ORIGINAL ARTICLE

JKMS

https://doi.org/10.3346/jkms.2016.31.S2.S200 • J Korean Med Sci 2016; 31: S200-207

Disability-Adjusted Life Years (DALYs) for Injuries Using Death Certificates and Hospital Discharge Survey by the Korean Burden of Disease Study 2012

Won Kyung Lee,[1] Dohee Lim,[2] and Hyesook Park[2]

[1]Department of Social and Preventive Medicine, Inha University School of Medicine, Incheon, Korea; [2]Department of Preventive Medicine, School of Medicine, Ewha Womans University, Seoul, Korea

Received: 30 November 2015
Accepted: 5 April 2016

Address for Correspondence:
Hyesook Park, MD
Department of Preventive Medicine, School of Medicine, Ewha Womans University, 1071 Anyangcheon-ro, Yangcheon-gu, Seoul 07985, Korea
E-mail: hpark@ewha.ac.kr

Funding: This study was supported by a grant provided by the Korean Health Technology R&D Project, Ministry of Health and Welfare, Republic of Korea (HI13C0729).

A system for assessing the burdens imposed by disease and injury was developed to meet healthcare, priority setting, and policy planning needs. The first such system, the Global Burden of Disease (GBD), was implemented in 1990. However, problems associated with limited data and assumed disability weightings remain to be resolved. The purpose of the present study was to estimate national burdens of injuries in Korea using more reliable data and disability weightings. The incidences of injuries were estimated using the Korean National Hospital Discharge Survey and the mortality data from the Korean National Statistical Office in 2010. Additionally, durations of injuries and age at injury onset were used to calculate disability-adjusted life years (DALY) using disability weightings derived from the Korean Burden of Disease (KBD) study. Korea had 1,581,072 DALYs resulting from injuries (3,170 per 100,000), which was 22.9% higher than found by the GBD 2010 study. Males had almost twice as heavy an injury burden as females. Road injury, fall, and self-harm ranked 1st, 2nd, and 3rd in terms of burden of injury in 2010. Total injury burden peaked in the forties, while burden per person declined gradually from early adulthood. We hope that this study contributes to the reliable evaluation of injury burden and a better understanding of injury-related health status using nation-specific, dependable data.

Keywords: Injuries; Disease Burden; Disability-Adjusted Life Years (DALYs); Health Related Quality of Life

INTRODUCTION

Disease can be classified into communicable disease, non-communicable disease, or injury, which has specific characteristics (1). Injury can occur via various mechanisms, such as, a transport-related accident, fall, drowning, fire, poisoning, or as a result of mechanical force (1), and injuries have different types of sequelae, such as, fracture, sprain, hemorrhage, burn, or laceration (2). Furthermore, injury is an important public health problem because it is the leading cause of death and is also related to severe disability (3,4). Globally, deaths from injuries were estimated at 4.092 million in 1990 and 5.073 million (a 30% increase) in 2010 (1). Besides, injury is preventable, and if this were achieved, premature deaths from unintentional injuries could be reduced by 39% and about 37,000 lives could be prolonged (5), which suggests injuries are better addressed as a separate problem.

The global burden of disease (GBD) study represented the foundation stone of assessing the burdens from diseases and injuries (6,7), and attempted to calculate comprehensive and comparable health losses associated with diseases. Burden of disease was estimated from years of life lost (YLLs) and years lived with disability (YLDs), and these were summed up to produce disability-adjusted life years (DALYs) (6). GBD data is useful for understanding health state, set priorities, and the evaluate effects of public health programs (8,9). It covers a wide range of diseases and regions, that is, up to 291 diseases and 21 regions. Furthermore, the GBD study has been used to evaluate national and sub-national burdens in some areas for policy makers and researchers (10,11). However, the reliability of GBD study has been debated because of limited data and disability weight. Therefore, other researchers have been trying to obtain more reliable, elaborate findings using other data sources and methods (12-14).

The purpose of this study was to estimate the national burden of injuries in Korea by injuries mechanism using more reliable data and disability weightings. We also explored the characteristics of its burden with respect to gender and age.

MATERIALS AND METHODS

Study design

This cross-sectional study involved an analysis of morbidity and mortality data related to injuries in South Korea in 2010. The in-

pISSN 1011-8934
eISSN 1598-6357

cidences of injury-related deaths and hospital admissions were estimated for 2010 because data on hospital admissions for 2010 was the most recent available. Life expectancies were also calculated using mortality data for 2010 and YLLs were evaluated using age of injury-related death and life expectancy data. Burden of injuries was estimated for 2010 in units of DALY.

Participants

The study population was the people who admitted in hospital or died from external cause in 2010. The mortality and hospital admission data included diagnostic codes of the 5th Korean Classification of Diseases (KCD-5) based on the 10th revision of the International Classification of Disease (ICD-10). The study participants were defined and categorized according the mechanism of injuries, which was adopted from the classification of the GBD 2010 study (Supplementary Table 1).

