Main results of the Korea National Hospital Discharge In-depth Injury Survey, 2004-2016

Sung Ok Hong¹, Boae Kim², Joongho Jo¹, Yunhyung Kwon¹, Yeon-Kyeng Lee¹, Youngtaek Kim³

¹Division of Chronic Disease Control, Korea Centers for Disease Control and Prevention, Cheongju, Korea; ²Occupational Health Research Department, Korea Occupational Safety and Health Agency, Ulsan, Korea; ³Public Health and Medical Service Office, Chungnam National University Hospital, Daejeon, Korea

OBJECTIVES: The purpose of this study was to estimate the incidence of injuries and to identify their causes by classifying injuries according to various categories including age, sex, mechanism of injury, body parts injured, and place of injury.

METHODS: This study used data from the Korea National Hospital Discharge In-depth Injury Survey (KNHDIS) from 2004 to 2016. The KNHDIS is conducted annually by the Korea Centers for Disease Control and Prevention, and its survey population includes all hospitalized patients discharged from medical institutions that have 100 or more beds, such as hospitals, general hospitals, and secondary community health centers. The number of injured cases is weighted and estimated using the mid-year estimated population of each year.

RESULTS: The injury discharge rate steadily increased since 2004 (1,505 per 100,000 population in 2004, 2,007 per 100,000 population in 2016) and most injuries were unintentional (annual average of 94.7%). On average, during the 13-year study period, the injury rate for males was 1.5 times as high as for females. The 2 main causes of injury were consistently traffic accidents and falls. Notably, the rate of injuries resulting from falls rose by 1.7-fold from 463 to 792 per 100,000 people, and exceeded the rate of traffic accidents in 2016.

CONCLUSIONS: The incidence of injuries steadily increased after the survey was first conducted, whereas mortality resulting from injuries mostly remained unchanged. This suggests that effective strategies and interventions should be reinforced to reduce unintentional injuries.

KEY WORDS: Injury, Hospitalization, Discharge, Surveillance, Korea

INTRODUCTION

An injury is defined as intentional or unintentional physical and/or psychological damage resulting from an external cause, including conditions such as trauma and poisoning [1]. The World Health Organization classifies injuries as a non-communicable disease (a category that also includes chronic diseases) because injuries follow a chronic course until a previously normal status is restored and often result in residual psychological or biological sequelae. Injuries occur in various circumstances such as violence in schools, industrial disasters, road accidents, agricultural accidents, and accidents at festivals. Injuries are handled by diverse social safety sectors depending on where they occur and whether they are intentional; therefore, there is a need to unify dispersed data to obtain a holistic overview of the epidemiology of injuries.

Korea is ranked as one of the top countries with regard to mortality resulting from injuries [2]. The situations regarding traffic accidents involving children and mortality from industrial accidents were similar to each other, and even though Korea’s safety-related indices greatly improved after it joined the Organization
for Economic Cooperation and Development (OECD), it still failed to reach OECD standards [3,4].

An analysis of injury-related disease codes in 2016 revealed that the direct health expenditures on injuries covered by national health insurance amounted to 4.0 trillion Korean won (KRW; 2.2 trillion KRW on admissions, 1.8 trillion KRW on outpatients) which accounted for 10% of all medical costs. This reflected a 3-fold increase in injury-related health expenditures since 2004, when expenditures on injuries totaled 1.4 trillion KRW (0.7 trillion KRW on admissions, 0.7 trillion KRW on outpatients) [5].

The social cost due to road accidents, one of the major causes of unintentional injuries, was 26.6 trillion KRW (1.9% of gross domestic product [GDP]) in 2014 [6]. This was a 9.5% increase from the 24.0 trillion KRW spent in 2013 and approximately triple the 9.7 trillion KRW (1.1% of GDP) spent in 2006 [7,8]. The loss of working days due to industrial disasters in 2016 was 47,040, and the estimated economic losses amounted to 21.4 trillion KRW. This was a 4.9% increase from the estimated economic loss of 20.4 trillion KRW in 2015 and double the estimated economic loss of 10.1 trillion KRW in 2002 [9]. It has been estimated that for every 600 near-miss cases of injury, there are 30 cases of property damage, 10 mild injuries, and 1 major injury (the 1-10-30-1 ratio) [10,11]. This suggests that the total costs of injuries would be much greater if unidentified injuries were included.

