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Yara K. Haddad Date

Approval Sheet

Method Comparison and Cost Estimation of the Healthcare Economic Burden of Older Adult Falls: A State Specific Perspective

by

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Degree to be awarded: M.P.H.
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Method Comparison and Cost Estimation of the Healthcare Economic Burden of Older Adult Falls: A State Specific Perspective

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An abstract of
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2017

ABSTRACT

Title: Method Comparison and Cost Estimation of The Healthcare Economic Burden of Older Adult Falls: A State Specific Perspective
By
Yara K. Haddad, PharmD

Introduction: Unintentional falls in older adults impose a significant economic burden on the health care system. Previous studies estimated the direct medical costs for falls at the national level; however, state level economic estimates are limited. This study compares two methods to estimate state level direct medical costs of falls in older adults.

Methods: In the partial attributable fraction method, the total personal health expenditure was obtained by state of residence from publically available National Health Expenditure Accounts (NHEA) categorized by payer type. The percentage of total spending by payer for older adults was obtained from age-gender files in NHEA to estimate payer expenditure for older adults by state. Then, the proportion of national spending attributable to older adult falls was applied to estimate the total health expenditure for older adult falls per state and payer. All payer expenditures were totaled to calculate state expenditure attributable to older adult falls.

In the count applied to cost method, counts of older adults hospitalized and treated in emergency department (ED) due to fall injury were obtained from the Healthcare Cost and Utilization Project (HCUP) using injury diagnosis and external causes of injury codes. The counts were multiplied by the average lifetime medical cost of treatment for ED treated and hospitalized older adult falls from the Web-based Injury Statistics Query and Reporting System (WISQARS). The two costs associated with hospitalization and ED visits were totaled for available states.

All costs were indexed to 2012 US-dollars.

Results: The count applied to cost estimates of direct medical costs due to falls were lower compared with the partial attributable fraction method.

Conclusion: The methods highlighted offer states a way to estimate the economic burden of older adult falls per year. The difference in cost estimates can be attributed to different cost categories used to calculate the direct medical costs. The partial attributable fraction method captures a more comprehensive cost estimate of all associated healthcare costs and displays the proportion of cost by each of the three major payers –Medicaid, Medicare and Private Insurance. The count applied to cost method allows for quick estimates per state generated hospitalization and ED records.

Word count: 350

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1. INTRODUCTION

1.1 Background

Unintentional falls are defined as those occurring unexpectedly from a resting or standing position while performing activities of daily living (1). Adults age 65 and older (older adults) commonly sustain a fall or fall related injury while walking, carrying objects, and reaching or leaning (2). Most commonly, older adults attribute falling to unstable balance, trip and slips, hurrying, and walking on uneven surfaces (3). Older adult falls can result in a loss of independence regardless of injury occurrence (4, 5). Additionally, many older adults develop a chronic fear of falling, limiting their mobility, reducing physical exercise to promote stability, and increasing movement hesitancy (4, 6). Studies have shown that fear of falling and a previous fall are strong predictors for repeat falls, causing a downward spiral of declining functional ability and overall health (7, 8).

1.2 Epidemiology of Older Adult Falls

Falls are the leading cause of injury, injury death, and a significant source of prolonged use of healthcare services in older adults (9, 10). About 2.8 million older adults were treated in emergency rooms for fall injuries in 2014, and there were 27,000 older adult fatalities due to a fall (10, 11). Additionally, approximately 29% of older adults reported a fall in 2014 (11). The majority of hip fractures in older adults result from unintentional falls (12). Many older adults sustaining a hip fracture post fall require assistance with activities of daily living, an increase in use of walking aids and an increased need for nursing home placement (13). Approximately 50 percent of hospitalized older adult fall injuries resulted in admission to a nursing home (14). Older adult fall injury poses a significant social burden to public health and the health care system due to the high incidence and long term effects.

1.3 Older Adult Fall Risk Factors

Numerous risk factors have been identified that increase the rate and risk of falling in older adults. Risk factors for falls include unsteady gait, loss of balance, muscle weakness, changes in vision, and multiple or certain types of medications (9). Classes of medications associated with an increased risk of falls include beta blockers, diuretics, sedatives, hypnotics, neuroleptics, antipsychotics, and benzodiazepines among others (15). Adverse events from such medications often result in hypotension, orthostatic hypotension, hypoglycemia, and impaired cognition which affect gait and balance and can result in a fall (15).

Additionally, falls in the older adult population are frequently attributed to environmental factors (9). Examples of environmental causes in homes or living quarters are throw rugs, clutter, presence of cords or wires, high or low cabinets, and non-slip resistant surfaces especially in bathtubs and kitchens (16).

1.4 Economic Burden of Older Adult Falls

Falls and fall injuries result in a high economic burden due to the direct medical costs of treatment and post treatment healthcare services (14). In 2015, the national direct medical cost of fatal falls for older adults was estimated at $573.3 million (10). Additionally, in 2015, the national direct medical cost due to older adult non-fatal fall injury was estimated at $18.0 billion for hospitalization and $4.0 billion for emergency department treated and released injuries (10).

The Web-based Injury Statistics Query and Reporting System (WISQARS) allows for national, regional, or state-level lifetime medical cost estimation of fatal falls through the cost of injury module. It provides a national estimate of nonfatal fall injuries total lifetime medical costs. However, WISQARS cost of injury reports does not provide state specific non-fatal fall cost estimation. A literature review of current available data of costs provides estimates of direct costs of fatal and non-fatal falls at the national level (17-23), lifetime cost of fall injury at the national level (18), and acute medical care costs due to falls at the national level (20). Currently, there are

no good estimates or uniform data across states to estimate the state level direct medical costs of older adult falls or fall injuries.

