Incidence and Costs of Transport-Related Injury in Western Australia

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Abstract

The aim of this study was to describe the burden of transport-related injury in Western Australia in 2012 and to analyse factors associated with the cost of transport-related injury. Data on transport-related injury was obtained from linked administrative health and personal motor injury claims data. Costs allocated to injury events included health sector costs, longer term care costs, loss of productivity and quality of life loss. The number of transport-related injury events in 2012 was 12,997, with total costs estimated at $1.3bn. Incidence and costs varied across multiple dimensions, with multivariate analysis showing age group and severity level as significant factors associated with the cost of a transport-related injury after adjustment for covariates. The major share of total costs of transport-related injury events was accounted for by loss of quality of life. Translating research into policy, the study provides a useful evidence base for policymakers in planning prevention strategies to reduce the burden of transport-related injury in WA.

Background

Transport-related injury is a leading cause of injury, internationally and in Australia. The Global Burden of Disease 2013 study showed transport-related injury accounting for 31.9% of the global burden of injury, with the increase of 11.3% in disability adjusted life years (DALYs) attributable to transport-related injury between 1990 and 2013 contrasting with the decrease across all injury of 8.4% (Haagsma et al., 2016). In Australia, transport-related injury has fallen, with the age-standardised burden rate measured in DALYs decreasing from an estimated 5.0 per 1000 people in 2005 to 4.0 per 1000 people in 2015 (Global Burden of Disease Study 2015, 2016). However, transport-related injury remains a serious public health problem, accounting for 23% of the total burden of all injury in both Australia and Western Australia (Australian Institute of Health and Welfare, 2016; Department of Health, 2017).

While data on the incidence of transport-related injury is reported at national and state levels by relevant agencies, limited information is available on the cost of these injuries. The Department of Infrastructure and Regional Development has estimated the annual cost of road crashes in Australia as $27 billion per annum (Department of Infrastructure and Regional Development), but no details were provided on the breakdown of these costs. In Western Australia, the Road Safety Commission in earlier reports on road crashes provided estimates of the cost of road crashes by crash severity and metropolitan or non-metropolitan region (Road Safety Commission, 2014a, 2014b) but more recent reports have presented estimates only of unit costs per fatal crash (Road Safety Commission, 2016, 2017).

The aim of this study was to describe the burden of transport-related injury in Western Australia in 2012, including incidence and costs stratified across multiple dimensions, and to analyse factors associated with the cost of transport-related injury. Quantifying costs associated with the different mechanisms of injury is important in providing a measure of the size of the problem in a common metric, thus enabling priorities for prevention to be set and the value of safety investments to be identified (Hendrie & Miller, 2004).

Method

Linked injury data were obtained from the WA Hospital Morbidity Data Collection, Emergency Department Data Collection, Death Registrations and Insurance Commission of WA's motor vehicle personal injury claims data via the Data Linkage Branch (DLB) at the Department of Health WA. Transport-related injuries in the hospital and death data were identified using International Classification of Diseases, 10th Edition-Australian Modification diagnosis codes, where an external cause code represented a transport-related injury (codes V00-V99). Emergency department records with external cause of injury classified as 'Pedestrian' or 'Transport Event' were also included. The four datasets were linked by the DLB to allow a single injury event to be created in place of discrete health events likely to be for the same injury. These single injury events were defined as a collection of episodes of care, with an episode of care defined as a collection of temporally contiguous emergency, hospital and mortality records (Hendrie, Miller, Randall, Brameld, & Moorin, 2016). Transport-related injury events were selected for all people who were injured in 2012.

Costs were calculated using a comprehensive cost method (willingness-to-pay costs), which includes health sector costs, costs relating to longer term care needs, loss of paid productivity and quality of life loss. Excluded were costs relating to property damage, workplace disruption, fire services, and criminal justice that result from injury incidents but are not injury costs. Costs were calculated using an incidence-based approach computed by assessing the lifetime costs of all injury events in a given year.

