hospitals in Saudi Arabia.

The primary outcome variable was total direct rehabilitation services' cost following RTIs for 1 year. The total cost was computed as the aggregate of multicategories of charge, including healthcare providers' visits, medical exams, rehabilitation visits, rehabilitation-related surgical procedures, medications, and any admissions and follow-up visits related to the injury after the first admission. The study focused on the mechanism of injury (motor vehicle, motorcycle, and pedestrian injuries) as the baseline for financial burden in the medical sector.

STATA® version 15 for mac (STATA Cooperation, TX) was used in all analyses. For quantitative variables such as total cost, age in years, gender, body mass index (BMI) categorized as obese or nonobese, GCS, and ISS, the mean, median, standard deviation, and interquartile range (IQR) were calculated and presented. Total costs were estimated for various groups such as age groups,

severity measure, or cause of injury (occupants or driver, motorcycle, or a pedestrian). Total costs in SAR were aggregated for all patients to estimate overall institutional costs.

All patients' data were gathered according to ethical guidelines and confidentiality of patients' identifiers was maintained throughout the study. Ethical approval was obtained from the Institutional Review Board vide Letter No. RC20/526/R dated 01/10/2020 with a waiver of informed written consent since this was a retrospective chart review study.

Results

Table 1 presents the descriptive characteristics of the study population by mechanism of injury. One hundred ninety-two patients were injured as occupants or drivers, 79 were involved in motorcycle injuries, and 28 sustained pedestrian injuries. The study population was relatively young (30.9 years \pm 14.5), and the motor vehicle occupants were the youngest age group (29.7 years \pm 13.2). BMI was within the overweight category (18.5–24.9). Pedestrian victims were more overweight (28.6 on average). GCS was similar to all mechanisms of injury. However, the median of ISS was higher in those who sustained injuries as pedestrians (10.5) than in other situations.

Table 2 shows the cost of different rehabilitation services. The mean cost of the annual rehabilitation

Table 1: Distribution of the patients with road traffic injuries (RTIs) according to the mechanism of injury (n=299)

Variable	Mean	Median	SD
All injury mechanisms (n=299)			
Age	30.9	26	14.5
BMI	25.6	25	7.6
GCS	13.0	15	3.8
ISS	12.6	9	10.4
Motorcycle injury (n=79)			
Age	31.4	26	15.6
BMI	25.3	24.4	6.2
GCS	13.2	15	3.6
ISS	11.7	8	9.2
Pedestrian injury (n=28)			
Age	37.3	31	18.1
BMI	28.6	27.0	8.4
GCS	12.3	15	5.1
ISS	12.9	10.5	10.5
Motor vehicle injury (n=192)			
Age	29.7	25	13.2
BMI	25.3	24.9	7.1
GCS	13.1	15	3.7
ISS	12.9	9	10.9

BMI=Body mass index, GCS=Glasgow Coma Scale, ISS=Injury Severity Scale, SD=Standard deviation

Table 2: Annual cost for rehabilitation of patients with road traffic injuries (RTIs) (n=299)

Variable	Total	N	Mean±SD	Median	25 th percentile–75 th percentile	IQR
Laboratory cost	942,739.4	140	6733.9±11,706.1	2654	1162–5962.2	4800.3
Radiology cost	1,032,261	213	4846.3±15,892.9	1586.25	520–4871.6	4351.6
Health-care provider cost	916,507	267	3432.6±6702.1	1350	600–3300	2700
Rehabilitation visits	1,494,124	272	5493.1±10,236.1	2235	1110–5260	4150
Prosthetics/orthotics cost	280,192.9	56	5003.5±7489.9	1426.5	436.3–7750	7313.8
Medication cost	135,863.2	171	794.5±4028.3	660	26.8–271.5	244.7
Bed utilization cost	1,311,972	96	13,666.4±27,172.5	5779.5	1922.5–11,382.5	9460.0
Overall cost	6,113,781	299	20,447.4±37,834.8	7875.2	3125–20,589.3	17,464.3

IQR=Interquartile range SD=Standard deviation

services for each patient was SAR 20,447 (\pm 37,834.7). The total cost of patients was SAR 6,113,781 (IQR: 20,589.3 – 3,125 = 17,464.3). Rehabilitation visits constituted the highest cost (mean SAR 1,494,124) followed by bed utilization (SAR 1,311,972) and radiology exams (SAR 1,032,261). Compared to other categories, laboratory cost and bed utilization accounted for the highest median cost (SAR 2654 and SAR 5,779.5, respectively).