No data was available for date of injury occurrence in death certificates. Therefore, some mortalities resulting from injuries suffered during 2009 may have been included, but on the other hand some injuries sustained in 2010 could have resulted in deaths in 2011. In the present study, we assumed that such gains and losses balanced each other. Regarding morbidity data, the Korean National Hospital Discharge Survey included date of injury and admission date. Date of injury was used to discriminate between the prevalence and incidence rates of injuries. An injury was considered an incident when dates of injury occurrence and hospital admission fell in 2010, whereas a case was considered as prevalent when injury occurred during the preceding year. Incident cases for 2010 were enrolled in this study, because the GBD 2010 study adopted an incident-based approach. In addition, we excluded in-hospital injuries that occurred during hospital stays.

Data source and measurement

We used morbidity data from the 7th Korean National Hospital Discharge Survey conducted by the Korean Center for Disease Control and Prevention (15). This survey sampled clusters of hospitals stratified by geographic location and number of beds in the first step. Hospitals with less than 100 beds and long-term care/rehabilitation hospitals were excluded. The number of the acute-care hospital sampled was 170. In the second step, approximately 9% of discharged patients were randomly sampled in hospitals with an electronic medical record system, whereas in hospitals with manual systems, 300-450 cases were retrieved according to bed numbers. Moreover, extraction rates depended on gender and age group. This representative data contained de-identified clinical information accessible to the public. The detailed sampling design used for the survey has been previous described (16). Weighting for the complex sample survey was considered when incidences of injured were estimated for YLD calculations.

Mortality data were obtained from the mortality records of the Korean National Statistical Office (17) from January 1 to December 31, 2010. Morbidity and mortality data were analyzed to estimate YLLs and YLDs, respectively, which were summed to obtain DALYs.

Variables

To calculate disease burden, incidences and mortalities of injury by mechanism were required for an incidence-based approach. There were up to two KCD-5 codes for mechanism of injury in hospital discharge survey data and one for mortality data. Numbers of injured were enumerated by injury mechanism and the classification of injury mechanisms was mutually exclusive. Most of the admitted patients had one mechanism code for injuries; only 0.99% of had two. Moreover, mortality data had only one diagnostic code for mechanism. Therefore, the incidence of injuries was essentially based on patient number, not on number of injuries, for the incidence-based approach. It is possible because the hospital survey was conducted using de-identified data that frequency included re-admissions.

Age and gender specific incidences of injury were estimated and corresponding mortalities were calculated. The weighted incidences of injuries were estimated for the whole population in Korea and for subpopulations based on gender (male and female) and age deciles (0-9, 10-11, 20-29, 30-39, 40-49, 50-59, 60-69, 70-79, ≥ 80), and the combination of gender and age groups. Duration of injuries and age at injury onset were estimated using Dismod II (18).

Statistical analysis

Using unique disability weightings, YLDs were estimated from injury incidences and durations and ages at injury onset. YLL was estimated using the formula for mortality and onset-age used in the GBD 2010 study and suggested in the overview of the Korean Burden of Disease Study 2012. After summing, burdens of injuries were calculated as DALYs per 1,000 in the registered population. The statistical analysis was performed using SAS version 9.3 (SAS Inc., Cary, NC, USA) and Dismod II version 1.04 (World Health Organization).

Ethics statement

This study was performed as a part of the Korean Burden of Disease Study 2012 funded by Ministry of Health and Welfare. The study was approved by the institutional review board of Korea University (1040548-KU-IRB-13-164-A-1).

RESULTS

Table 1 shows the demographic findings of the study subjects. In morbidity and mortality data, total numbers of newly injured and those that succumbed to injury were 27,398 and 22,831, re-

spectively, in 2010. The weighted frequency of newly injured was 831,240. Men were more likely to be involved in injuries than women, and those that died of injuries tended to be older. After weighting, around one third of the patients admitted to an acute-care hospital, claimed automobile insurance. The beneficiary of medical aid consisted of 5.2%. The most common locations of injuries were roads followed by homes. Of those that succumbed to injury 35.2% and 7.5% died hospital or on the way to hospital, respectively.