The Healthcare Cost and Utilization Project data (HCUP) offers one potential method of estimating state costs due to older adult falls. The State Emergency Department Databases (SEDD) and the State Inpatient Databases (SID) contain data on total charges for each hospital discharge. The charges do not reflect the actual hospital services cost or the amount hospitals were reimbursed for the services; rather, it shows the amount the hospital billed for a service. The files available for the SID and SEDD contain cost to charge ratios that can be used to adjust the charges. However, these are hospital-specific, making it difficult to use this method for a state level estimation of direct medical costs (24).

1.5 Study aims

This study further investigates methods to estimate state-level healthcare costs of falls in older adults. The primary aim is to estimate direct medical costs using two different methods, compare the estimates, and discuss the strengths and weaknesses of each. The methods will include: 1. the partial attributable fraction method which applies the national fraction of healthcare spending attributable to older adult falls to the state annual health expenditures by payer, and 2. the count applied to cost method which uses counts of fall injures from SID and SEDD databases with WISQARS Cost of Injury Reports. The end result of this study is to provide assistance to states in estimating the economic burden of older adult falls.

2. LITERATURE REVIEW

2.1 Background

Unintentional falls are the leading cause of injury and death in older adults and result in significant use of healthcare services (17, 22, 23, 25). In 2014, 60% of all injury related emergency department visits for older adults were due to unintentional falls (10). Additionally, 79% of all injury hospitalization in older adults were attributed to falls (10). For 2014, the average lifetime direct medical cost for non-fatal older adult falls is $42,239 for hospitalization and $3,240 for emergency department treated and released injuries (10). In the United States, the older adult population is projected to increase 55% by 2030 (26). With this projected growth, the direct medical costs due to falls will continue to increase, amplifying the economic burden of fall injuries (27). Currently however, there is not a standardized method to estimate the economic burden of older adult falls on a state level. This is important for states to estimate their healthcare spending on older adult fall injuries and to track changes in spending across the years. The change in spending allows state health departments to evaluate the outcome of policies or interventions introduced for fall prevention. This review will highlight the numerous methods previously used to estimate the national direct medical costs of falls and fall injuries and compare for similarities and differences.

Medically treated injuries from falls can be determined from medical records using the External Cause of Injury codes (E-codes) a subset of the International Classification of Diseases codes (ICD codes) (28). The International Collaborative Effort (ICE) on injury statistics utilizes E-codes to classify injury by mechanism and intent. Mechanism of injury is classified as motor vehicle, fall, firearm, poisoning and the intent

is classified as unintentional, homicide, suicide or undetermined. The external cause of injury codes for unintentional falls are listed in categories E880-E886.9 and E888 in the ninth revision of clinical modification classification (ICD-9-CM) which was in use in the United States from January 1, 1999 to October 1, 20151. The Centers for Disease Control and Prevention has also published a recommended framework of E-code groupings to code for external causes of injury by mechanism/ cause of injury and the manner/ intent of injury (29).

2.2 National Cost Estimation of Older Adult Falls

A study to estimate the cost of fall related injury among community dwelling older adults utilized a prevalence approach with data from the Medical Expenditure Panel Survey (MEPS) (22). MEPS provides a complete source of data on the cost and use of health care and health insurance coverage. It collects information from patients, medical providers and employers regarding payments and charges for use of medical care services. For this study, the authors used two components of the MEPS: Household component (HC) and Medical Provider Component (MPC) (22). The self-reported medical conditions were described by the 3 digit ICD-9 CM codes associated with treatment, the 2 digit ICD-9 CM associated with the condition, and the outcome of the health condition as death or place of treatment: emergency room, inpatient hospitalization, home health care, office based visits, dental visits, outpatient visits, and prescription drugs (22). The study estimated cost and utilization of medical care for falls in the United States. The direct medical cost associated with falls was estimated at $6.2 billion for the year 1997 (inflated to $10.4 billion in 2012 dollars) with a mean cost per person due to falls at $2,039 in in 1997 (inflated to $2,713 in 2012 dollars). Limitations

reported by authors include use of self-reported data, recall bias from participants, and low participation rates.

The acute medical costs of fall injury were estimated in an analysis conducted by Roudsari et al (20). The study design utilized the 1998 MarketScan® Medicare Supplemental database. The MarketScan® is a healthcare database for the private sector and includes data from employers, health plans, and government organizations that estimates hospital reimbursement from payers. The cost estimation was based on reimbursement received by hospitals, emergency departments and outpatient facilities for services rendered in treating unintentional falls in older adults. The authors identified unintentional falls using ICD-9-CM Ecodes (E880- 888.0) in 14 diagnosis fields for hospital admissions and 2 diagnosis fields for outpatient visits. The study estimated a mean cost of $234 in 2004 (inflated to $289 in 2012 dollars) for a single ED visit, and a mean length of hospital stay of 7.6 days with a mean cost of $17,483 in in 2004 (inflated to $21,614 in 2012 dollars) due to unintentional falls for older adults. The limitation of this study is that it only reports the costs of falls treated in an ED or hospital. In addition, they reported a likely underreporting of unintentional-fall-related E-codes for fallers in the MEPS database as only 6.7% of older adults with a hip/femur fracture were also coded with a fall-related-injury E-code.

Another study used multiple datasets to estimate the total lifetime costs of injuries for all ages in medical costs (18). In the analysis, medical costs of non-hospitalized injuries were estimated using MEPS but due to the small sample size, the number of hospitalizations were obtained from the HCUP–Nationwide Inpatient Sample (NIS) and the number of Emergency Department (ED) treated injuries were obtained from the

National Electronic Injury Surveillance System – All Injury Program (NEISS-AIP). Hospitalized injury costs were estimated using HCUP-NIS cost-to-charge ratio, with MarketScan ® to quantify other medical costs during hospitalization. Incidence and lifetime medical costs of injury by age group and by mechanism were reported for the year 1985 and inflated to year 2000 US $ (30). Limitations reported by the authors include the use of multiple data sources of varying quality and different years to generate the incidence and cost estimates and a possible loss of data from coding differences (30).

