Injury Among Older Adults in Ohio

Final Project Report

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Introduction

Injury is an important cause of death and disability among adults age 70 years or older in the United States and Ohio. In 2007, unintentional injury was the ninth leading cause of death among adults age 65 years or older in the United States.[1] In addition to deaths, many non-fatal injuries lead to a sudden loss of functional independence among the elder population. The population age 65 years or older increased 11-fold between 1900 and 1994, while the nonelderly population increased only 3-fold. Older adults represented 12.4% of the US population in 2000, and that percentage is projected to rise to 19.0% by 2030.[2] Because the proportion of the US population that is 70 years or older is increasing, the public health importance of injuries among older adults will continue to increase in future years.

This study describes the medical and economic impact of injuries to older adults age 70 years or older in Ohio in 2004-2009 with an emphasis on mechanisms of injury that are known to be more common and/or severe in the geriatric population, including falls, motor vehicle crashes, pedestrian collisions, residential fires, self-inflicted injury/suicide, unintentional suffocation, and unintentional poisoning.

Data for this report were derived from the Ohio Department of Public Safety's crash records, emergency medical services (EMS) records, and trauma registry; the Ohio Hospital Association's hospital emergency department (ED) and inpatient discharge databases; and the Ohio Department of Health's death certificate database. In addition, two probabilistically-linked statewide databases were utilized: (1) the Ohio crash records and the Ohio hospital discharge database, and (2) the Ohio hospital inpatient discharge database and the Ohio Trauma Registry.

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Executive Summary

Background

Injury is an important cause of death and disability among adults age 70 years or older in the United States and Ohio. In 2007, unintentional injury was the ninth leading cause of death among adults age 65 years or older in the United States.[1] In addition to deaths, many non-fatal injuries lead to a sudden loss of functional independence among the elder population. The population age 65 years or older increased 11-fold between 1900 and 1994, while the nonelderly population increased only 3-fold. Older adults represented 12.4% of the US population in 2000, and that percentage is projected to rise to 19.0% by 2030.[2] Because the proportion of the US population that is 70 years or older is increasing, the public health importance of injuries among older adults will continue to increase in future years.

Study Objective

This study describes the medical and economic impact of injuries to older adults age 70 years or older in Ohio in 2004-2009 with an emphasis on mechanisms of injury that are known to be more common and/or severe in the geriatric population, including falls, motor vehicle crashes, pedestrian collisions, residential fires, self-inflicted injury/suicide, unintentional suffocation, and unintentional poisoning.

Methodology

Data for this report were derived from the Ohio Department of Public Safety's crash records, emergency medical services (EMS) records, and trauma registry; the Ohio Hospital Association's hospital emergency department (ED) and inpatient discharge databases; and the Ohio Department of Health's death certificate database. In addition, two probabilistically-linked statewide databases ((1) Ohio crash records and the Ohio hospital discharge database, and (2) the Ohio hospital inpatient discharge database and the Ohio Trauma Registry) were utilized.

Conclusions

The findings of this study clearly demonstrate that injuries are an important public health problem among Ohioans age 70 years or older. The reduction of injury-related mortality and morbidity among the geriatric population in Ohio must be prioritized through informed public policy and evidence-based, targeted educational efforts in order to promote quality of life among the geriatric population at both the state and national levels.

Investigators and Project Personnel - Information/Qualifications

Principal Investigator - Gary A. Smith, MD, DrPH. - Dr. Gary Smith is a Professor of Pediatrics of the Ohio State University College of Medicine with joint faculty appointments in the Division of Epidemiology, College of Public Health, and in the Department of Emergency Medicine. He is founder and Director of the Center for Injury Research and Policy (CIRP) and is a pediatric emergency medicine physician at Nationwide Children's Hospital in Columbus, Ohio. Dr. Smith is board certified in the specialties of pediatrics and general preventive medicine and public health, and in the subspecialty of pediatric emergency medicine. In addition to his clinical training, Dr. Smith holds Master of Public Health and Doctor of Public Health degrees from the Johns Hopkins Bloomberg School of Public Health. Dr. Smith is the principal investigator of the Ohio CODES program and several other ongoing injury research projects.

Co-Investigator - Huiyun Xiang, MD, PhD, MPH. - Dr. Xiang is an Associate Professor of Pediatrics in the Ohio State University College of Medicine and a research faculty member in CIRP. Dr. Xiang is an injury epidemiologist with advanced training in biostatistics. He has more than 15 years experience in large data management and statistical analysis. Dr. Xiang is the PI of several ongoing injury research projects, and is Co-PI of the Ohio CODES Program.