Costs were allocated to injury events based on actual costs, direct mapping of unit costs and cost modelling using regression analysis (Hendrie et al., 2016). Hospital costs were mapped to injury events based on the Australian Refined Diagnosis Related Groups code on each record (Commonwealth Department of Health and Ageing, 2011), with emergency department presentations assigned the average cost per presentation based on the National Hospital Cost Data Collection (Commonwealth Department of Health and Ageing, 2011). Other health care costs were based directly on payments to motor vehicle personal injury claimants where insurance records linked with an injury event in the hospital morbidity data or emergency department data or were assigned based on regression models developed from the injury claims data for similar types of injury.

Loss of paid productivity was calculated differently depending on the severity of the injury event. For loss of paid productivity where the injury event resulted in death, the present value of loss of earnings was calculated by single ages and sex based on average weekly earnings, life expectancy and the productivity growth rate (Australian Bureau of Statistics, 2015a, 2015c; Productivity Commission, 2015). Where the injury event did not result in death, loss of paid productivity for each injury event was derived from actual or modelled costs from the injury claims data.

Quality of life loss was also calculated based on injury severity. For injury events resulting in treatment at an emergency department only, quality of life loss for each injury event was derived from actual or modelled costs from the injury claims data using loss of amenities as a proxy for quality of life loss. Where the injury event resulted in a hospitalisation not resulting in death, quality of life loss was modelled from the Global Burden of Disease study 2013 based on disability weights for injury in the short term and long term and the probability of long term outcomes, with health loss measured in DALYs (Australian Bureau of Statistics, 2015c; Bhalla & Harrison, 2015). Health loss measured in DALYs was monetised based on the value of a statistical life of $4.2 million as recommended by the Office of Best Practice Regulation, adjusted to exclude the after-tax value of loss of paid productivity, adjusted for the present value of length of time over which quality of life was lost (Australian Bureau of Statistics, 2015b, 2015c; Office of Best Practice Regulation, 2014).

Quality of life loss for fatalities was valued using the Office of Best Practice Regulation's value of statistical life, computed net of the after-tax value of loss of paid productivity.

All costs were expressed in 2014 Australian dollars. Unit costs in earlier years were inflated to 2014 values by applying appropriate price indices (Australian Institute of Health and Welfare, 2015). Costs in future years such as longer term care needs, loss of paid productivity and quality of life loss were discounted to present values for 2014 by applying a 5% discount factor. Incidence and cost data were analysed across multiple dimensions using descriptive statistics. To identify factors associated with the cost of transport-related injury, a generalised linear regression model was applied, with gamma distribution and a log-link function. The model used sex, age categories (<15, 15-24, 25-64, 65+), indigenous status, socioeconomic status, health region, mechanism (either pedestrian or not), whether the injury resulted in a fatality, and whether the injury resulted in an emergency presentation only, as potential factors.

Results

The number of transport-related injury events in 2012 was 12,997, the equivalent of 5.3 per 1000 population (Table 1). Fatal injury events accounted for 1.5% of the total, hospitalised injury events accounted for 44.4%, and emergency department presentations accounted for 54.2%. Total lifetime costs associated with transport-related injury were $1.3 billion, with the cost of fatalities accounting for 68% of total cost. Estimated mean cost per injury event was $97,500, ranging from $4.5m for fatalities to $13,100 for emergency department presentations.

Table 1. Estimated incidence and cost of transport-related injury by severity

Injury severity	Incidence n	Rate[a]	Total costs $m	Mean cost $
Total				
Fatal	191	0.1	863	4,517,740
Hospitalisation	5,765	2.4	313	54,216
ED attendance[b]	7,041	2.9	92	13,101
Total	12,997	5.3	1,268	97,537

a. Rate per 1000 population
b. 50.3% of ED injury admissions did not have information on the cause of injury; as such, this number is likely to be an underestimate.