The Korea Centers for Disease Control and Prevention developed the Korea National Hospital Discharge In-depth Injury Survey (KNHIDS), a national representative survey of injury-related discharges from general hospitals in 2005 to understand the scale of injuries, to identify risk factors, and to provide data supporting prevention policies and intervention strategies. On the basis of this nationally representative injury survey, the total number of injuries severe enough to require admission can be estimated. We investigated trends from 2004 to 2016 and reported updated national injury incidence estimates in Korea since 2004.

### MATERIALS AND METHODS

The KNHIDS, which has been conducted since 2004, collects data on approximately 9% of discharged cases from medical institutions with 100 or more beds, including hospitals, general hospitals, and secondary community health centers. Hospitals with a single specialty, long-term care hospitals, geriatric hospitals, military hospitals, and rehabilitation hospitals were excluded even if they had 100 or more beds. The KNHIDS applied stratified 2-stage cluster sampling, with individual hospitals as the primary sampling unit and discharged patients in a sampled hospital as the secondary sampling unit. The hospitals were sampled based on clusters of hospitals stratified by geographic location and number of beds. The hospitals were divided into 4 categories according to the number of beds (100-299, 300-499, 500-999, and over 1,000 beds).

### Table 1. Estimated injury discharge rates, 2004-2016

| Characteristics | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|-----------------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Total (n)       | 1,773| 1,871| 1,939| 1,956| 2,010| 2,061| 2,241| 2,199| 2,312| 2,301| 2,313| 2,356| 2,285|
| Sex             |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Male            | 2,182| 2,269| 2,379| 2,368| 2,390| 2,452| 2,638| 2,571| 2,694| 2,639| 2,620| 2,644| 2,512|
| Female          | 1,359| 1,470| 1,495| 1,541| 1,628| 1,667| 1,843| 1,825| 1,929| 1,962| 2,006| 2,068| 2,056|
| Age (yr)        |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 0-12            | 897  | 875  | 818  | 825  | 880  | 832  | 858  | 856  | 882  | 867  | 889  | 822  | 750  |
| 13-18           | 961  | 1,098| 1,190| 1,257| 1,356| 1,382| 1,463| 1,582| 1,592| 1,490| 1,533| 1,635| 1,471|
| 19-64           | 1,886| 1,986| 2,033| 2,061| 2,052| 2,122| 2,252| 2,193| 2,262| 2,244| 2,197| 2,229| 2,120|
| ≥65             | 3,360| 3,508| 3,776| 3,550| 3,856| 3,820| 4,446| 4,216| 4,615| 4,564| 4,735| 4,784| 4,887|
| Intent          |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Unintentional   | 1,505| 1,590| 1,622| 1,669| 1,721| 1,762| 1,947| 1,913| 2,021| 2,006| 2,015| 2,070| 2,007|
| Intentional     | 111  | 113  | 114  | 106  | 112  | 106  | 105  | 101  | 92   | 92   | 90   | 82   | 74   |
| Self-harm       | 38   | 39   | 43   | 33   | 40   | 39   | 40   | 39   | 37   | 40   | 37   | 37   | 34   |
| Assault         | 73   | 74   | 72   | 72   | 71   | 67   | 65   | 62   | 54   | 52   | 53   | 45   | 40   |
| Unknown         | 10   | 10   | 15   | 12   | 4    | 4    | 5    | 1    | 6    | 19   | 16   | 17   | 6    |
| Mechanism       |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Traffic accident| 669  | 690  | 714  | 746  | 743  | 743  | 772  | 733  | 771  | 729  | 731  | 738  | 670  |
| Falls           | 463  | 491  | 518  | 504  | 532  | 558  | 654  | 668  | 703  | 748  | 736  | 783  | 792  |
| Struck by/against| 164 | 173  | 246  | 243  | 242  | 239  | 238  | 263  | 274  | 248  | 251  | 252  | 231  |
| Poisoning       | 47   | 47   | 61   | 52   | 55   | 58   | 58   | 55   | 57   | 57   | 59   | 59   | 50   |
| Stabbing        | 86   | 141  | 87   | 72   | 77   | 68   | 74   | 67   | 69   | 75   | 62   | 68   | 77   |
| Unknown         | 262  | 292  | 189  | 219  | 250  | 257  | 290  | 286  | 301  | 309  | 320  | 319  | 331  |

Values are presented as number per 100,000 population.