Co-Investigator – Jonathan I. Groner, MD. - Dr. Groner is a Clinical Professor of Surgery at the Ohio State University College of Medicine, the Medical Director of the Level 1 Pediatric Trauma Program at Nationwide Children's Hospital, and an affiliate research faculty member in CIRP. He was president of the Central Ohio Trauma System.

Project Research Manager – Lynne Rochette, PhD. - Dr. Rochette obtained her degree in experimental psychology from Ohio University. She has experience in conducting research, performing data analysis, peer-reviewed publication, and teaching research methods and statistics.

Data Analysis Supervisor - Brenda J. Shields, MS. - Ms. Shields has more than 17 years of experience with managing and analyzing large and complex datasets. She is lead or co-author of numerous research studies on injury-related topics published in the peer-reviewed scientific literature.

Literature Review

Injury is an important cause of death and disability among adults age 70 years or older in the United States and Ohio. In 2005, unintentional injury was the eighth leading cause of death among adults age 65 years or older in the United States.[1] In addition to deaths, many non-fatal injuries lead to a sudden loss of functional independence among the elder population.

A number of mechanisms of injury are known to be more common and/or severe in the geriatric population, including falls, motor vehicle crashes, pedestrian collisions, residential fires, self-inflicted injury or suicide, unintentional suffocation, and unintentional poisoning.[2] Falls are the leading cause of injury death among older adults. In 2005, among individuals age 65 or older in the United States, falls accounted for 15,800 deaths, more than 433,000 hospitalizations, and approximately 1.8 million emergency department visits.[3] Fall-related injury risk increases with age. In 2004, approximately 85% of fall-related deaths were among adults age 75 or older. In 2000, the direct costs of fall-related injuries among individuals age 65 years or older was more than $19 billion.[4]

Motor vehicle-related fatalities are the second leading cause of death among adults age 65 or older.[2] In 2009, this age group accounted for 14% of all traffic deaths, 14% of vehicle occupant fatalities, and 19% of pedestrian deaths nationally.[5] Age is a strong predictor of severe injury in motor vehicle crashes.[6] Drivers age 80 years or older have higher crash fatality rates per mile driven than all but teen drivers.[7] Older pedestrians are at increased risk of injury due to losses in hearing, vision, cognitive function, reflexes, flexibility, and ambulatory speed. Pedestrians age 60 years or older struck by a motor vehicle have higher in-hospital fatality rates than younger pedestrians.[8] Pedestrians age 70 years or older accounted for 15% of all pedestrian fatalities and 6% of all pedestrian injuries in the US in 2008.[9] Older adults are the most vulnerable population in the US to fire-related injury and death. Fire/burns is the seventh leading cause of injury death among individuals age 65 years or older.[2] Risk factors include cognitive and physical impairments, medication use, and increased likelihood of living in poverty. In 2004, persons age 65 years or older accounted for 12% of the US population but sustained more than 30% of all fire-related fatalities. This age group is 2.6 times more likely to die in a fire than the general population.[10]

Suicide is a leading cause of death among older adults; suicide by use of firearm is the fourth leading cause of injury death among persons age 65 years or older.[2] In 2004, adults age 65 years or older comprised 12% of the US population and accounted for 16% of suicides. That same year, the suicide rate among older adults was 14.3 per 100,000 compared with approximately 11 per 100,000 in the general population.[11]

Between 1999 and 2007, unintentional suffocation was the fifth leading cause of injury death in adults age 65 years or older, and the third leading cause in adults over the age of 85 years.[2] In 2009, the nonfatal unintentional suffocation injury rate among adults age 70 years or older was approximately 35 per 100,000 compared with 7.8 per 100,000 in adults ages 18-69 years.[2] Older adults are believed to be at high risk for unintentional suffocation injuries due to the prevalence of central nervous system (CNS) diseases that can impair coordination and/or mental function, such as stroke, Parkinson's disease, Alzheimer's disease, and other forms of dementia. A common medical condition called dysphagia

(difficulty swallowing), often associated with CNS conditions, can make tasks such as swallowing food or medication difficult and is believed to play a role in elderly suffocation injuries.