Table 1. Demographic characteristics of injured according to Korean morbidity and mortality data

Demographic parameters	Incidence		Mortality	
	No.	Weighted, %	No.	%
Total	22,831		27,398	
Gender				
Male	13,367	58.5	19,033	69.5
Female	8,464	41.4	8,365	30.5
Age groups, yr				
0-9	1,142	3.7	291	1.1
10-19	1,929	8.3	815	3.0
20-29	3,057	12.9	2,543	9.3
30-39	3,257	14.2	3,499	12.8
40-49	3,798	17.6	4,958	18.1
50-59	3,615	16.6	4,833	17.6
60-69	2,585	11.5	4,170	15.2
70-79	2,312	10.2	4,099	15.0
≥ 80	1,136	5.0	2,190	8.0
Place of injuries				
Home	3,571	14.2	7,233	26.4
School	334	1.3	9,647	35.2
Playground	829	3.1	2,044	7.5
Road	9,047	41.3	454	1.7
Construction	1,030	0.4	136	0.5
Others	1,904	12.6	5,360	19.6
Unknown	6,116	27.1	2,524	9.2
Type of payer				
Health insurance	13,127	54.4		
Medical aid	1,102	5.2		
Car insurance	7,154	33.8		
Others	1,448	6.6		
Intention of injuries				
Unintentional	21,311	94.0		
Self-harm	639	2.3		
Violence	879	3.7		
Unknown	2	0.01		

Total injury burden in Korea was estimated at 1,581,072 DALYs in 2010, which corresponded to 3,170 per 100,000 (Table 2). This consisted of 604,361 YLLs and 976,712 YLDs. Males had nearly twice the burden (1,008,632) of females (572,440). From neonates to those in their twenties, injury burden increased from 992 to 4,070 per 100,000, and then stayed at over 3,000 through the 4th to 8th deciles and decreased to 2,639 for those over 80 years old.

Table 3 presents injury burden by mechanism which was categorized into 3 levels (higher, middle and lower level). All injuries were classified into higher-level (broad) classifications as: 1) transport injuries, 2) unintentional injuries other than transport injuries, 3) self harm and interpersonal violence, and 4) forces of nature, war, and legal intervention. These classes accounted for 35.5%, 39.8%, 24.3%, and 0.4%, respectively, of the total injury burden. These classes were further categorized into middle-level (detailed) classification which was further categorized into lower-level (most detailed) classification again. For instance, transport injuries were categorized into transport injuries by agricultural injuries and road injuries which were further categorized into pedestrian injury, pedal cycle injury, 2-wheeled motorized vehicle injury and etc. Among middle-level classification, the five highest ranking were road injuries (DALY: 546,477), falls (376,697), self harm (299,422), exposure to mechanical forces (91,406), and unclassified unintentional injuries (85,778). The road injuries involving a 3/4-wheeled motorized vehicle (347,832), a pedestrian (100,367), a 2-wheeled motorized vehicle (73,888) accounted for almost all (95.5%) road injuries in the lower-level classification.

Table 2. Estimated burdens of injuries in Korea by gender and age

Gender/age	YLL		YLD		DALY			% (YLD/DALY)
	No.	%	No.	%	No.	%	Rate	
Gender								
Male	408,940	67.7	599,692	61.4	1,008,632	63.8	4,038	59.5
Female	195,420	32.3	377,020	38.6	572,440	36.2	2,299	65.9
Age group, yr								
0-9	22,775	3.8	25,241	2.6	48,017	3.0	992	52.6
10-19	37,585	6.2	99,442	10.2	137,027	8.7	2,012	72.6
20-29	99,926	16.5	182,006	18.6	281,932	17.8	4,070	64.6
30-39	117,731	19.5	179,383	18.4	297,114	18.8	3,569	60.4
40-49	138,396	22.9	193,093	19.8	331,489	21.0	3,803	58.3
50-59	97,537	16.1	149,477	15.3	247,014	15.6	3,672	60.5
60-69	50,223	8.3	80,222	8.2	130,445	8.3	3,187	61.5
70-79	30,553	5.1	53,542	5.5	84,095	5.3	3,315	63.7
≥ 80	9,634	1.6	14,305	1.5	23,939	1.5	2,639	59.8
Total	604,361	100.0	976,712	100.0	1,581,072	100.0	3,170	61.8

Rate unit: per 100,000 persons.
YLL, years of life lost; YLD, years lived with disability; DALY, disability-adjusted life year.