Table 3 represents the average cost of annual rehabilitation services by age group, GCS, and ISS in different mechanisms of injury. Most injured patients aged between 20 and 39 years ($n = 223$), and those aged 40–59 years and ≥ 60 years accounted for the highest average annual rehabilitation services cost SAR (31,564 and 32,639, respectively). In GCS, those who had severe GCS had the highest average rehabilitation services cost of SAR 37,039. Of the severely injured patients, motorcycle injuries were associated with higher rehabilitation services costs (SAR 44,441 and 35,239 for those aged 16–25 years and >25 years categories) than other mechanisms of injury.

Discussion

The aim of this study was to estimate the annual rehabilitation services costs associated with RTIs in Saudi Arabia. We found that RTIs placed a significant economic burden on the provision of healthcare. Of particular interest was that patients aged 40 years or older, with severe GCS, and/or with ISS >25 accounted for the highest average annual rehabilitation services costs.

This study demonstrated that the total cost of the annual rehabilitation services for the study sample was SAR 6,113,781 (\$ 1.6 million). The high cost of rehabilitation services of RTIs patients revealed in this study is consistent with the existing literature. For example, a previous report published by the US Department of Transportation, National Highway Traffic Safety Administration, demonstrated that \$127.46 (477.98 million SAR) million was spent on inpatient

rehabilitation of RTIs patients in 2000.^[23] Another study conducted in Italy found that the annual rehabilitation service costs for nonfatal RTIs are as high as \$18 million (67.5 million SAR).^[29]

The results provided by this study are of great value as the cost of rehabilitation services of RTI patients in this report can inform the efforts to reduce the burden of RTIs.^[15] According to the Ministry of Health's national survey, 3% of Saudis sustained an RTI in a single year.^[30] This represents over 400 thousand individuals in a single year. Of those, it is likely that at least 20% of this number would have required rehabilitation. As a result, the aggregated expenditure may reach 1.6 billion SAR in annual rehabilitation services. Our estimate was only based on following patients for a single year. Therefore, it is likely that the total economic burden would be staggering as many of these patients will require further treatment beyond the 1st year.

According to the Global Burden Disease report in 2017, transportation injuries have been found to be one of the top leading causes of disability in Saudi Arabia.^[26] Consequently, many patients are likely to require long-term rehabilitation services after discharge from hospital. Therefore, effective strategies, including population education, law enforcement, and provision of optimal hospital and rehabilitation services, are necessary for the management of the burden of disability and its associated consequences. In addition, ways to reduce the length of hospital stay after RTIs and lower the care cost by referring patients to outpatient rehabilitation clinics should be explored to bring down the cost of rehabilitation services.

Our results showed that most of the injured were aged 20–39 years. This concurs with the existing literature, showing that young individuals were more likely to be involved in RTIs.^[31] However, patients aged 40–59 years and ≥ 60 years accounted for the highest average annual rehabilitation services cost of SAR 31,564 and SAR 32,639.2, respectively. This might be explained by the age-related issues (e.g., chronic diseases) which tend to worsen RTIs, and thus delay the recovery time, increase

Table 3: Total rehabilitation cost for patients with road traffic injuries (RTIs) by mechanism of injury, age, and severity of injury (n=299)