Another study of older adult falls by Burns et al estimated direct medical costs of both fatal and non-fatal injuries in the hospital, ED, and outpatient settings in 2012 (19). The study used HCUP-NIS for number of fall-injury related hospitalizations, HCUP-NEDD for number of fall related ED visits, and MEPS for falls treated in outpatient non-emergency and physician office settings. The cost of fatal falls was available through the CDC's WISQARS data. The costs of non-fatal falls were estimated using claims data from the 1998/1999 Medicare fee-for-service Standard Analytical files. The findings show that in 2012, there were 3.2 million non-fatal falls that received medical treatment and 24 thousand fatalities. The direct medical costs were estimated at 30.3 billion (2012 US$) for non-fatal falls and 616.5 million (2012 US$) for fatalities. A limitation of this study is the use of multiple data systems with their variations in coding and reporting to calculate an estimated cost of fall injuries.

A recent study estimated health care costs of older adult falls by applying the fraction of total expenditures attributable to falls based on modelling Medicare Current Beneficiary Survey data to National Health Expenditure Accounts (NHEA) (31). The total attributable fraction due to non-fatal falls was 6.34% for Medicare, 8.89 % for

Medicaid and 5.01% for private insurances and out of pocket spending (31). Key findings indicate that health care expenditures attributable to falls vary by payer type and place of service. The study reported the personal healthcare expenditure attributable to older adult falls was higher than $49 billion dollars in 2012 (31).

2.3 State Cost Estimation of Falls

In their study, "The Cost and Frequency of Hospitalization for Fall-Related Injuries in Older Adults", Alexander et al. estimated the cost of falls of older adults in Washington state using a population based hospital discharge registry with Ecodes (23) . Although the data presented is dated, this study provides another perspective in estimating costs. The authors used 1989 hospital discharge data from the Washington State Commission Hospital, excluding Veterans Administration and military hospitals. Patients were stratified into groups using both ICD discharge codes and Ecodes suggesting mechanism and intent of injury. For fall related trauma, ICD trauma codes (800-904, 910-957) were used with Ecodes for falls (E880-E889). The frequency and cost of hospitalization for fall related injuries were obtained from hospital discharge data and then compared with other causes of trauma (non-fall related, trauma of unknown cause, non-trauma injuries, and injuries of unknown cause). The data analysis confirmed that falls are the leading cause of injury in older adults, and estimated the cost of falls resulting in hospitalization as $92 per person per year in 1989 US$ (inflated to $236 in 2012 dollars). The authors indicate that this is a gross underestimation of the cost and attribute the finding to limitations including incomplete use of Ecodes when reporting, non-prioritized diagnosis codes, and incomplete cost estimation of medical charges post hospitalization. Individual states may track unintentional older adult falls through their

state specific Injury Surveillance Data System (ISDS). In Florida, the ISDS obtains data from three primary sources: Vital records, hospital discharge data, and emergency department discharge data. External cause of injury Ecodes are used to stratify intent, mechanism and description of the injury. Unintentional fall Ecodes include E880-E886, E888, E957, E968.1, E987. The report for the year 2014 indicated a total of 50,734 non-fatal fall injuries resulting in hospitalization and 158,197 total treated in ED for older adults. The limitations reported by the Florida State Department of Health include possible underestimation due to incomplete reporting of injury using ICD-9-CM Ecodes. Additionally, readmissions and multiple hospital visits were not excluded in the analysis (32).

California defines unintentional injury from falls with slightly different Ecodes (880-886, and 888). In 2014, California reported 74, 945 cases of unintentional non-fatal fall hospitalizations and 208,564 cases of ED treated/released or treated/transferred to another facility for adults 65 and older (33). These examples indicate that there is limited consistency among states even with the definition of an unintentional fall related injury reported on the state level. The limitation for Florida and California in determining the number of medically treated fall injuries is due to incomplete coding or coding inconsistencies between provider types and facilities. It is also difficult to obtain economic estimates from hospital discharge data. Hospital records are generally presented as charges and not actual medical costs. Additionally, this method of estimating injuries treated in emergency departments and inpatient settings excludes many other medical services used for fall injury treatment.

2.4 Conclusion

Prior national estimates of non-fatal fall related injury costs in older adults vary widely due to differences in the method of identifying a fall related injury by diagnosis and E-codes, use of multiple and varying databases to extract information, and the differences in study design. Additionally, although the target study group is older adults, the population composition varies by source of data; for example hospital discharge claims, Medicare data and Medical Expenditure Panel Survey all include different populations and include people under 65 years of age. This has made it difficult to compare or update direct medical costs of falls between studies.

Similarly, there is a general lack of accurate and consistent data on the state level to estimate the cost of falls in older adults. This poses a concern when estimating the economic burden of injury due to a fall on a state level. Falls incur the highest costs of injury in older adults nationwide compared to other causes of injury (21).

3. STUDENT CONTRIBUTIONS

3.1 Student Contribution to Project

I researched data sources and obtained data for the analysis. I conducted the literature search and review. I conducted the data analysis, cost comparison between the methods, and developed tables of results and findings. I obtained assistance with writing the SAS code for the HCUP-SID/SEDD files from Elizabeth Burns, MPH and LiKang Xu, MD, MS at the Centers for Disease Control and Prevention (CDC) – National Center for Injury Prevention and Control (NCIPC). The code was specific for the E-codes of interest to measure incidence of fall related injury in individuals above 65 years old and additional specifications to exclude readmission data in states with available data variables. I adjusted the code to fit my project asks and interests. I conducted the remainder of the analysis, compiling data of incidence for 28 states in the SID database and 18 states in the SEDD database. I then extrapolated costs associated with fall injury from the WISQARS cost of injury reports. The remainder of the work including attributable fraction calculations, analysis, result display, and writing the article, I completed individually but under the supervision of site advisor Gwen Burgen, PhD, MPH, MS with guidance from health economist Curtis S. Florence, PhD both with the CDC's NCIPC.