Drug-related problems are common in older adults. According to the Centers for Disease Control and Prevention, more than 500,000 adults age 65 years or older suffered nonfatal unintentional poisoning-related injuries between 2001 and 2007.[2] In addition, Hu and Baker reported that the unintentional poisoning ED admission rate among adults age 65 years or older increased 143% between 2001 and 2007.[13] In 2007, unintentional poisoning was the eighth leading cause of injury death among adults age 65 years or older.[2] Poisoning risk among the elderly is likely related to physiologic changes associated with aging, increased prevalence of disease, non-adherence with medications, multiple medication use, inappropriate prescribing practices, and many other factors.[14] Prior research has noted that certain medication classes such as analgesics, anticoagulants, anticonvulsants, asthma therapies, psychotherapeutics, and some cardiovascular agents were associated with higher risk of serious outcomes among older adults.[15]

This study investigated the medical and economic impact of injuries to older adults age 70 years or older in Ohio in 2004-2009 with an emphasis on mechanisms of injury that are known to be more common and/or severe in the geriatric population, including falls, motor vehicle crashes, pedestrian collisions, residential fires, self-inflicted injury/suicide, unintentional suffocation, and unintentional poisoning. Through this investigation, we have identified key risk and preventive factors associated with the outcome of injured older adults in Ohio. This Ohio-specific information will ultimately contribute to the development of informed public policy and evidence-based, targeted educational efforts in our state to prevent these injuries.

Historical Perspectives

The population age 65 years or older increased 11-fold between 1900 and 1994, while the nonelderly population increased only 3-fold. Older adults represented 12.4% of the US population in 2000, and that percentage is projected to rise to 19.0% by 2030.[2] Because the proportion of the US population that is 70 years or older is increasing, the public health importance of injuries among older adults will continue to increase in future years.

Current Status in Ohio

The Ohio Commission on the Prevention of Injury was convened by the Ohio Department of Health from 2001-2003 to evaluate the status of injury in Ohio with particular emphasis on the pediatric and geriatric populations. The Injury Commission's final report, titled “Injury in Ohio: A Report of the Ohio Commission on the Prevention of Injury” (URL: http://www.ems.ohio.gov/trauma/injprevcommreports.htm), did not include a comprehensive analysis of Ohio-specific injury data, especially injury morbidity data. This was

primarily due to difficulty in accessing some databases, such as the proprietary emergency department and hospital inpatient database of the Ohio Hospital Association, and the lack of linked statewide databases. The Injury Commission recognized the need for expansion and improvements in the use of injury surveillance data in Ohio, and one of its core recommendations was the linkage of existing statewide databases. Linkage of these databases was begun in 2004 with the initiation of the Ohio CODES Program. The Ohio Department of Health released a report in October 2008 titled "The Burden of Injury from Unintentional Falls in Ohio, 2002-2005" (URL: http://www.healthyohioprogram.org/diseaseprevention/falls.aspx). This report included descriptive analyses of data regarding falls-related injury among Ohioans, including the elder population; however, it primarily used data from Ohio hospital discharge records and death certificates, and its analyses were limited to injuries caused by falls. Ohio legislators invariably request Ohio-specific injury data when considering legislation to prevent injury among Ohioans, and these data have often been unavailable in the past. This study analyzed linked and unlinked injury-related data from 5 statewide databases in Ohio and provides the most comprehensive and detailed evaluation of injuries among older Ohioans ever completed.

Regional and National Trends

As previously mentioned, because the proportion of the Ohio and US populations that is 70 years or older is increasing, the public health importance of injuries among older adults will continue to increase in future years in Ohio and nationally.

Financial Considerations

Not applicable to this research project.

Education and Training Considerations

Not applicable to this research project.

Legislative and Regulatory Considerations

Not applicable to this research project

Data Considerations

Data Sources

This report utilized data from the Ohio crash database, Emergency Medical Services (EMS) database, hospital emergency department and inpatient discharge databases, trauma registry, and death certificates to study the medical and economic impact of injuries among older adults age 70 years or older in Ohio from 2004 through 2009. In addition to stand-alone data sets, probabilistic linkage was used to

link the Ohio crash records with the hospital discharge database and the hospital discharge database with the Ohio Trauma Registry.

Crash Records

Crash records are collected and maintained by the Ohio Department of Public Safety (ODPS). The crash database contains all reported crash incidents that involve an injury event or property damage in excess of $400. Approximately 350,000 crashes are reported by Ohio law enforcement agencies annually.

Emergency Medical Services (EMS) Records

EMS records are maintained by the Division of Emergency Medical Services of ODPS. EMS agencies in the state are required to submit data for each emergency run made. Current compliance is estimated at 88% of EMS agencies statewide. Ohio EMS began the transition toward a new system of reporting (Emergency Medical Services Incidence Report System, or EMSIRS-2, in the 2008 data year. As a result, some agencies reported using EMSIRS-1 and others reported using EMSIRS-2. EMSIRS-2 no longer includes an external cause of injury code, and instead utilizes broad injury categories. For the purposes of this project, every effort was made to reconcile injury categories between the two reporting structures for 2008 and 2009. In this study, an injury was defined as a mechanism of injury or external cause of injury code (E-code) in the range of E800-E988 (EMSIRS-1) or a record indicating an injury event (EMSIRS-2).