https://doi.org/10.3346/jkms.2016.31.S2.S200

Table 3. Estimated burdens of injuries by its mechanisms in Korea

Type of injuries	YLL	YLD	DALY		
			No.	%	Rate
Injuries	604,361	976,712	1,581,072	100.0	3,170
Transport injuries	129,028	432,659	561,687	35.5	1,126
Road injuries	120,775	425,702	546,477	34.6	1,096
Pedestrian injury by road vehicle	38,164	62,203	100,367	6.3	201
Pedal cycle vehicle	4,573	19,029	23,602	1.5	47
Motorized vehicle with two wheels	22,842	51,045	73,888	4.7	148
Motorized vehicle with three or more wheels	54,540	293,292	347,832	22.0	697
Road injury by animal drawn vehicle	655	132	788	0.0	2
Transport injury by agricultural vehicle	8,253	6,957	15,210	1.0	30
Unintentional injuries other than transport injuries	129,900	498,640	628,539	39.8	1,260
Falls	35,386	341,311	376,697	23.8	755
Drowning	18,337	564	18,901	1.2	38
Fire, heat and hot substances	8,303	29,603	37,906	2.4	76
Poisonings	3,974	3,365	7,339	0.5	15
Exposure to mechanical forces	14,643	76,764	91,406	5.8	183
Mechanical forces (firearm)	3,122	184	3,307	0.2	7
Mechanical forces (other)	11,520	76,580	88,100	5.6	177
Adverse effects of medical treatment	3,644	2,864	6,508	0.4	13
Animal contact	749	3,256	4,004	0.3	8
Animal contact (venomous)	538	2,342	2,880	0.2	6
Animal contact (non-venomous)	210	914	1,124	0.1	2
Overexertion and strenuous movements	44,865	40,913	85,778	5.4	172
Self-harm and interpersonal violence	338,932	45,017	383,949	24.3	770
Self-harm	285,986	13,437	299,422	18.9	600
Interpersonal violence	52,947	31,580	84,527	5.3	169
Assault by firearm	14,568	67	14,634	0.9	29
Assault by sharp object	16,278	998	17,277	1.1	35
Assault by bodily force	22,101	30,515	52,616	3.3	105
Forces of nature, war and legal intervention	6,501	396	6,897	0.4	14
Exposure to forces of nature	4,698	396	5,094	0.3	10
Collective violence and legal intervention	1,803	-	1,803	0.1	4

DALY, disability-adjusted life year; YLL, years of life lost; YLD, years lived with disability.

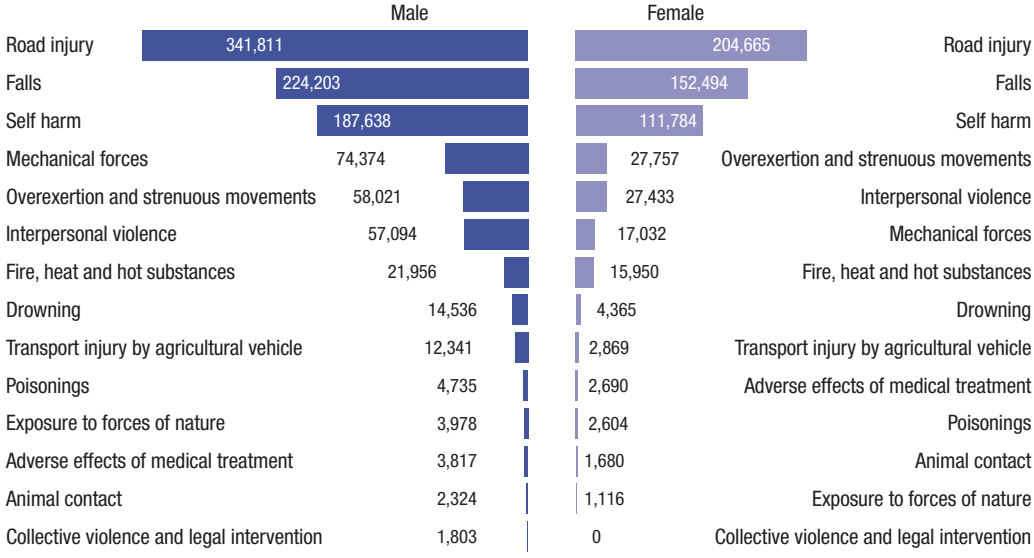

Fig. 1. Disability-adjusted life years (DALYs) for injuries by gender in Korea.

Differences between male and female injury burdens are shown in Fig. 1. Road injuries, falls, and self harm had the greatest disease burdens for males and females, and the 2nd and 3rd ranking were injuries from falls and self-harm. However, a dif-