Variable	N	Total cost (SAR)		
		Mean	Median	SD
All injury				
Age group, mean (30.85)				
<20	27	13,783.6	7638.7	16,983.3
20-39	223	18,939.7	6878.6	38,535.7
40-59	22	31,564	11,878.3	46,452.3
≥61	22	32,639.2	16,886.6	40,269.7
Gender				
Male	264	20,071.1	7859.6	38,869.6
Female	35	23,286.3	9096.1	29,158.1
BMI categories				
Obese	65	22,478.2	9325.1	36,250.2
Nonobese	234	19,883.3	7582.9	38,319.6
GCS				
Mild	235	16,756.1	6692.9	27,899
Moderate	15	24,075.5	4247.6	48,140.3
Severe	49	37,039.9	13,002	63,755.4
Injury severity score				
0-15	201	15,646.4	6278.8	31,555.9
16-25	64	29,581.9	12,738.1	50,034.9
>25	34	31,635.8	12,763.5	41,000.6
Motor vehicle injury				
Age group, mean (29.68)				
<20	19	15,479.3	10,604	18,297.3
20-39	145	18,293.1	7788.4	35,856.5
40-59	14	34,686.2	9666.7	54,548.3
≥61	11	37,282.9	22,776.4	37,690.6
Gender				
Male	168	19,526.5	7952.6	37,101.4
Female	24	27,105.2	18,803.46	31,014.9
BMI categories				
Obese	41	27,532.1	10,044.4	43,274.9
Nonobese	151	18,557.4	7788.4	34,225.0
Glasgow coma score				
Mild	150	18,075	8189.9	30,389.3
Moderate	11	22,508.0	4120	55,762
Severe	31	31,359.5	10,550	51,617
Injury severity score				
0-15	133	17,826.1	6878.6	37,219.8
16-25	37	23,586.7	8763.2	31,527
>25	22	31,245.8	19,257.5	38,248.2
Motorcycle injury				
Age group, mean (31.41)				
<20	6	12,748.5	7786.1	14,654.1
20-39	61	21,924.6	6180	47,602.1
59-40	5	22,891.5	12,120	29,241.6
≥61	6	35,592.1	12,252.5	58,452.9
Gender				
Male	71	22,539.8	7843.1	46,906.6
Female	8	18,677.5	5288.2	27,352.3
BMI categories				
Obese	16	12,614.4	7165	12,712
Nonobese	63	24,570.2	7638.7	50,018.1

Contd...

Table 3: Contd...

Variable	N	Total cost (SAR)		
		Mean	Median	SD
GCS				
Mild	63	16,803.7	6048.4	25,564.8
Moderate	3	28,730.3	33,362.8	24,980.6
Severe	13	46,532.7	20,568.8	94,838.5
Injury severity score				
0-15	51	11,353.2	5571.2	13,476.2
16-25	20	44,441.0	18,684.8	77,279.5
>25	8	35,239.1	9682.3	52,855.5
Pedestrian injury				
Age group, mean (37.25)				
<20	2	778.85	778.85	29.91
20-39	17	13,744.4	5209.5	21,665.3
59-40	3	31,447.1	18,635.1	36,740.1
≥61	5	18,879.6	10,508.8	19,550.6
Gender				
Male	25	16,718.9	6356.4	22,998.6
Female	3	5025.1	3194.3	3529.2
BMI categories				
Obese	8	16,304.9	8,678.1	23,479.8
Nonobese	20	15,130.6	5158.2	22,027.2
Glasgow coma score				
Mild	22	7627.8	4429.7	9555.5
Moderate	1	27,353.9	27,353.9	-
Severe	5	47,576.8	49,200	33,614.7
Injury severity score				
0-15	17	11,473.1	5209.5	18,277.3
16-25	7	18,816.1	9615	17,842.5
>25	4	26,573.9	7807.8	40,773.6

SAR=Saudi Riyals, SD=Standard deviation, BMI=Body mass index, GCS=Glasgow Coma Scale

hospital stays, and consequently swell the healthcare costs.^[32] Furthermore, existing studies have demonstrated that older adults become physically inactive during hospitalization, a situation associated with a significant decrease in functional ability.^[33,34] Therefore, structured strategies for incorporating interventions of physical activity into the rehabilitation programs are essential to help improve patients' overall health status and reduce overall healthcare costs.^[35]

Patients who had severe GCS incurred the highest average rehabilitation services costs. Other studies have reported similar findings showing that healthcare costs, including rehabilitation services for those with GCS 13–15 (mild brain injury), were less than those who had GCS 3–8 (severe brain injury).^[36,37] This is understandable because patients with severe injuries usually need to stay longer in rehabilitation units with higher levels of care.