Males had a rate of transport-related injury of more than double the female rate, and a higher mean cost per injury event (Table 2). The rate of transport-related injury for the 15 to 24 year age group was considerably higher, and for the 65 year and above group was lower, than for other age groups. Mean cost increased consistently for older age groups, with older age groups having relatively more fatal events and hospital admissions and relatively fewer emergency department presentations. Aboriginal people had a somewhat higher transport-related injury rate than non-Aboriginal people but mean cost per injury event was almost double. Across socio-economic groups, the notable difference was between the most disadvantaged and least disadvantaged quintiles, with the most disadvantaged group having both a higher injury rate and mean cost. Non-metropolitan health regions had higher transport-related injury rates than metropolitan health regions, with rates highest for the Wheatbelt and Kimberley regions (Figure 1). Most non-metropolitan health regions had higher mean costs per injury event, with the Wheatbelt and Goldfields having the highest mean cost.

Table 2 Estimated incidence and cost of transport-related injury by demographic and socio-economic characteristics, and mechanism

Variable	**Incidence n**	**Rate[a]**	**Total costs $m**	**Mean cost $**
Total	12,997	5.3	1,268	97,537
Sex				
Males	8,753	7.1	933	106,621
Females	4,241	3.5	334	78,829
Age (years)				
<15	2,310	4.9	60	25,807
15-24	3,593	10.6	319	88,151
25-64	6,296	4.7	753	119,549
≥65	798	2.6	139	173,769
Aboriginality				
Aboriginal	588	6.6	105	177,956
Non-Aboriginal	12,409	5.3	1,163	93,726
SEIFA[b]				
Quintile1	2,718	5.9	335	123,367
Quintile 2	2,501	5.2	230	91,922
Quintile 3	2,525	5.2	232	92,009
Quintile 4	2,542	5.0	242	95,138
Quintile 5	2,449	4.8	189	77,130
Health regions [c]				
North metro	2,025	2.0	300	148,233
South metro	1,904	2.1	358	187,994
Goldfields	206	3.4	53	255,493
Great Southern	129	2.2	28	219,071
Kimberly	187	4.9	29	154,653
Midwest	222	3.3	53	239,384
Pilbara	196	3.1	32	161,770
Southwest	403	2.4	105	261,550
Wheatbelt	421	5.5	131	311,404

a. Rate per 1000 population.
b. SEIFA = Socio-economic indexes for areas; Quintile 1 = most disadvantaged, 5= least disadvantaged.
c. Excludes emergency department presentations as large number of missing codes for external cause of injury for non-metropolitan hospitals.