3.2 Intended Journal for Publication

The intended journal for first submission is the 'Journal of Public Health Management & Practice'. This is a peer-reviewed journal with a primary focus on practice-based research and programs to improve population health. Submission is required via electronic file in

Microsoft Word. Requirements include submission of a title page including any disclaimers or acknowledgements, abstract, implications for policy and practice (100-200 word max), and a human participant compliance statement in addition to the manuscript text.

3.3 Institutional Review Board Exemption

An IRB application was submitted for review and approval from the Emory University institutional review board. Because the data used does not include research with human subjects, the project received an exemption and informed consent was waived.

4. PUBLIC HEALTH IMPLICATIONS

Older adult non-fatal fall related injuries are associated with significant and prolonged economic costs to the patient and health care system. However, the economic burden is often underestimated at the national level. There are no consistent state level estimates. Much of the policy and practice for fall prevention strategies happen at the state level or lower. It is important for states to understand the economic impact of older adult falls and to be able to track spending across the years. The tracking allows states to determine if strategies implemented to address the problem have positive outcomes and are resulting in a decreased incidence and associated cost of fall injuries. Numerous interventions identified can reduce the risk and rate of falls in older adults. However, implementation of interventions remains insufficient to address this major public health concern in many healthcare settings and states.

Currently, limited studies provide guidance on estimating the economic burden of falls on a state level. My study provides public health officials at the state and local levels two different methods to measure the direct medical costs of falls and fall injuries for their perspective states. The results of this study will aid in the assessment of the magnitude of the problem and in allocation of sufficient resources for implementing fall prevention interventions. Both methods of cost estimation offer valuable insight in calculating the economic burden of unintentional injury from falls. States may choose to use their own counts for residents hospitalized or admitted to ED applied to the WISQARS cost of injury module to obtain an estimate of medical costs of facility and associated charges. This provides states with the ability to obtain quick modifiable estimates of cost of fall injuries. The more comprehensive partial attributable fraction

method of health care expenditure, available for a number of historical years and future projections, offers more details of spending by payer type – Medicare, Medicaid, and private insurance. This allows states to track their spending on potentially preventable injuries using Medicare dollars and state sponsored Medicaid costs.

5. MANUSCRIPT

Introduction

Unintentional falls in individuals 65 years and older (older adults) are the leading cause of injury, injury death, and a significant source of prolonged use of healthcare services in the United States (17, 22, 23, 25). These injuries impose a significant economic burden to public health and the health care system due to the high incidence and long term effects (19, 23, 26). In 2014, approximately 30% of older adults reported a fall (11), 2.8 million older adults were treated in emergency rooms due to unintentional falls, and 27,000 older adults died due to falls (10, 11). Among older adults, 61% of injury related emergency department visits and 79% of injury hospitalizations were attributed to falls in 2014 (10). Furthermore, the older adult population is projected to increase by 55% in the United States by 2030 (27). With this projected growth, the direct medical costs due to falls will continue to increase, amplifying the economic burden of fall injuries (28).

There are a number of studies that estimated the direct medical costs for fatal and non-fatal falls (17-23). A recent study estimated health care costs of non-fatal falls by applying the fraction of total expenditures attributable to falls based on modelling Medicare Current Beneficiary Survey data to expenses from theNational Health Expenditure Accounts (NHEA) (29). The total attributable fraction due to non-fatal falls was 6.34% for Medicare, 8.89 % for Medicaid and 5.01% for private insurances and out of pocket spending (29). The total older adult health care spending estimate attributable to a fall was over $49 billion dollars in 2012 (29). Another estimate of older adult falls cost calculated a total cost using direct medical cost estimates of both fatal and non-fatal injuries in the hospital, ED, and outpatient settings in 2012 (19). The findings show that in 2012

there were 3.2 million non-fatal falls that received medical treatment that cost an estimated 30.3 billion in 2015 US$ (19). Another recent study explored healthcare spending in the United States by condition for year 2013 (21). In 2013, the total personal healthcare spending on fall injuries was reported as $76.3 billion with an estimated 48.2% of that attributed to adults age 65 and older ($36.8 billion) (21).

Prior national estimates of non-fatal fall-related injury costs in older adults vary widely due to differences in the methods used to identify a fall, use of multiple and varying databases to extract information, and the differences in study design. Additionally, although the target study group is adults older than 65 years old, the population composition varies due to source of data such as hospital discharge claims, Medicare data and the Medical Expenditure Panel Survey of patients and providers. This has made it difficult to compare or update direct medical costs of falls between studies.

Currently, there are no estimates of state level costs of fall related injuries in older adults. Many of the databases that have these costs on a national level are based on samples across the states. The Healthcare Cost and Utilization Project data (HCUP) offers one potential method of estimating medical costs of falls at the state level. The State Emergency Department Databases (SEDD) and the State Inpatient Databases (SID) contain data on total charges for each hospital discharge. The charges do not reflect the actual hospital services cost or the amount hospitals were reimbursed for the services; rather they show the amount the hospital billed for a service. The files available for the SID and SEDD contain cost to charge ratios that can be used to adjust the charges but these are hospital-specific, making it difficult to use this method for a state level estimation of direct medical costs (24). Ultimately, there is a general lack of accurate and consistent data on the state

level to estimate the cost of falls in older adults. This poses a concern when estimating or tracking the economic burden of injury due to a fall on a state level.

This study investigates methods to estimate state-level medical and healthcare costs of falls in the older adult. The primary aim is to estimate direct medical costs using two different methods, compare the estimates, and discuss the strengths and weaknesses of each. The end result of this study is to provide assistance to states in estimating the economic burden of older adult falls.

Methods

The two methods to estimate the healthcare spending attributable to older adult falls are (1) applying the national fraction of medical spending attributable to falls to total state health expenditures (partial attributable fraction method) and (2) use HCUP SID and SEDD databases to obtain medically treated fall injuries and multiply by the average cost per medically treated injury from the Web-based Injury Statistics Query and Reporting System (WISQARS) Cost of Injury Reports (count applied to cost method). The incidence and cost of falls were limited to older adults for both cost estimation methods. The states included for the final comparison were limited to those available in the 2011 SEDD dataset, although costs are shown for all states when available.