1 Estimates with relative standard error of less than 5.
| Characteristics | 0-12 | 13-18 | 19-64 | ≥65 |
|-----------------|------|-------|-------|-----|
|                 | 2004 | 2016  | 2004  | 2016 | 2004 | 2016 |
| **Total**       | 67,800 | 40,234 | 34,424 | 48,223 | 557,174 | 682,614 | 122,049 | 298,208 |
| **Intention**   |      |       |       |       |       |       |       |       |
| Unintentional   | 67,072 | 39,934 | 30,613 | 44,737 | 509,023 | 652,438 | 116,313 | 291,179 |
| Self-harm       | 75\(^1\) | - | 413\(^3\) | 711 | 15,125 | 12,489 | 2,882 | 4,146 |
| Assault         | 578\(^1\) | 280\(^3\) | 3,311 | 2,629 | 29,611 | 16,035 | 1,447\(^3\) | 1,559 |
| Unknown\(^1\)  | 75\(^1\) | 20\(^3\) | 88\(^3\) | 146\(^3\) | 3,414 | 1,652 | 1,408 | 1,324 |
| **Mechanism**   |      |       |       |       |       |       |       |       |
| Traffic accident | 26,705 | 8,642 | 12,194 | 15,770 | 250,025 | 256,178 | 32,567 | 62,663 |
| Fall            | 20,980 | 16,158 | 9,819 | 12,875 | 127,503 | 205,226 | 63,991 | 171,354 |
| Struck by/against | 4,899 | 5,702 | 7,603 | 10,095 | 62,418 | 87,964 | 3,834 | 14,851 |
| Stabbing        | 3,209 | 1,372 | 2,514 | 1,789 | 34,270 | 32,109 | 1,505 | 4,315 |
| Fire/heat/flame | 4,662 | 4,269\(^3\) | - | - | - | - | - | - |
| Poisoning       | - | - | 194\(^3\) | 667 | 16,883 | 16,573 | 4,821 | 8,087 |
| Unknown\(^1\)  | 7,345 | 4,091 | 2,101 | 7,027 | 66,075 | 84,564 | 15,331 | 36,938 |
| **Source of traffic accident** |      |       |       |       |       |       |       |       |
| Subtotal        | 26,705 | 8,642 | 12,194 | 15,770 | 250,025 | 256,178 | 32,566 | 62,663 |
| Pedestrian      | 14,245 | 3,797 | 2,415 | 2,530 | 31,841 | 30,631 | 8,582 | 10,699 |
| Bicycle         | 4,295 | 2,466 | 1,357 | 2,964 | 9,441 | 22,044 | 2,907 | 6,975 |
| Motorcycle      | - | - | 4,205 | 5,622 | 24,776 | 24,167 | 5,293 | 10,499 |
| Automobile      | 5,672 | 2,160 | 3,103 | 3,817 | 134,558 | 152,443 | 5,612 | 18,079 |
| Unknown\(^1\)  | 2,493 | 219\(^3\) | 1,114\(^3\) | 837\(^3\) | 49,409 | 26,893 | 10,172 | 11,061 |
| **Place of injury** |      |       |       |       |       |       |       |       |
| Residence       | 16,905 | 8,885 | 3,337 | 2,814 | 58,273 | 65,448 | 34,717 | 78,504 |
| School          | 5,255 | 3,331 | 4,611 | 4,345 | - | - | - | - |
| Field/stadium   | 3,840 | 2,329 | 3,410 | 6,172 | 15,798 | 20,060 | - | - |
| Roadway         | 22,754 | 8,714 | 12,926 | 16,312 | 237,336 | 270,717 | 31,501 | 71,782 |
| Workplace       | - | - | - | - | 6,361 | 42,078 | - | - |
| Farm            | - | - | - | - | - | - | 1,255\(^3\) | 10,245 |
| Lake-Steamp-sea-outdoor | - | - | - | - | - | - | 5,816 | - |
| Unknown\(^1\)  | 19,046 | 16,975 | 10,140 | 18,580 | 239,406 | 284,311 | 54,576 | 131,861 |
| **Nature of injury** |      |       |       |       |       |       |       |       |
| Fracture        | 25,166 | 19,843 | 15,221 | 19,379 | 167,256 | 235,910 | 68,370 | 182,455 |
| Dislocation\(^2\) | 231\(^1\) | 190\(^1\) | 330\(^3\) | 888 | 4,807 | 8,608 | 1,371\(^1\) | 1,947 |
| Sprain/strain\(^2\) | 3,290 | 2,197 | 3,756 | 10,974 | 127,891 | 178,330 | 8,892 | 23,992 |
| Internal organ  | 12,813 | 4,305 | 6,004 | 4,356 | 101,031 | 77,773 | 21,291 | 35,477 |
| Open wound      | 8,734 | 2,330 | 2,715 | 1,523 | 36,204 | 25,589 | 4,830 | 9,036 |
| Traumatic amputation | 937\(^1\) | 108\(^3\) | 72\(^3\) | 73\(^3\) | 10,355\(^3\) | 4,656 | 1,108\(^3\) | 534\(^3\) |
| Vascular injury | 15\(^1\) | 111\(^3\) | - | 140\(^3\) | 2,336 | 2,472 | 145\(^3\) | 527\(^3\) |
| Contusion-superficial injury | 4,638 | 3,177 | 2,138 | 3,738 | 32,447 | 42,885 | 5,796 | 17,277 |
| Crush injury    | 1,755\(^1\) | 46\(^3\) | 206\(^3\) | 103\(^3\) | 10,388 | 1,962 | 682\(^3\) | 375\(^3\) |
| Burn            | 5,872\(^2\) | 4,607\(^3\) | 613\(^3\) | 879\(^3\) | 14,198 | 19,229\(^3\) | 2,106 | 6,423 |
| Nerve injury    | 138\(^1\) | 259\(^3\) | 485\(^3\) | 154\(^3\) | 2,957 | 2,992 | 119\(^3\) | 405\(^3\) |
| Poisoning       | 723 | 533 | 227\(^3\) | 668 | 19,033 | 15,414 | 6,749 | 7,870 |
| Others          | 4,201 | 2,494 | 3,466 | 5,205 | 36,620 | 66,016 | 4,255 | 11,728 |
| Unknown\(^1\)  | 526 | 34\(^3\) | 338\(^3\) | 143\(^3\) | 4,178 | 778 | 218\(^3\) | 162\(^3\) |