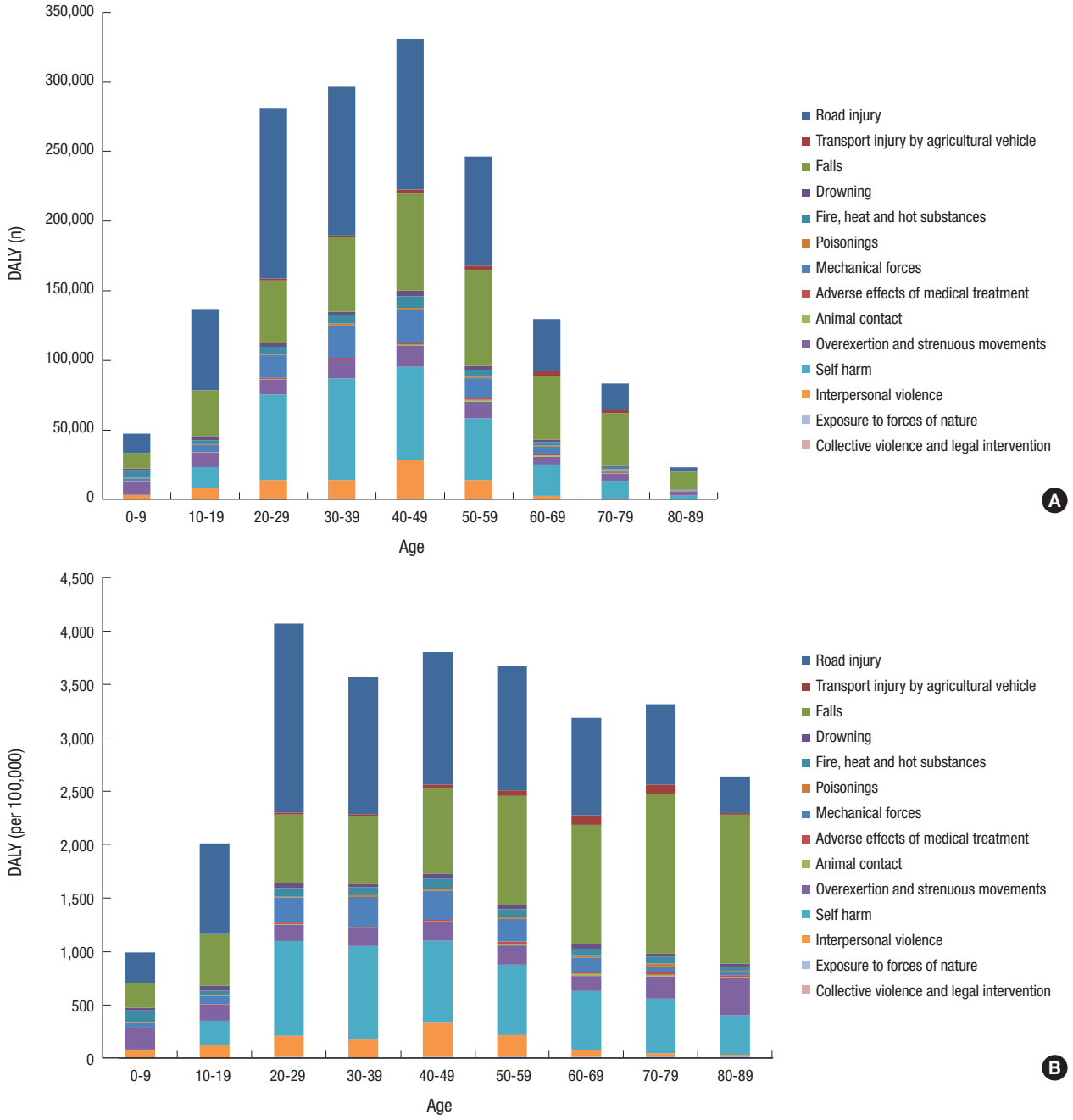

Fig. 2. Disability-adjusted life years (DALYs) for injuries by age in Korea. (**A**) Shows the total injury burden by age group and (**B**) shows the injury burden per person after adjusting for the age-matched number in the general population.

ference between male and female rankings occurred from the 4th ranked item. Injuries from mechanical forces (4th rank) were more influential than the injuries from overexertion and strenuous movements (5th rank) and interpersonal violence (6th rank) in males. In contrast, the injuries from overexertion and strenuous movements (4th rank) were more influential than interpersonal violence (5th rank) and mechanical forces (6th rank) in females.

Contributions to injury burden by mechanism are presented in Fig. 2. Fig. 2A shows the total burden of injuries by age group, whereas Fig. 2B provides the estimates of injury burden per person based on numbers in the population in specific age groups. Fig. 2A shows an inverse V shape in injury burden which peaked in the forties. On the other hand, when analyzed by age group, those in their twenties had the heaviest burden per person and this burden declined slowly with age (Fig. 2B). In particular, road injuries decreased gradually from age 20. On the contrary, fall related injury in terms of injury burden per person increased