Overview of Method 1

In the partial attributable fraction method, the personal healthcare spending by state of residence by payer (Medicare, Medicaid, Private and Other) was obtained from publically available Centers for Medicare & Medicaid Services (CMS) health expenditure by state of residence report for 2009. By applying the state-specific average annual percent growth provided in the health expenditure report, we estimated the personal health care

spending indexed to 2012 US$ by state by payer for Medicare, Medicaid and private insurance spending. Additionally, the national health expenditure data is reported by age groups for each of the three payers. For the year 2012, a total of 80.1% of total Medicare spending, 22.2% of total Medicaid spending, and a total of 14.2 % of private insurance spending was attributable to older adults. These percentages were applied to the personal health spending by state and payer to estimate the personal healthcare spending by state and payer by age group for our target population. Next, the proportion of personal health care spending in older adults attributable to falls was estimated using the fraction of total national healthcare spending attributable to falls by payer type. The national attributable fraction of expenditure on healthcare spending due to falls is 6.34% (95% CI: 2.29% ; 10.4%) for Medicare spending, 8.89% (95% CI: -1.44% ; 19.23%) for Medicaid spending, and 5.01% (95% CI: 1.17% ; 8.84%) for private and out of pocket expenditures (29). The end result was a personal healthcare spending by state by payer for older adults attributed to falls. The three payer estimates were totaled per state to obtain a total personal healthcare spending due to falls for older adults. The national estimate for personal healthcare spending due to falls for older adults was obtained by totaling all 50 states.

Overview of Method 2

In the count applied to cost method, the total number of older adults admitted to a hospital due to a fall injury was obtained using the SID database which contains all inpatient care records from 28 participating states. The dataset includes principal and secondary diagnoses, admission and discharge status, and patient demographics. The SID databases were available for the year 2011 for the following states: Arizona, Arkansas, California, Colorado, Florida, Hawaii, Iowa, Kentucky, Maine, Maryland, Massachusetts,

Michigan, Mississippi, Nebraska, Nevada, New Jersey, New Mexico, New York, North Carolina, Oregon, Rhode Island, South Carolina, South Dakota, Utah, Vermont, Washington, West Virginia, and Wisconsin.

Fall hospitalizations in SID were determined by an injury diagnosis of falls in any of the first three fields and an external cause of injury E-code of falls. The E-codes used for unintentional injury of fall (E880.0-E886.9, E888) are consistent with the classification of the Centers for Disease Control and Prevention (CDC) (30). For 12 states (Arkansas, California, Florida, Iowa, Massachusetts, Mississippi, Nebraska, New Mexico, New York, Utah, Vermont, and Washington) the SID included two additional variables: VisitLink and DaystoEvent, which assisted in identifying and removing readmission in the same year for fall injury. Readmissions were not removed for the states without the additional variables.

The total number of older adults treated in an emergency department due to a non-fatal fall injury was obtained using the SEDD which captures discharge information on all emergency department visits that do not result in a hospital admission. The SEDD databases were available for the year 2011 for 18 states: Arizona, California, Florida, Iowa, Kentucky, Maine, Maryland, Massachusetts, Nebraska, Nevada, New Jersey, New York, North Carolina, Rhode Island, South Carolina, Utah, Vermont, and Wisconsin.

Emergency department visits for fall injury were identified in SEDD by an injury diagnosis of falls in any of the first three diagnosis fields and an external cause of injury E-code of falls, similar to above. Additionally, the VisitLink and DaystoEvent variables assisted in identifying and removing repeat ED visit for a non-fatal fall related injury. Readmission were removed for the 8 states with additional variables: California, Florida, Iowa, Massachusetts, Nebraska, New York, Utah, and Vermont. The counts obtained from

SID and SEDD were then multiplied by lifetime medical cost for an older adult ED treated and released visit or a hospitalization for a fall from WISQARS.

The counts were input into the WISQARS cost of injury reports by type of injury outcome as "hospitalization" or "ED treated and released", intent as "unintentional" and mechanism of injury as "fall". The start year was 2011 with 2010 US$ costs indexed to 2012 US$ and the age was limited to older adults. The two costs were totaled for available states: Arizona, California, Florida, Iowa, Kentucky, Maine, Maryland, Massachusetts, Nebraska, Nevada, New Jersey, New York, North Carolina, Rhode Island, South Carolina, Utah, Vermont, and Wisconsin.

The national estimate of cost of unintentional falls in older adults was obtained from the WISQARS cost of injury report. The average lifetime medical costs for a hospitalization and ED-treated and released visit were obtained with the intent identified as "unintentional", mechanism as "fall", and age as 65 and older.

Study Results

Results for Method 1

For the partial attributable fraction method, the total national Medicare spending attributable to older adult falls was estimated at $30.3 billion in 2012 (Table 1) The total national Medicaid spending attributable to older adult falls was estimated at $8.6 billion in 2012 (Table 2). The total national private insurance spending attributable to older adult falls was estimated at $6.0 billion in 2012 (Table 3). The total national (all payer) personal healthcare spending attributable to older adult falls was estimated at $44.9 billion in 2012 (Table 4).

The states with the highest estimated total personal healthcare spending for older adult falls included California ($4.83 billion), Florida ($3.21 billion), New York ($3.73

billion), and Texas ($3.23 billion). The states with the lowest estimated total personal healthcare spending for older adult falls included Alaska ($87 million), North Dakota ($85 million), and Wyoming ($67 million). Medicare spending for older adult falls ranged from an estimated $38 million in Alaska to $3.22 billion in California. Medicaid spending for older adult falls ranged from an estimated $13 million in North Dakota and Wyoming to $1.12 billion in New York. Private insurance spending for older adult falls ranged from an estimated $12 million in Wyoming to $630 million in California.