Hospital Discharge Records

Hospital discharge records, including inpatient admissions and emergency department (ED) visits, are collected and maintained by the Ohio Hospital Association (OHA) from information reported by the approximately 174 member hospitals. Ninety-eight percent of member hospitals report inpatient discharge data to OHA, and 80% are compliant in reporting ED data. For this report, an individual was classified as injured if the record contained a diagnosis code in the range of 800.00-960.00 or an E-code indicating an external cause of injury (E800-E999) according to the 9th Revision of the International Classification of Diseases, Clinical Modification (ICD-9-CM). The primary cause of injury was defined as the first-listed E-code in the hospital record. For the purposes of this analysis, we excluded those cases with an external cause of injury classified as the adverse effects of medical care or drugs (E870-E879, E930.0-E949.9).

Ohio Trauma Registry

Trauma registry records are maintained by the Division of Emergency Medical Services of ODPS. The Ohio Trauma Registry is a database that contains detailed information on all injured patients admitted to a hospital in Ohio for 48 hours or longer, injured patients who died at any point during their treatment, or injured patients who were transferred into or out of a hospital for further trauma care. By definition, all

records in the trauma registry were considered injuries for the purposes of our analyses. Poisonings are not recorded in the registry database. Trauma registry cases are referred to as "severe trauma" admissions in this report.

Death Records

Death records are maintained by the Ohio Department of Health (ODH), Office of Vital Statistics. A death was considered to be a fatal injury when a certifying physician identified an injury as the underlying cause of death. Death records with an ICD-10 code in the range of V01–Y98 were included in this report.

Ohio Population

US census data for the state of Ohio were used to calculate annual rates per 100,000 persons. Census counts for 2004, 2005, 2006, 2007, 2008, and 2009 were averaged together to obtain the average annual population in Ohio over the six-year study period.

Data Analyses

SAS version 9.2 was used to generate descriptive statistics (frequencies, means, medians, ranges) and to conduct logistic and linear regression model analyses to determine the influence of selected risk/protective factors on health outcomes. The Ohio crash records and the Ohio hospital discharge database and the hospital discharge database and the Ohio Trauma Registry were probabilistically linked using CODES2000 software to create two extensive combined research data sets for analysis. Our data analytic strategy included multiple imputation of missing values, with analyses conducted on five imputed data sets using the SAS MIanalyze procedure.[15,16,17,18]

Injury Severity Score (ISS) was determined from injury diagnosis codes (ICD-9-CM) using ICDMAP-90 software.[19] In order to make more accurate comparisons, hospital charges were adjusted for inflation using the Hospital Services Consumer Price Index (CPI) published by the Bureau of Labor Statistics.[20] All estimates of charges presented in this report are in 2009 dollars. Except where noted, incidences presented in this report are annual averages over the study period. So as not to introduce additional rounding bias, percentages are based on non-missing totals over the entire six-year period, rather than on annual averages.

Limitations

There were some limitations to this research investigation. Assignment of E-codes was often incomplete, resulting in missing data or nonspecific coding. In our study period, 47.8% of hospital inpatient records and 30.5% of ED records were not assigned an E-code, after exclusion of cases involving adverse effects of medical care. In addition, race and ethnicity data were not available in the hospital database and were missing for 16.7% of EMS records. Hospital charges are billed charges and not actual hospital costs. It

is likely that there were injured older adults who received medical care for whom our probabilistic linkage techniques were unable to link their crash and hospital or hospital and trauma records. Regression analyses presented in this report only included individuals who had a crash and hospital record or hospital and trauma record link. Finally, for this report, we chose to define an injury as an ICD-9-CM diagnosis of injury in any of the diagnosis code fields. This broader definition of injury allows us to gather a more complete picture of the injury burden among older adults in Ohio, but may also include cases in which the primary reason for admission was not related to injury.