 https://doi.org/10.3346/jkms.2016.31.S2.S200

Male										Disease cause name	Female									
0-9	10 -19	20 -29	30 -39	40 -49	50 -59	60 -69	70 -79	80+	All age		All age	80+	70 -79	60 -69	50 -59	40 -49	30 -39	20 -29	10 -19	0-9
333	1,129	2,215	1,735	1,417	1,317	1,107	924	528	1,368	Road injuries	822	266	634	732	1,009	1,056	812	1,287	533	229
291	712	896	898	1,082	1,110	1,053	1,193	1,103	898	Falls	612	1,512	1,704	1,181	929	506	374	373	225	167
2	217	923	1,017	1,035	956	811	777	594	751	Self-harm	449	277	331	311	360	490	728	845	229	-
48	116	390	454	436	326	234	81	28	298	Exposure to mechanical forces	68	29	34	40	97	100	99	67	29	33
198	248	215	257	242	243	182	208	346	232	Overexertion and strenuous movements	111	348	210	101	117	101	69	88	43	207
91	179	253	228	494	165	94	23	15	229	Interpersonal violence	110	15	35	42	233	134	103	130	65	73
134	36	92	92	126	72	70	56	49	88	Fire, heat and hot substances	64	36	64	52	83	66	57	71	43	84
31	65	67	50	80	58	49	33	37	58	Drowning	18	22	28	30	20	10	5	18	25	19
0	3	25	29	61	81	146	166	40	49	Transport injury by agricultural vehicle	12	6	31	40	23	7	-	12	-	3
11	7	7	24	27	19	31	45	19	19	Poisonings	10	12	18	13	8	13	8	7	12	8
1	4	2	12	29	35	26	21	21	16	Exposure to forces of nature	4	22	18	7	6	5	1	3	1	-
1	3	8	21	19	28	20	26	14	15	Adverse effects of medical treatment	11	16	24	19	13	7	3	20	5	5
2	3	6	3	10	18	30	12	6	9	Animal contact	7	15	13	13	15	9	1	3	2	1
-	6	34	8	-	1	2	-	-	7	Collective violence and legal intervention	-	-	-	-	-	-	-	-	-	-
1,144	2,729	5,134	4,828	5,058	4,430	3,857	3,567	2,799	4,038	Injuries	2,299	2,574	3,144	2,580	2,912	2,504	2,259	2,925	1,211	829
※1st	(1)	2nd	(2)	3rd	(3)	4th	(4)	5th	(5)											

Fig. 3. Disability-adjusted life years (DALYs) rankings of injuries by age in Korea.

rapidly from early adulthood.

Injury burden per person is visualized in gender and age groups (Fig. 3). Road-related injuries are ranked as 1st in the most of age groups. Fall and self-harm is the 2nd and 3nd ranking, respectively in males and females, although the exact ranking depends on the age group. Mechanical forces were not a common cause of injury burden in females, while it ranked 4th in males during physically and economically active period. Total DALYs among the age groups in males and females were suggested in Supplementary Tables 2 and 3.

DISCUSSION

This study presents incidence-based burden of injuries in Korea using nation-specific data and disability weightings. Korea had 1,581,072 DALYs from injuries (3,170 per 100,000). Males had almost twice the burden from injuries than females. In both genders, road-related injuries, falls, and self-harm ranked as 1st, 2nd, and 3rd with respect to burden of injury. Injury burden reached an obvious peak in the forties in the study population, while burden per person declined gradually from early adulthood.

Injuries have unique problems as compared with communicable and non-communicable diseases. Unlike diseases, injuries can be under-estimated when national health insurance data is used, because a substantial portion of transport and work-related injuries are covered by private or occupational insurance (19,20). Furthermore, the mechanisms of injuries can be complex and multiple injury types can result from a single accident (21). Therefore, a reliable database for injuries is essential to estimate injury burdens and to understand how injuries occur (22). A high quality database containing data on diagnoses and mechanisms of injuries would provide a basis for such estimations.

Injury burden was estimated to be larger in the KBD than in the GBD country profile of 2010 (23). In the GBD 2010 country profile, the total burden was 1,286,733 DALYs, that is, 893,825 for males and 392,908 for females, and the total burden was

18.6% less than that found in the KBD study. Moreover, some differences were evident in the rankings of injury burdens determined by these two studies. Road injury, fall, self-harm, mechanical force, overexertion and strenuous movements, interpersonal violence, and fire were the top 7 ranked causes of injury burden in descending order in the present study. However, in the GBD 2010 study the order was self-harm, road injury, fall, mechanical force, drowning, interpersonal violence, and transport injury by agricultural vehicle.

There could be some explanation in the difference between this study and GBD 2010 study (13,21). Difference was not suspected to come from classifications of types and sequelae because the classification of our study was the same as that of the GBD study to allow comparisons. However, in the GBD study, a prevalence-based approach was used and raw data, except for mortality data, was obtained from the South Korea Patient Survey (24). In this survey, de-identified inpatient and outpatient data, which contained one main diagnosis and one sub-diagnosis, was collected for one month (25). The study included an oriental clinic and convalescent hospital and was conducted to understand medical use in Korea. On contrast, the KBD study was performed using an incidence-based approach using the Korea National Hospital Discharge Survey data, which contained one main diagnosis, up to 20 sub-diagnoses and date of injury over a period of one year at acute-care hospitals. Therefore, the Korea National Hospital Discharge Survey was deemed to provide more reliable information on the incidence of injury, while the South Korea Patient Survey was considered to provide a good estimate of the prevalence of medical disease.