Results for Method 2

For the count applied to cost method, the number of older adults hospitalized with fall related injury per state is reported in table 5. For 2012, the lifetime medical costs of fall related injuries are as follows: Arizona ($599 million), Arkansas ($269 million), California ($2.22 billion), Colorado ($388 million), Florida ($2.12 billion), Hawaii ($102 million), Iowa ($256 million), Kentucky ($367 million), Maine ($144 million), Maryland ($427 million), Massachusetts ($664 million), Michigan ($725 million), Mississippi ($151 million), Nebraska ($166 million), Nevada ($202 million), New Jersey ($798 million), New Mexico ($141 million), New York ($1.62 billion), North Carolina ($708 million), Oregon ($278 million), Rhode Island ($107 million), South Carolina ($342 million), South Dakota ($67 million), Utah ($142 million), Vermont ($48 million), Washington ($445 million), West Virginia ($171 million), and Wisconsin ($500 million).

The number of individuals admitted to an ED with fall related injury per state is reported in table 6. For 2012, the lifetime medical costs of fall related injuries are as follows: Arizona ($104 million), California ($459 million), Florida ($362 million), Iowa ($61 million), Kentucky ($86 million), Maine ($41 million), Maryland ($88 million), Massachusetts ($123 million), Nebraska ($28 million), Nevada ($33 million), New Jersey

($140 million), New York ($270 million), North Carolina ($175 million), Rhode Island ($26 million), South Carolina ($89 million), Utah ($29 million), Vermont ($14 million), and Wisconsin ($94 million).

The estimated national non-fatal fall injury hospitalization was 16.6 billion and national non-fatal emergency department treated and released was $3.47 billion. The estimated national non-fatal fall injury cost was $20.3 billion in 2010 (inflated to $21.1 in 2012 dollars).

Tables 7 shows the difference in results when comparing the two methods of cost estimation for states with available data. The difference varies widely with about a 21-49% lower estimate for state and 53% lower estimate for national by count applied to cost method per events recoded. However, the cost from the count applied to cost falls within the range of partial attributable fraction's 95% confidence interval (CI) for all 28 states compared.

Discussion

This study compares estimates of total direct medical costs of falls in older adults on a state and national level using two methods. The estimated cost of falls on a state and national level was considerably lower using the count applied to cost method as compared to the partial attributable fraction method. This is due to a number of factors.

The partial attributable fraction method follows a previously cited national study (29). This method offers a more comprehensive cost estimation of health care spending due to a fall injuries by using the Medicare Current Beneficiaries Survey of reported falls applied to the National Health Expenditure Accounts. The NHEA measures total healthcare spending by state of residence, type of payer, and certain demographics of the US

population. The cost estimated by this method captures a wider set of health care costs beyond those associated with hospitalization or treatment in ED. These include (1) hospital care, (2) physician and clinical services, (3) other professional services, (4) dental services, (5) home health care, (6) prescription drugs and non-durable medical products, (7) durable medical products, (8) nursing home costs, and (9) other residential and personal care costs (31).

In the count applied to cost method, the WISQARS cost module calculates the lifetime medical costs including treatment and rehab associated with an injury event by injury outcome (non-fatal hospitalization, non-fatal ED visit) and intent (intentional and unintentional). The cost categories used for estimating medical costs of non-fatal injury hospitalizations include: (1) facility costs of inpatient stay, (2) non-facility costs of inpatient stay, (3) hospital readmission, (4) short to medium term follow up costs, (5) long term follow up costs beyond 18 months, (6) long term or lifetime costs of spinal cord injuries or traumatic brain injuries (7) hospital rehabilitation costs, (8) transportation to hospital costs and (9) nursing home costs (32). The cost categories used for estimating medical costs of non-fatal non-admitted injuries treated in the ED includes: (1) total ED charges associated with visit, (2) follow up visits and medicals up to 18 months after injury, (3) follow up costs beyond 18 months, (4) emergency transport, and (5) claims administration (32).

Both methods of cost estimation offer valuable insight in calculating the economic burden of unintentional injury from falls. States may choose to use their own counts for residents hospitalized or admitted to ED applied to the WISQARS cost of injury module to obtain an estimate of medical costs of facility and associated charges.

The more comprehensive attributable fraction method of health care expenditure, available for a number of historical years and future projections, offers more details of spending by payer type – Medicare, Medicaid, and private insurance.

By year 2050, the aging population will grow to an estimated 84 million older adults aged 65 or older, that is one in every five of the population (33). Falls remain the leading cause of fatal and non-fatal injuries in older adults (10), imposing a significant economic burden on the healthcare system (28). This study provides state health departments with the tools to estimate costs of non-fatal falls in their respective states to properly allocate funding for policy development and practice enhancement to address the risk of older adult injury and promote prevention. It also allows states to track their spending on fall injuries year to year while monitoring the outcome of fall prevention efforts and interventions.

There are known risk factors identified that increase the rate and risk of falling in older adults, including unsteady gait, loss of balance, muscle weakness, changes in vision, and multiple or certain types of medications (9). Classes of medications with increased risk of falls include beta blockers, diuretics, sedatives, hypnotics, neuroleptics, antipsychotics, and benzodiazepines among others (15). Adverse events from such medications often result in hypotension, orthostasis, hypoglycemia, and impaired cognition affecting gait and balance resulting in falls (15). Additionally, falls in the older adult population are frequently attributed to environmental factors (9) such as throw rugs, clutter, presence of cords or wires, high or low cabinets, and non-slip resistant surfaces especially in bathtubs and kitchens (16).

States and local authorities often promote policies and practices to address risk factors with evidence based interventions to reduce the high incidence of fall injuries and all its associated health and economic complications.

This study has several limitations. Both methods of cost estimation are based on nationally calculated costs from secondary sources based on average cost per fall injury. This may provide an overestimation or underestimation for any specific state.

Limitations and Advantages Method 1

The partial attributable fraction method assumes that fall estimates and fall injury spending are consistent across states and years. It also assumes the proportion of older adults in the population across states is consistent. The availability of state level data is another limitation. The most recent year available is 2009 due to the lag in NHEA data for states. An advantage of the partial attributable fraction method is the availability of the state expenditure estimation by type of payer. This allows states to track their spending on potentially preventable injuries using Medicare dollars and state sponsored Medicaid costs.