Researcher Findings

Key Findings

- During 2004-2009, 1,619 older adults died as a result of an injury each year, equating to an annual death rate due to injury of 144.3 deaths per 100,000 population. In comparison, the annual death rates among adults ages 18-69 years and children 17 years or younger were 62.1 per 100,000 and 14.3 per 100,000, respectively.
- For each injury-related death among older adults, there were approximately 34 inpatient hospitalization and 68 ED visits.
- On average, an adult age 70 years or older visited the ED for treatment of an injury every five minutes.
- Overall, adults age 70 years or older accounted for 41.3% of all injury-related inpatient hospitalizations statewide, yet made up only 9.8% of the total population.
- The number of injury-related severe trauma admissions among older adults increased 48.9% between 2004 (7,857) and 2009 (11,700).
- Compared with adults ages 18-69 years, older adults were 1.14 times more likely to be admitted to the intensive care unit (ICU), 1.22 times more likely to have an injury severity score (ISS) >24, and 2.71 times more likely to die as a result of their injuries.
- Each year between 2004 and 2009, injured adults age 70 years or older accrued nearly $1.6 billion in hospital charges and spent nearly 323,000 days in the hospital.
- An annual average of 51,990 older Ohioans were treated in the ED and 20,828 (83.5% of those with a recorded cause) were hospitalized for a fall-related injury during 2004-2009.
- Older adults injured due to falls accumulated more than $480 million in hospital charges and spent nearly 96,317 days in the hospital each year during the six-year period.
- An annual average of 714 deaths due to falls occurred among adults age 70 years or older (63.6 per 100,000); the number of deaths due to falls among older adults increased 48.9% between 2004 and 2009.
- An annual average of 37,827 older Ohioans was involved in motor vehicle crashes in 2004-2009; 7,050 older adults were injured in these crashes.

- 93.0% of adults age 70 years or older injured in a motor vehicle crash were properly restrained, compared with 85.5% of adults ages 18-69 years and 82.2% of children age 17 years or younger.
- Older adults injured in motor vehicle crashes spent 3,048 days in the hospital and accrued nearly $21 million in hospital charges each year during 2004-2009.
- 74.9% of injuries due to pedestrian collisions among older adults occurred during daylight hours (6:00am - 6:00pm), compared with 53.3% among adults ages 18-69 years and 68.7% among children age 17 years or younger.
- There were an annual average of 169 EMS runs, 136 ED visits, and 54 inpatient hospitalizations among adults age 70 years or older for injuries sustained in pedestrian collisions during 2004-2009; the number of ED visits increased 14.5% over the study period.
- 19 older adults died as a result of injuries sustained in pedestrian collision injuries each year (18.3% of all pedestrian injury-related deaths)
- Residential fire/burn-related injuries among older adults resulted in an annual average of 488 ED visits and 109 inpatient hospitalizations; the number of inpatient hospitalizations increased 34.8% between 2004 and 2009.
- Adults age 70 years or older were 5.94 times more likely to die from residential fire-related injuries compared with adults ages 18-69 years, and 8.95 times more likely compared with children age 17 years or younger.
- Older adults spent 770 days in the hospital and accrued more than $4.3 million in hospital charges each year due to residential fire-related injuries. Mean hospital charge was $40,261 and mean length of stay was 7.1 days.
- 15.1% of trauma patients age 70 years or older admitted for fire-related injuries died compared with only 3.5% of adults ages 18-69 and 2.3% of children age 17 years or younger.
- There were 160 inpatient hospitalizations for self-inflicted injuries among older adults per year in 2004-2009. Poisoning, cutting/piercing, and firearms were the most common causes of admission.
- During 2004-2009, 145 adults age 70 years or older committed suicide each year, representing 10.9% of all suicides during this time period; the number of suicides among older adults decreased 11.9% between 2004 and 2009.
- A firearm was the cause of injury death for 74.5% (108) of suicides among older adults.
- The inpatient hospitalization rate for unintentional suffocation injuries among adults age 70 years or older was 8.1 per 100,000, more than three times the rate in both adults ages 18-69 years (1.2 per 100,000) and children age 17 years or younger (2.4 per 100,000).
- 24.7% of older adults hospitalization for unintentional suffocation injuries each year was noted to have one or more associated CNS conditions, such as dysphagia, stroke, Parkinson's disease, Alzheimer's disease, or other forms of dementia.

- Between 2004 and 2009, the number of inpatient hospitalizations for unintentional poisonings among older adults increased 26.1%.

Please see the accompanying report titled “Injury Among Older Adults in Ohio, 2004–2009” for a complete description of study findings.

Conclusions

The findings of this study clearly demonstrate that injuries are an important cause of morbidity and mortality among Ohioans age 70 years or older. Injury-related disability and death within the geriatric population has a substantial medical and economic impact, resulting in nearly $1.6 billion in hospital charges and nearly 323,000 days of hospitalization annually during 2004-2009. Regardless of the cause of injury, older adults are consistently more likely to require long-term care and ultimately die as a result of their injuries when compared with younger age groups.

Recommendations

Evidence-based, targeted prevention efforts aimed at reducing injury-related morbidity and mortality in this vulnerable population should be implemented at the state and local levels in Ohio.

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