In terms of ISS, rehabilitation services following motorcycle injury cost more (SAR 44,441.0 and 35,239.1 for those who scored 16–25 and >25, respectively, on the scale) compared to other mechanisms of injury (i.e., pedestrian and motor vehicle injuries). A previous

study utilized a major trauma registry in Riyadh, Saudi Arabia, and found that 2.1% of injuries were related to motorcycle accidents.^[38] The severity of injury resulting from motorcycle accidents might be higher than other mechanisms of injury because of lower protection afforded by motorcycles,^[39] and the most injured sites of the body from motorcycle accidents in Saudi Arabia were the extremities followed by the head.^[40] Thus, implementing protective strategies for motorcyclists such as rider training, speed limit, use of headlights, wearing of helmets and special clothing, and taking pre-specified roads are required to reduce RTIs of motorcycle riders or drivers.

There were several limitations in our study. First, this study focused on direct medical costs for rehabilitation services following nonfatal RTIs for 1 year only. As a result, the actual economic cost of rehabilitation services may have been underestimated, since rehabilitation services go beyond mere physiotherapy, occupational therapy, or prosthetic and orthotic provision. Second, our study did not assess the long-term rehabilitation services costs beyond 1 year for patients with RTIs. A previous review concluded that injured persons had an increased use of long-term health services compared with the general population.^[41] Therefore, it is recommended that future studies provide a comprehensive overview of the overall rehabilitation services costs over a long period. Third, the findings of this study were based on data collected from a single hospital in Riyadh; therefore, the generalizability of these results is unknown. Fourth, since the data were collected retrospectively from the hospital's registry, the burden might have been underestimated since patients who dropped out for nonadherence or were referred to other institutions to get the rehabilitation services may have been left out. Therefore, the results should be interpreted with caution. Fifth, this study did not collect data on a specific breakdown of the costs of rehabilitation services for each injured region. However, existing literature shows that the rate of healthcare use by patients with spinal cord injury was twice that of those without injury.^[41] Sixth, the cost includes only direct costs and estimates were based on the hospital's business center's pricing list and public hospital system and may not reflect private sector costs. Despite the limitations mentioned above, to our knowledge, this is the first study to estimate the overall rehabilitation services costs of patients with nonfatal RTIs in Saudi Arabia.

Conclusion

This study found the cost of rehabilitation services associated with nonfatal RTIs high. The findings may be useful for policymakers and researchers to reduce the burden of rehabilitation services for RTIs in Saudi Arabia.

Public health interventions are needed to reduce the burden of RTIs in terms of prevention and improvement of road safety. It will also be useful for policymakers to support rehabilitation services and improve access to care and insurance coverage for RTI patients in the future planning of the national health insurance scheme.

Acknowledgment

The authors would like to acknowledge Taif University, Taif, Saudi Arabia for supporting this project and Dr. Ahmad Qureshi for his input on the manuscript.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. World Health Organization. Global status report on road safety 2018. *Int J Mach Tools Manuf* 2018;5:86-96. Available from: <https://www.who.int/publications/i/item/9789241565684>. [Last accessed on 2021 Aug 14].
2. Chen S, Kuhn M, Prettner K, Bloom DE. The global macroeconomic burden of road injuries: Estimates and projections for 166 countries. *Lancet Planet Health* 2019;3:e390-8.
3. Mansuri FA, Al-Zalabani AH, Zalat MM, Qabshawi RI. Road safety and road traffic accidents in Saudi Arabia. A systematic review of existing evidence. *Saudi Med J* 2015;36:418-24.
4. Bazargan-Hejazi S, Ahmadi A, Shirazi A, Ainy E, Djalalinia S, Fereshtehnejad SM, *et al.* The burden of road traffic injuries in Iran and 15 surrounding countries: 1990-2016. *Arch Iran Med* 2018;21:556-65.
5. Reich MR, Nantulya VM. The neglected epidemic: Road traffic injuries in developing countries. *Br Med J* 2002;324:1139.
6. Ministry of Health of Saudi Arabia. Ministry of Health Statistical Yearbook. 2017. Available from: <https://www.moh.gov.sa/en/Ministry/Statistics/book/Documents/ANNUAL-STATISTICAL-BOOK-1438H.pdf>. [Last accessed on 2021 Aug 11].
7. Orf AA, Waheed KB, Baig AA, Mohammad KS, El Sirafy MN, Amin MS, *et al.* Patterns of injury detected by pan-computed tomography after road traffic accidents: Retrospective review from a trauma center in Saudi Arabia. *Ann Saudi Med* 2018;38:245-50.
8. Saudi Vision 2030 Report; 2016. Available from: https://www.vision2030.gov.sa/media/rc0b5oy1/saudi_vision203.pdf. [Last accessed on 2021 Aug 13].
9. Vision 2030 Achievements from 2016 to 2020; 2020. Available from: <https://www.vision2030.gov.sa/media/c1oaba3c/vision-2030-achievements-2016-to-2020.pdf>. [Last accessed on 2021 Aug 13].
10. Henry JA, Reingold AL. Prehospital trauma systems reduce mortality in developing countries: A systematic review and meta-analysis. *J Trauma Acute Care Surg* 2012;73:261-8.
11. General authority for statistics. [homepage on the Internet] *Demogr Surv* 2016; Available from: https://www.stats.gov.sa/sites/default/files/ar-demographic-research-2016_5.pdf. [Last accessed on 2021 Jul 27].
12. CDSI. Central Department of Statistics and Information, Saudi Arabia; 2016. Available from: <http://www.stats.gov.sa/english/index.php>. [Last accessed on 2021 Jul 27].
13. Ministry of Health, Statistical Book; 2015. Available from: <https://>