Values are presented as number of estimated cases.
\(^1\)Unknown includes unclassified cases.
\(^2\)Dislocations, sprains, and strains were collected without a detailed classification.
\(^3\)Estimates with relative standard error of 25% or greater.
Injuries are the leading cause of death in young people aged 10-30 years old, and play a major role in causing premature death at all ages [13]. To establish sustainable development and to reach the standards of developed countries, the rising trend of the incidence of injuries needs to be reversed through safety promotion initiatives. The total incidence of injuries steadily increased since 2004 in this study. Despite the increased incidence of injuries over the last 10 years, the mortality rate due to injuries has remained stable. This suggests that preventative measures against injuries have not been as effective as measures that address their aftermath. A marked increase in injuries in the elderly has resulted in growing medical costs for chronic diseases, with negative impacts on quality of life; as such, injuries in the elderly have the potential to become a huge obstacle to health promotion in Korean society, which is now in an advanced-age era. On the one hand, there have been improvements in survival and functional recovery after serious injuries due to advances in the treatment of emergencies and in the medical system. On the other hand, close attention needs to be paid in order to reduce the incidence of injuries by reinforcing preventative activities that target what happens before accidents and to yield a synergistic effect with health policies aimed at dealing with what happens subsequent to accidents. Furthermore, according to recent study, regional variations need to be prioritized with individual variations such as age and sex [14].

There are several limitations to this study. First, the KNHDIS captured injuries in patients admitted to hospitals with over 100 beds because the KNHDIS was designed to assess trends at the national level, and detailed information on injuries that were recorded as unknown was not identified. As community and individual risk factors were found to influence the risk of hospitalization.
tion for unintentional injuries [14], the surveillance system will be considered as a way to collect data at the community level and on geographical characteristics for developing intervention strategies and implementing prevention programs. Although this was a comparative study over time, we utilized the crude rates in the published statistics of the KNHIDS; thus, future research should use age-adjusted data. Despite these limitations, this survey data allowed us to estimate the number of injury cases on the national scale according to injury mechanism, so the present findings have value for utilization in policy-making to prevent injuries. Further comparative research is needed to identify relevant risk factors to reduce unintentional injuries, drawing upon linkage with various sources of health data such as the Korea National Health and Nutrition Examination Survey.

CONFLICT OF INTEREST

The authors have no conflicts of interest to declare for this study.

FUNDING

None.