Different disability weights could also explain observed differences in injury burdens (13,26). Disability weights were calculated using an online survey of Korean medical professionals, which allowed nation-specific disabilities to be produced and used to calculate injury burden. It has been suggested disability weights could be the main reason for different estimates of injury burden (26). As was found in the present study, other studies have reported that estimations of injury burden at the national level are considerably higher than the results of the GBD study (13,26). In the UK, when disability weights and home-based cohort data were used, the national burden of injuries was calculated to be 2.6 fold higher (13). The authors suggested that the many assumptions made and data limitations could have been responsible for this discrepancy.

In one study, injury burden was compared among developed countries in the western pacific region (23). Regarding gross domestic product (GDP) per capita, Australia, Singapore and Japan reported higher GDPs ($67,473, $55,980 and $38,634, respectively) and China lower GDP ($6,992) than Korea ($25,998) (27). According to GBD 2013 study, total injury burdens reported were; Singapore 1,234 (1,080-1,415), Australia 1,780 (1,612-1,977), Japan 2,143 (1,875-2,430), Korea 2,577 (2,097-2,865), and China 2,603 (2,353-2,915) (28), which followed the GDP pattern. However, Korea had a much higher burden from self-harm (1,010) than Australia (475), Singapore (377), Japan (763), or China (313).

The implication of this KBD study was that we could estimate the national injury burden as more reliable value. Moreover, our study could provide to a more precise understanding of injury burden and enable the establishment of proper priorities for public health strategies and interventions. The strength of this study is that it provides a means of estimating more reliably the burdens of injuries in Korea. In this study, findings could be compared with the GBD study because it used the same classification and framework. Furthermore, reliable data and disability weights were used in the present study, which suggests results are dependable. However, it has a number of limitations. In particular, the burdens of minor injuries on outpatients and inpatients treated by hospitals with fewer than 100 beds were excluded, which suggests the possible under-estimation of injury burden (14). According to the Korean National Health and Nutrition Examination Survey, the numbers of patients treated at an outpatient clinic or admitted to hospital were 1,572 and 1,086 million, respectively, in 2010 (29). There is the other possibility of under-estimation of injury burden. The hospital survey was based on the discharge date and therefore the patient who got injured in 2010 and still admitted to 2011 was not included in the 2010 data. Furthermore, re-admissions were not discernible due to de-identification of the database, which indicates a possible over-estimation of injury burden, although this is not likely to be substantial because long-term care and rehabilitation hospitals were excluded. Finally, injury burden was estimated using 2010 data because this was the most recent Korean National Hospital Discharge Survey data available.

DISCLOSURE

The authors have no potential conflicts of interest to disclose.

AUTHOR CONTRIBUTION

Study conception and design: Park H. Data interpretation and statistical analysis: Lee WK, Lim D. Writing of the draft and manuscript revision: Lee WK. Approval of the final manuscript: all authors.

ORCID

Won Kyung Lee http://orcid.org/0000-0002-6014-8854
Dohee Lim http://orcid.org/0000-0002-0549-8704
Hyesook Park http://orcid.org/0000-0002-9359-6522