- www.moh.gov.sa/en/Ministry/Statistics/book/Documents/StatisticalBook-1436.pdf. [Last accessed on 2021 Jul 27].
14. Al-Zamanan MY, Al-Yami AS, Al-Najrani AA, Al-Asmari MY, Manaa AA, Al-Qahtani AM, *et al.* Injury pattern among road traffic accidents' victims in Najran City, Saudi Arabia. *Int J Clin Med* 2018;09:270-80.
 15. National Traffic Plan Aims to Cut Accident Rates – Saudi Gazette; 2013. Available from: <https://saudigazette.com.sa/article/59091>. [Last accessed on 2021 Aug 13].
 16. Syamala Buragadda EA. Rehabilitation services in Saudi Arabia: An overview of its current structure and future challenges. *J Gen Pract* 2014;02:2-5.
 17. Makic KA, Mary B. Trauma Nursing, 5th Edition From Resuscitation Through Rehabilitation; 2019. Available from: <https://pdfweek.com/downloads/trauma.nursing.from.resuscitation.through.rehabilitation.pdf>. [Last accessed on 2021 Aug 13].
 18. Mohan D, Tiwari G, Khayesi M, Nafukho FM. Road Traffic Injury Prevention Training Manual. WHO; 2006. p. 1-126. Available from: https://apps.who.int/iris/bitstream/handle/10665/43271/9241546751_eng.pdf. [Last accessed on 2021 Jul 27].
 19. López Bastida J, Serrano Aguilar P, Duque González B. The economic costs of traffic accidents in Spain. *J Trauma Inj Infect Crit Care* 2004;56:883-8.
 20. Riewpaiboon A, Piyauthakit P, Chaikledkaew U. Economic burden of road traffic injuries: A micro-costing approach. *Southeast Asian J Trop Med Public Health* 2008;39:1139-49.
 21. Al-Naami MY, Arafah MA, Al-Ibrahim FS. Trauma care systems in Saudi Arabia: An agenda for action. *Ann Saudi Med* 2010;30:50-8.
 22. Alghnam S, Alkelya M, Aldahnim M, Algerian N. Healthcare costs of road injuries in Saudi Arabia: A quantile regression analysis. *Accid Anal Prev* 2021;159:106266.
 23. McKay MP. National Highway Traffic Safety Administration notes. Rehabilitation costs and long-term consequences of motor vehicle injuries. *Ann Emerg Med.* 2007;49:817-8. doi: 10.1016/j.annemergmed.2007.03.030. PMID: 17536247.
 24. DeNicola E, Aburizaize OS, Siddique A, Khwaja H, Carpenter DO. Road traffic injury as a major public health issue in the Kingdom of Saudi Arabia: A review. *Front Public Health* 2016;4:215.
 25. Alharbi MF. An analysis of the Saudi health-care system's readiness to change in the context of the Saudi National Health-care Plan in Vision 2030. *Int J Health Sci* 2018;12:83-7.
 26. Alghnam S, AlSayyari A, Albabtain I, Aldebasei B, Alkelya M. Long-term disabilities after traumatic head injury (THI): A retrospective analysis from a large level-I trauma center in Saudi Arabia. *Inj Epidemiol* 2017;4:29.
 27. Matis G, Birbilis T. The Glasgow Coma Scale – A brief review. Past, present, future. *Acta Neurol Belg* 2008;108:75-89.