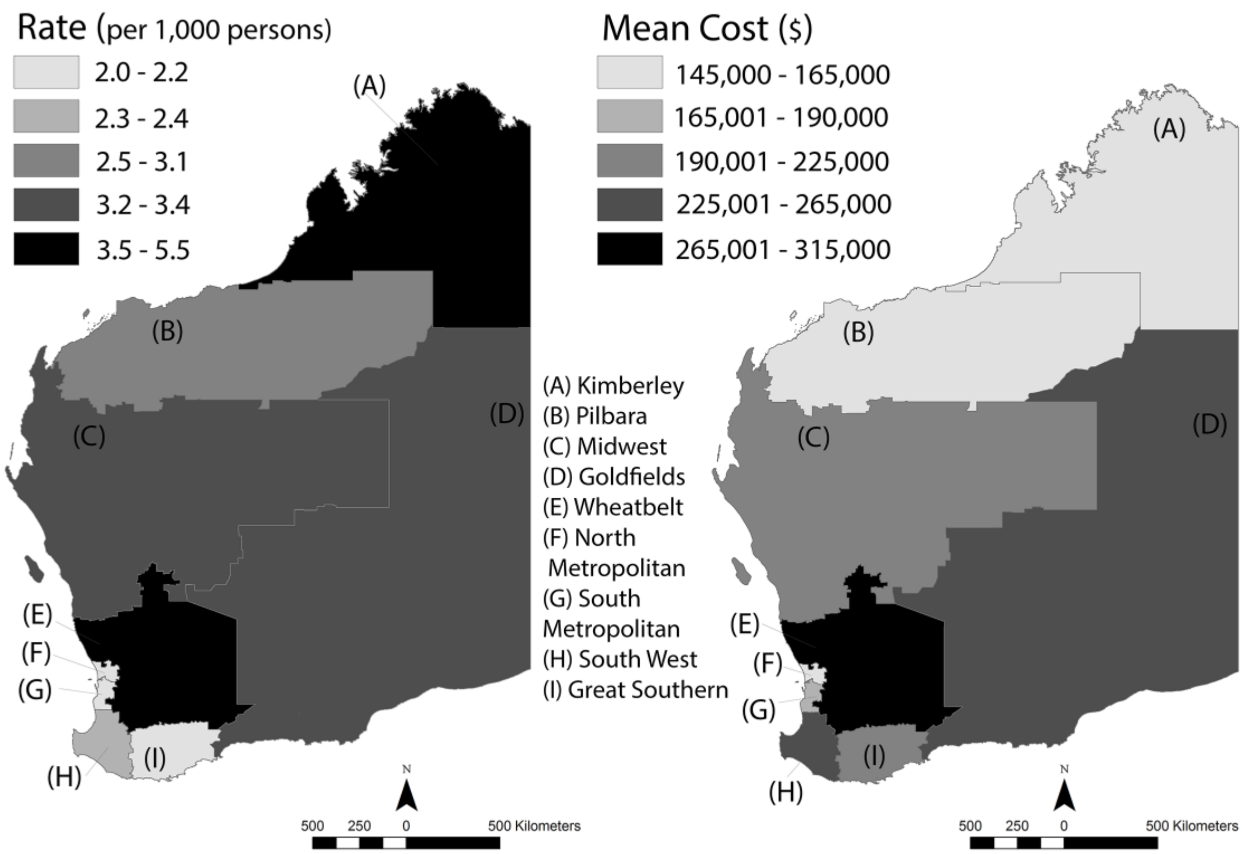

Figure 1. Incidence and mean cost of transport-related injury events by health region

Emergency department data for most hospitals outside of the metropolitan area do not record diagnosis codes but, for fatalities and hospital admissions, injury events can be analysed by mode of transport (Table 3). Motor vehicles accounted for the highest number of transport-related injury events for the age groups 15 to 24 years and above, followed by motorcycles for the 15 to 24 year olds and 25 to 64 year olds and pedestrians for the over 65 year olds. In the younger age groups, bicycles accounted for the highest number of injury events in the 5 to 14 year age group, while bicycles and motor vehicles accounted for similar numbers for 0 to 4 year olds.

Costs relating to injuries sustained in motor vehicle crashes represented almost half of the total costs of transport-related injury events and were the major contributor to total costs for all age groups other than 0 to 4 year olds. For this youngest age group, the share of total costs from injury to pedestrians was highest followed by injuries sustained in motor vehicle crashes. Cost of injury to pedestrians was also relatively high for the oldest age group. For the 15 to 24 year age group and 25 to 64 year age group, the cost of injury to motor cyclists also contributed a relatively high share of total costs.

Table 3 Estimated incidence and costs of transport-related injury events by intent and age group, Fatalities and hospitalisations only

	Age group[a]									
	0-4		5-14		15-24		25-64		≥65	
	Incidence									
	n	Rate[b]	n	Rate[b]	n	Rate[b]	n	Rate[b]	N	Rate[b]
Motor vehicle[c]	42	0.3	77	0.3	561	1.7	1,188	0.9	287	1.0
Motorcycle[d]	6	0.0	118	0.4	498	1.5	892	0.7	34	0.1
Bicycle	43	0.3	217	0.7	183	0.5	551	0.4	60	0.2
Pedestrian	16	0.1	52	0.2	77	0.2	174	0.1	67	0.2
Other[e]	9	0.1	89	0.3	208	0.6	420	0.3	87	0.3