ACKNOWLEDGEMENTS

This article is based on a previous article entitled “Epidemiological characteristics of patients admitted for injured inpatients in Korea, 2015” published in “Public Health Weekly Report, 2018; Vol.11, No.11”, which is the newsletter of the Korea Centers for Disease Control and Prevention. However, according to subparagraph 306 of the rules and regulations of the publication, its contents can be reused in other publications without copyright issues. Moreover, data from 2016 were used in this article, whereas data from 2015 were used in the previous article, further negating the issue of duplicate submission.

AUTHOR CONTRIBUTIONS

Conceptualization: YK. Data curation: SOH, BK. Formal analysis: YK, BK. Funding acquisition: None. Methodology: YK, YK. Project administration: YK, SOH, YKL. Visualization: YK, JJ, YKL. Writing-original draft: YK, JJ, OH, BK. Writing-review & editing: YK, YKL.

ORCID

Sung Ok Hong: http://orcid.org/0000-0002-0787-4267; Boae Kim: http://orcid.org/0000-0002-2225-5421; Joongho Jo: http://orcid.org/0000-0002-1802-7602; Yunhyung Kwon: http://orcid.org/0000-0002-7113-4626; Yeon-Kyeng Lee: http://orcid.org/0000-0002-0828-455X; Youngtaek Kim: http://orcid.org/0000-0003-0139-7620

REFERENCES

1. World Health Organization. Manifesto for Safe Communities: safety - a universal concern and responsibility for all [cited 2020 May 9]. Available from: https://www.iadt-dentaltrauma.org/Manifesto%20for%20Safe%20Communities.pdf.
2. Organization for Economic Cooperation and Development. Health status: causes of mortality [cited 2020 May 9]. Available from: https://stats.oecd.org/index.aspx?queryid = 30115.
3. International Labour Organization. Fatal occupational injuries per 100,000 workers by sex and migrant status-annual [cited 2020 Jul 13]. Available from: https://www.ilo.org/shinyapps/bulkexplorer/dis8/?lang=en&segment=indicator&tid=INJ_FATL_SEX_MIG_RT_A.
4. International Transport Forum. Road safety annual report 2018 [cited 2020 Jul 13]. Available from: https://www.itf-oecd.org/sites/default/files/docs/irtad-road-safety-annual-report-2018_0.pdf.
5. Health Insurance Review & Assessment Service. 2016 National health insurance statistical yearbook; 2017 [cited 2020 Jul 14]. Available from: https://www.hira.or.kr/bbsDummy.do?pgmid=HIRAA020045010000&brdScnBltNo=4&brdBltNo=2293&pgIndex=4 (Korean).
6. Park K, Han M, Lee U, Jang S, Yu G, Kim Y, et al. Estimation and evaluation of road traffic accident cost. Wonju: Road Traffic Authority; 2015, p. 85 (Korean).
7. Chang T, Kim T, Lee U, Jang S, Jo H, Yu G, et al. Estimation and evaluation of road traffic accident cost. Seoul: Road Traffic Authority; 2014, p. 85 (Korean).
8. Jang Y, Park H, Jo H, Lee U, Yu C, Hwang J, et al. Estimation and evaluation of road traffic accident cost. Seoul: Road Traffic Authority; 2007, p. 63 (Korean).
9. Ministry of Employment and Labor. 2015 Industrial disaster occurrence current status and analysis. Sejong: Ministry of Employment and Labor; 2016, p. 9 (Korean).
10. Lee J, Kim Y, Jeong G, Park H, Kim J, Eun S, et al. Accident statistics database establishment and analysis and research of current status [cited 2019 Jan 24]. Available from: www.snu-dhpm.ac.kr/pds/files/안전사고통계DB%20최종보고서(공단).pdf (Korean).
11. Frank E Bird FE, George L Germain GL. Practical loss control leadership. Loganville: Det Norske Veritas; 1996, p. 21.
12. Lee KO. A study on sampling design and weighting for Korea hospital discharge survey. Seoul: Korea Centers for Diseases Control and Prevention. 2007, p. 29-56 (Korean).
13. Kim J, Kim RH. 2017 Causes of mortality. Daejeon: Statistics Korea; 2018, p. 9 (Korean).
14. Park HS. Investigation of injury-related risk factors affecting injury hospitalization using multiyear data from the Korea national injury discharge surveillance. Cheongju: Korea Centers for Diseases Control and Prevention. 2017, p. 79-114, 255 (Korean).