 https://doi.org/10.3346/jkms.2016.31.S2.S200

REFERENCES

1. Lozano R, Naghavi M, Foreman K, Lim S, Shibuya K, Aboyans V, Abraham J, Adair T, Aggarwal R, Ahn SY, et al. Global and regional mortality from 235 causes of death for 20 age groups in 1990 and 2010: a systematic analysis for the global burden of disease study 2010. *Lancet* 2012; 380: 2095-128.
2. Vos T, Flaxman AD, Naghavi M, Lozano R, Michaud C, Ezzati M, Shibuya K, Salomon JA, Abdalla S, Aboyans V, et al. Years lived with disability (YLDs) for 1160 sequelae of 289 diseases and injuries 1990-2010: a systematic analysis for the global burden of disease study 2010. *Lancet* 2012; 380: 2163-96.
3. Kim KS, Kim SD, Lee SH. Trend of mortality rate and injury burden of transport accidents, suicides, and falls. *J Prev Med Public Health* 2012; 45: 8-13.
4. Khang YH. Burden of noncommunicable diseases and national strategies to control them in Korea. *J Prev Med Public Health* 2013; 46: 155-64.
5. Centers for Disease Control and Prevention (US). Up to 40 Percent of Annual Deaths from Each of Five Leading US Causes Are Preventable. Atlanta, GA: Centers for Disease Control and Prevention, 2014.
6. Murray CJ, Vos T, Lozano R, Naghavi M, Flaxman AD, Michaud C, Ezzati M, Shibuya K, Salomon JA, Abdalla S, et al. Disability-adjusted life years (DALYs) for 291 diseases and injuries in 21 regions, 1990-2010: a systematic analysis for the global burden of disease study 2010. *Lancet* 2012; 380: 2197-223.
7. Murray CJ, Lopez AD. The Global Burden of Disease: a Comprehensive Assessment of Mortality and Disability from Diseases, Injuries and Risk Factors in 1990 and Projected to 2020 (Global Burden of disease and Injury Series Vol. 1). Cambridge, MA: Harvard University Press, 1996.
8. Polinder S, Haagsma J, Bos N, Panneman M, Wolt KK, Brugmans M, Weijermars W, van Beeck E. Burden of road traffic injuries: Disability-adjusted life years in relation to hospitalization and the maximum abbreviated injury scale. *Accid Anal Prev* 2015; 80: 193-200.
9. Bao C, Mayila M, Ye Z, Wang J, Jin M, He W, Chen K. Forecasting and analyzing the disease burden of aged population in China, based on the 2010 global burden of disease study. *Int J Environ Res Public Health* 2015; 12: 7172-84.
10. Gilmour S, Liao Y, Bilano V, Shibuya K. Burden of disease in Japan: using national and subnational data to inform local health policy. *J Prev Med Public Health* 2014; 47: 136-43.
11. Zhou M, Wang H, Zhu J, Chen W, Wang L, Liu S, Li Y, Wang L, Liu Y, Yin P, et al. Cause-specific mortality for 240 causes in China during 1990-2013: a systematic subnational analysis for the global burden of disease study 2013. *Lancet* 2016; 387: 251-72.
12. Haagsma JA, Polinder S, Lyons RA, Lund J, Ditsuwan V, Prinsloo M, Veerman JL, van Beeck EF. Improved and standardized method for assessing years lived with disability after injury. *Bull World Health Organ* 2012; 90: 513-21.
13. Lyons RA, Kendrick D, Towner EM, Christie N, Macey S, Coupland C, Gabbe BJ; UK Burden of Injuries Study Group. Measuring the population burden of injuries--implications for global and national estimates: a multicentre prospective UK longitudinal study. *PLoS Med* 2011; 8: e1001140.
14. Derrett S, Samaranayaka A, Wilson S, Langley J, Ameratunga S, Cameron ID, Lilley R, Wyeth E, Davie G. Prevalence and predictors of sub-acute phase disability after injury among hospitalised and non-hospitalised groups: a longitudinal cohort study. *PLoS One* 2012; 7: e44909.
15. Korea Centers for Disease Control and Prevention. The 7th Korea National Hospital Discharge Survey. Cheongwon: Korea Centers for Disease Control and Prevention, 2010.
16. Hong J, Lee WK, Kim MK, Lee BE, Shin SD, Park H. Effect of comorbidity on length of hospital stay and in-hospital mortality among unintentionally injured patients. *Accid Anal Prev* 2013; 52: 44-50.
17. Statistics Korea. Causes of Death Statistics in 2010. Seoul: Statistics Korea, 2011.
18. Barendregt JJ, Van Oortmarssen GJ, Vos T, Murray CJ. A generic model for the assessment of disease epidemiology: the computational basis of DisMod II. *Popul Health Metr* 2003; 1: 4.
19. Lim SJ, Chung WJ, Cho WH. Economic burden of injuries in South Korea. *Inj Prev* 2011; 17: 291-6.
20. Park K, Lee JS, Kim Y, Kim YI, Kim J. The socioeconomic cost of injuries in South Korea. *J Prev Med Public Health* 2009; 42: 5-11.
21. Gabbe BJ, Lyons RA, Harrison JE, Rivara FP, Ameratunga S, Jolley D, Polinder S, Derrett S. Validating and improving injury burden estimates study: the injury-VIBES study protocol. *Inj Prev* 2014; 20: e4.
22. Lyons RA. Measuring the burden of injury. *Inj Prev* 2008; 14: 3-4.
23. Institute for Health Metrics and Evaluation (US). Data Visualizations: GBD Compare. Seattle, WA: Institute for Health Metrics and Evaluation, 2010.
24. Institute for Health Metrics and Evaluation (US). Counrtry Profiles: South Korea. Seattle, WA: Institute for Health Metrics and Evaluation, 2015.
25. Ministry of Health and Welfare, Korea Institute for Health and Social Affairs. Patient Survey. Seoul: Korea Institute for Health and Social Affairs, 2010.
26. Polinder S, Meerding WJ, Mulder S, Petridou E, van Beeck E; EUROCOST Reference Group. Assessing the burden of injury in six European countries. *Bull World Health Organ* 2007; 85: 27-34.
27. The World Bank (US). GDP Per Capita (Current US$). Washington, D.C.: The World Bank, 2010.
28. Institute for Health Metrics and Evaluation (US). Data Visualizations: GBD Compare. Seattle, WA: Institute for Health Metrics and Evaluation, 2015.
29. Ministry of Health and Welfare, Korea Centers for Disease Control and Prevention. Korea Health Statistics 2010: Korea National Health and Nutrition Examination Survey (KNHANES V-1). Cheongwon: Korea Centers for Disease Control and Prevention, 2011.