Total	**116**	**0.7**	**553**	**1.8**	**1,527**	**4.5**	**3,225**	**2.4**	**535**	**1.8**
	Costs									
	Total $m	**%**	**Total $m**	**%**	**Total $m**	**%**	**Total $m**	**%**	**Total $m**	**%**
Motor vehicle	5	32.6	13	46.3	147	50.2	411	58.6	65	47.8
Motorcycle	0	0.9	3	11.0	76	26.1	144	20.5	12	9.0
Bicycle	1	6.6	4	15.1	9	2.9	27	3.8	9	6.7
Pedestrian	9	58.7	6	19.9	28	9.5	80	11.3	43	31.5
Other	0	1.2	2	7.8	33	11.3	41	5.8	7	4.9
Total	**16**	**100.0**	**29**	**100.0**	**292**	**100.0**	**702**	**100.0**	**137**	**100.0**

a. Excludes case for whom age was missing.
b. Rate per 1000 population.
c. Includes car occupants, van occupants and truck occupants.
d. Includes occupants of two and three-wheeled vehicles.
e. Includes bus occupants, other road injury cases, rail cases and other transport cases.

The composition of costs by component provides an indication of the distribution of the burden of injury by sector, with health sector costs largely borne by the government, long term care costs by the government and individuals and their families, loss of paid productivity by employers and to a lesser extent the government from loss of tax revenue and individuals from loss of income, and quality of life loss by individuals and their families.

Of the total costs of transport-related injury events, two-thirds was attributed to quality of life loss followed by loss of paid productivity (21.6%).

Table 4. Estimated costs of transport-related injury events by cost component

Cost component	**Total costs**		**Mean cost**
	$m	**%**	**$**
Hospital	64	5.0	4,928
Emergency department	8	0.6	627
Other medical	39	3.1	3,017
Ambulance	4	0.3	278
Long term care including aids and appliances	39	3.1	3,003
Sub-total: Resource costs	*154*	*12.1*	*11,857*
Loss of paid productivity	274	21.6	21,062
Quality of life loss	840	66.2	64,619
Sub-total: Loss of productivity quality of life loss	*1,114*	*87.9*	*85,682*
Total	**1,268**	**100.0**	**97,537**

The regression analysis showed that, after adjustment for other covariates, demographic characteristics and injury severity were the main factors associated with cost of a transport-related injury event. Costs were significantly higher for males, for people in the 15 to 24 year and 25 to 64 year age groups and for fatalities, and significantly lower if the injury required an emergency department presentation only.

Table 5. Factors associated with total costs of transport-related injury events

Injury severity	Coefficient	95% CI		p-value
		Lower	Upper	
Sex				
Males	1.000			
Females	0.717	0.642	0.800	<0.001
Age (years)				
<15	1.000			
15-24	1.606	1.051	2.117	<0.001
25-64	1.923	1.655	2.235	<0.001
≥65	1.153	0.900	1.477	0.261
Aboriginality				
Aboriginal	1.065	0.808	1.404	0.656
Non-Aboriginal	1.000			
SEIFA				
Quintile1	1.000			
Quintile 2	1.024	0.872	1.203	0.768
Quintile 3	1.014	0.863	1.192	0.865
Quintile 4	1.232	1.048	1.448	0.012
Quintile 5	1.105	0.935	1.306	0.239
Health regions				
North metro	0.753	0.508	1.117	0.159
South metro	0.807	0.545	1.195	0.284
Goldfields	1.000			
Great Southern	0.733	0.396	1.358	0.324
Kimberly	1.252	0.697	2.249	0.451
Midwest	0.954	0.563	1.618	0.862
Pilbara	1.211	0.699	2.097	0.495
Southwest	1.386	0.869	2.210	0.170
Wheatbelt	1.044	0.668	1.631	0.850
Mechanism				
Pedestrian	1.150	0.955	1.385	0.141
Non-pedestrian	1.000			
Fatality				
Fatal	88.807	57.775	136.507	0.001
Not fatal	1.000			
Emergency only				
ED only	1.000			
Not ED only	3.372	3.003	3.788	<0.001

Conclusions

This study examined the burden of transport-related injury in Western Australia, showing the number of injury events to be approximately 13,000 (5.3 per 1000 population) with total costs of $1.3 billion. Incidence and costs varied across multiple dimensions, with multivariate analysis showing age group and severity level as significant factors associated with the cost of a transport-related injury. While motor vehicles accounted for the highest number and greater share of costs for most age groups, injury resulting from bicycle crashes was an important contributor to the injury burden for younger age groups, injury to pedestrians for older people, and injury to motorcyclists for young adults and those middle-aged. The major share of total costs of transport-related injury events was accounted for by loss of quality of life.