 28. Reynolds P, Scattoloni J, Ehrlich P, Cladis F, Davis P. Anesthesia for the pediatric trauma patient injuries. In: *Smith's Anesthesia for Infants and Children*. 8th ed. United Kingdom (Amsterdam): Elsevier; 2011. Available from: <https://doi.org/10.1016/B978-0-323-06612-9.00030-4>. [Last accessed on 2021 Oct 17].
 29. Chini F, Farchi S, Camilloni L, Giarrizzo ML, Giorgi Rossi P. Health care costs and functional outcomes of road traffic injuries in the Lazio region of Italy. *Int J Inj Contr Saf Promot* 2016;23:145-54.
 30. Alrabiah T. World Health Survey of Saudi Arabia. Riyadh, Saudi Arabia; 2019. Available from: <https://www.moh.gov.sa/en/Ministry/Statistics/Population-Health-Indicators/Documents/World-Health-Survey-Saudi-Arabia.pdf>. [Last accessed on 2021 Jul 27].
 31. Marchetti P, Morandi A, Lombardo C, Berzolari FG, Brunco V, Marinoni A, *et al.* Human risk factors and injuries due to road accidents: Analysis of current data. *Epidemiol Prev* 2009;33:154-60.
 32. Yadollahi M, Pazhuheian F, Jamali K, Hadi Niakan M. Hospitalization due to traffic accidents among the elderly, Shiraz, 2018; mortality, severity, and injury pattern. *Arch Trauma Res* 2020;9:106-10.
 33. Meesters J, Conijn D, Vermeulen HM, Vlieland TP. Physical activity during hospitalization: Activities and preferences of adults versus older adults. *Physiother Theory Pract* 2019;35:975-85.
 34. Ehrenberg A, Ehnfors M, Ekman I. Older patients with chronic heart failure within Swedish community health care: A record review of nursing assessments and interventions. *J Clin Nurs* 2004;13:90-6.
 35. Marashi A, Ghassem Pour S, Li V, Rissel C, Girosi F. The association between physical activity and hospital payments for acute admissions in the Australian population aged 45 and over. *PLoS One* 2019;14:e0218394.
 36. Raj R, Bendel S, Reinikainen M, Hoppu S, Luoto T, Ala-Kokko T, *et al.* Temporal trends in healthcare costs and outcome following ICU admission after traumatic brain injury. *Crit Care Med* 2018;46:e302-9.
 37. Mikkonen ED, Skrifvars MB, Reinikainen M, Bendel S, Laitio R, Hoppu S, *et al.* One-year costs of intensive care in pediatric patients with traumatic brain injury. *J Neurosurg Pediatr* 2020;27:79-86.
 38. Alghnam S, Alkelya M, Al-Bedah K, Al-Enazi S. Burden of traumatic injuries in Saudi Arabia: Lessons from a major trauma registry in Riyadh, Saudi Arabia. *Ann Saudi Med* 2014;34:291-6.
 39. Robertson A, Branfoot T, Barlow IF, Giannoudis PV. Spinal injury patterns resulting from car and motorcycle accidents. *Spine (Phila Pa 1976)* 2002;27:2825-30.
 40. Alghnam S, Alsulaim HA, BinMuneif YA, Al-Zamil A, Alahmari A, Alshafi A, *et al.* Injuries following motorcycle crashes at a level-1 trauma center in Riyadh. *Ann Saudi Med* 2019;39:185-91.
 41. Cameron CM, Kliewer EV, Purdie DM, McClure RJ. Long term health outcomes after injury in working age adults: A systematic review. *J Epidemiol Community Health* 2006;60:341-4.