Limitations and Advantages Method 2

A limitation of the count applied to cost method is that it abstracts number of individuals hospitalized or treated in ED based on healthcare provider coded fall related injuries, which is subject to variation across facilities, providers, and states. For a number of available states, readmissions were not excluded due to unavailability of the data. This might have imposed an overestimation per state. Additionally, the costs were then estimated from a separate cost of injury module based on national averages of total charges associated with a fall injury hospitalization or fall injury emergency department visit. The costs obtained from WISQARS were inflated to our target year of 2012. However, the

counts were not inflated from 2011 as there is not a easy way to estimate increase in incidence of falls per state. The number of older adults and number of falls are on the rise. This may contribute to an underestation using the count applied to cost method. An advantage to the count applied to cost method is the ability of states to obtain quick estimates of cost of fall injuries.

Conclusion

With the current inconsistencies in estimating economic burden of older adult falls on a national and state level, this study introduces two methods applicable to estimate state spending of older adult falls or fall injuries. This is important because much of the policy and practice for fall prevention strategies happen at the state level or lower. Both methods offer vlauble insight for states to understand the economic impact of older adult falls and to track their spending across years. The count applied to cost is modifiable and allows states to use their own counts of hospitalizations and ED visits to estimate a cost. The partial attributable fraction provides details of the spending down to the payer type allowing for easier tracking of publically funded plans such as Medicaid.

[1] As of October 1, 2015, ICD 10 CM was used to code morbidity data in the U.S. All data used in this paper were coded prior to this date so only ICD 9 CM is discussed here.

6. APPENDIX

Table 1: Medicare total personal healthcare spending attributable to older adult falls by state, US, 2012

State	Medicare spending from NHEA, 2009, in million [1]	Average annual% growth in Medicare spending [2]	Medicare spending, 2012, in millions	Medicare spending attributable to older adults (80.1%), 2012, in millions [3]	Medicare spending attributable to older adult falls 6.34% (95% CI) (2.29% ; 10.4%), 2012, million [4]
Alabama	$8,042	7.9	$10,103	$8,093	$513 ($185 ; $842)
Alaska	$553	10.6	$748	$599	$38 ($14 ; $62)
Arizona	$8,451	9.0	$10,944	$8,766	$556 ($201 ; $912)
Arkansas	$4,657	7.6	$5,802	$4,647	$295 ($106 ; $483)
California	$50,604	7.8	$63,393	$50,778	$3,219 ($1,163 ; $5,281)
Colorado	$5,254	8.9	$6,785	$5,435	$345 ($124 ; $565)
Connecticut	$6,187	7.4	$7,665	$6,140	$389 ($141 ; $639)
Delaware	$1,512	8.5	$1,931	$1,547	$98 ($35 ; $161)
DC	$856	5.3	$999	$800	$51 ($18 ; $83)
Florida	$39,119	8.6	$50,104	$40,134	$2,544 ($919 ; $4,174)
Georgia	$11,743	8.6	$15,040	$12,047	$764 ($276 ; $1,253)
Hawaii	$1,533	8.3	$1,947	$1,559	$99 ($36 ; $162)
Idaho	$1,749	9.8	$2,315	$1,855	$118 ($42 ; $193)
Illinois	$19,176	7.4	$23,756	$19,029	$1,206 ($436 ; $1,979)
Indiana	$9,696	8.4	$12,350	$9,893	$627 ($227 ; $1,029)
Iowa	$4,329	7.2	$5,333	$4,272	$271 ($98 ; $444)
Kansas	$4,009	7.4	$4,966	$3,978	$252 ($91 ; $414)
Kentucky	$7,162	8.3	$9,098	$7,287	$462 ($167; $758)
Louisiana	$7,854	7.5	$9,757	$7,815	$495 ($179; $813)
Maine	$2,285	8.8	$2,944	$2,358	$149 ($54 ; $245)
Maryland	$8,748	8.0	$11,021	$8,827	$560 ($202 ; $918)
Massachusetts	$11,721	7.0	$14,358	$11,501	$729 ($263 ; $1,196)
Michigan	$17,638	8.0	$22,219	$17,798	$1,128 ($408 ; $1,851)
Minnesota	$6,856	8.2	$8,685	$6,957	$441 ($159 ; $723)
Mississippi	$5,205	8.5	$6,649	$5,326	$338 ($122; $554)
Missouri	$9,581	7.7	$11,970	$9,588	$608 ($220 ; $997)
Montana	$1,247	7.9	$1,567	$1,255	$80 ($29 ; $131)
Nebraska	$2,519	8.3	$3,199	$2,562	$162 ($59 ; $266)
Nevada	$3,324	11.1	$4,559	$3,652	$232 ($84 ; $380)
N. Hampshire	$1,905	9.3	$2,487	$1,992	$126 ($46 ; $207)
New Jersey	$15,526	7.9	$19,504	$15,623	$990 ($358 ; $1,625)
New Mexico	$2,467	9.2	$3,213	$2,573	$163 ($59 ; $268)
New York	$34,081	7.3	$42,103	$33,725	$2,138 ($772 ; $3,507)
N. Carolina	$14,105	9.9	$18,722	$14,997	$951 ($343 ; $1,560)
N. Dakota	$859	7.0	$1,053	$843	$53 ($19 ; $88)
Ohio	$19,263	7.6	$23,998	$19,222	$1,219 ($440 ; $1,999)
Oklahoma	$5,918	8.3	$7,517	$6,021	$382 ($138 ; $626)
Oregon	$4,967	8.3	$6,309	$5,054	$320 ($116 ; $526)
Pennsylvania	$23,771	5.8	$28,152	$22,549	$1,430 ($516 ; $2,345)