The cost of transport-related injury reported in this study is consistent with the estimated annual cost of road crashes in Australia of $27 billion as estimated by the Department of Infrastructure and Regional Development (undated), after adjusting for Western Australia's share of the population and costs resulting from injury incidents, which are not injury costs, likely to have been included in the Department of Infrastructure and Regional Development's estimate. Non-injury costs, including property damage, workplace disruption, emergency and police services, correctional services, legal costs and insurance administration account for approximately 42% of the total cost of road crashes (Bureau of Infrastructure, Transport, & Regional Economics, 2009). Similarly, total costs of $1.3 billion as reported in this study are consistent with the Road Safety Commission's cost estimate for road crashes in Western Australia of $2.1 billion (human capital method) or $2.7 billion (willingness to pay method) after taking account of non-injury costs included in the latter estimates (Bramwell, Hill, & Thompson, 2014).

A strength of this study was the use of linked health data to obtain statewide population data on the incidence of tranport-related injury in WA. Using linked health data allowed better estimates of injury events to be derived by enabling injury-based discrete health events likely to be for the same injury to be joined into a single incident case. Additionally, linking the health data to injury claims data from ICWA allowed the cost of many components to be directly mapped when an injury event record linked with an insurance record. Where an injury event did not link with an insurance record, the cost of these components was modelled using the injury claims data for similar types of injuries.

Another strength of the study was the adoption of a comprehensive cost approach, which included health sector costs, resources required for long term care needs, loss of productivity and quality of life loss. Injury cost models do not always adopt this wider perspective, with some studies covering health sector costs only thus providing a more limited understanding of the burden of injuries to society (Meerding, Mulder, & van Beeck, 2006; Polinder et al., 2005).

However, the study had several limitations. Excluding cases with relatively minor injuries who were fully treated by a general practitioner or other primary health care provider, and with cause of injury not being recorded on half of emergency department presentations, underestimates the incidence and costs of injury in WA. Also, in regard to injury incidence, in combining discrete health events into injury events, assumptions had to be made about which health events related to the same injury event and these assumptions may under- or over-estimate incident cases.

The cost estimates presented in this study are also subject to some limitations. First, ICWA's injury claims data represent payments to motor vehicle occupants who have been injured in a crash. Personal injury insurers have policies to determine eligibility for compensation, permissible claims, reasonable payment levels and thresholds values (Insurance Commission of Western Australia). These policies determine payment to claimants, but payments may not represent actual costs of the injury event. Moreover, out-of-pocket payments by claimants are excluded. Second, quality of life loss measured in DALYs was converted to monetary values based on the value of a statistical life year. While monetising loss (or gain) of health measured in quality adjusted life years (QALYs) or DALYs is common practice, much debate exists in regard to applying a uniform value to a QALY/DALY in all situations given evidence supporting the value of a QALY/DALY being context specific (Hammitt, 2007; Haninger & Hammitt, 2011; Johannesson & Johansson, 1997; Mortimer & Segal, 2008). Finally, consistent with international practice (Finkelstein, Corso, & Miller, 2006; O'Dea & Wren, 2012), resource costs relating to property damage, workplace disruption, legal and investigation, and correctional, police and fire servcies were excluded. To the extent that dealing with injury events increases the cost to government of law enforcement, excluding these costs will understimate the cost of injury reported in this study.

From a policy perspective, the incidence and cost estimates provide guidance in regard to targeting transport-related injury prevention strategies and programs, with several priority areas identified as having a high incidence rate, high costs per injury event, or a combination of both. These findings can be used to evaluate and select interventions that most efficiently reduce the burden of transport-related injury. However, the study only provides an overview of the incidence and costs of transport-related injury in WA. More in-depth analysis of the impact of tranport-related injury on specific sociodemographic groups and regions would provide additional insight into how best to reduce the burden these injuries impose on society.

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