Rhode Island	$1,824	7.1	$2,241	$1,795	$114 ($41 ; 187)
S. Carolina	$7,211	10.4	$9,703	$7,772	$493 ($178 ; $808)
S. Dakota	$1,096	7.8	$1,373	$1,099	$70 ($25; $114)
Tennessee	$10,337	8.5	$13,204	$10,576	$671 ($242 ; $1,100)
Texas	$33,288	9.9	$44,185	$35,392	$2,244 ($810; $3,681)
Utah	$2,280	9.7	$3,010	$2,411	$153 ($55 ; $251)
Vermont	$941	9.0	$1,219	$976	$62 ($22 ; $102)
Virginia	$9,736	8.5	$12,435	$9,961	$632 ($228 ; $1,036)
Washington	$7,971	8.2	$10,098	$8,088	$513 ($185 ; $841)
West Virginia	$3,521	7.6	$4,386	$3,513	$223 ($80 ; $365)
Wisconsin	$7,943	8.1	$10,034	$8,037	$510 ($84 ; $836)
Wyoming	$639	8.5	$816	$653	$41 ($15 ; $68)
NATIONAL	**$471,260**	**----**	**$595,966**	**$477,369**	**$30,265 ($10,932 ; $49,646)**

[1] Obtained from National Health Expenditure Report from CMS by payer type for 2009

[2] Growth as reported by health expenditure report

[3] Proportion of older adults obtained from age-gender national health expenditure report for 2012

[4] Proportion of spending attributable to older adult falls obtained from "Economic Burden of Falls" by Florence et in press

Table 2: Medicaid total personal healthcare spending attributable to older adult falls by state, US, 2012

State	Medicaid spending from NHEA, 2009, million [1]	Average Annual% Growth in Medicaid spending [2]	Medicaid spending, 2012, million	Medicaid spending attributable to older adults (22.2%), 2012, millions [3]	Medicaid spending attributable to older adult falls 6.34% (95% CI) (-1.44% ; 19.23%) , 2012, million [4]
Alabama	$4,101	9	$5,312	$1,179	$105 ($0 ; $227)
Alaska	$1,058	10	$1,408	$312	$28 ($0 ; $60)
Arizona	$7,549	13.5	$11,037	$2,450	$218 ($0 ; $471)
Arkansas	$3,383	8.3	$4,298	$954	$85 ($0 ; $183)
California	$38,900	8.6	$49,824	$11,061	$983 ($0 ; $2,127)
Colorado	$3,423	8.8	$4,408	$979	$87 ($0 ; $188)
Connecticut	$5,511	6.9	$6,732	$1,494	$133 ($0 ; $278)
Delaware	$1,106	10	$1,472	$327	$29($0 ; $63)
DC	$1,577	6.2	$1,889	$419	$37 ($0 ; $81)
Florida	$14,347	8.6	$18,376	$4,080	$363 ($0 ; $784)
Georgia	$6,852	7.2	$8,441	$1,874	$167 ($0 ; $360)
Hawaii	$1,146	8.8	$1,476	$328	$29 ($0 ; $63)
Idaho	$1,246	9.4	$1,631	$362	$32 ($0 ; $70)
Illinois	$13,828	9	$17,908	$3,976	$353 ($0 ; $765)
Indiana	$5,828	6.3	$7,000	$1,554	$138 ($0 ; $299)
Iowa	$2,875	6.7	$3,493	$775	$69 ($0 ; $149)
Kansas	$2,309	7.3	$2,852	$633	$56 ($0 ; $122)
Kentucky	$5,174	8.5	$6,609	$1,467	$130 ($0 ; $282)
Louisiana	$6,240	6.5	$7,537	$1,673	$149 ($0 ; $322)
Maine	$2,447	9	$3,169	$704	$63 ($0 ; $135)
Maryland	$6,084	8	$7,665	$1,702	$151 ($0 ; $327)
Massachusetts	$11,102	6.7	$13,487	$2,994	$266 ($0 ; $576)
Michigan	$9,563	6.5	$11,552	$2,565	$228 ($0 ; $493)
Minnesota	$6,761	7.4	$8,375	$1,859	$165 ($0 ; $358)
Mississippi	$3,629	8.6	$4,648	$1,032	$92 ($0 ; $198)
Missouri	$7,390	10.5	$9,970	$2,213	$197 ($0 ; $426)
Montana	$851	7.1	$1,045	$232	$21 ($0 ; $45)
Nebraska	$1,593	7.8	$1,995	$443	$39 ($0 ; $85)
Nevada	$1,303	10.1	$1,739	$386	$34 ($0 ; $74)
N. Hampshire	$1,321	8.9	$1,707	$379	$34 ($0 ; $73)
New Jersey	$9,185	6.5	$11,095	$2,463	$219 ($0 ; $474)
New Mexico	$2,911	11.3	$4,014	$891	$79 ($0 ; $171)
New York	$47,557	6.2	$56,963	$12,646	$1,124 ($0 ; $2,432)
N. Carolina	$10,619	9.8	$14,057	$3,121	$277 ($0 ; $600)
N. Dakota	$584	4.8	$673	$149	$13 ($0 ; $29)
Ohio	$13,330	6.8	$16,239	$3,605	$320 ($0 ; $693)
Oklahoma	$3,803	8.3	$4,830	$1,072	$95 ($0 ; $206)
Oregon	$3,510	9.1	$4,558	$1,012	$90 ($0 ; $195)
Pennsylvania	$15,683	8.5	$20,032	$4,447	$395 ($0 ; $855)
Rhode Island	$1,786	6.9	$2,181	$484	$43 ($0 ; $93)
S. Carolina	$4,793	7.8	$6,005	$1,333	$119 ($0 ; $256)

S. Dakota	$692	5.6	$815	$181	$16 ($0 ; $35)
Tennessee	$6,561	8.4	$8,357	$1,855	$165 ($0 ; $357)
Texas	$22,509	9.1	$29,230	$6,489	$577 ($0 ; $1,248)
Utah	$1,577	7.7	$1,970	$437	$39 ($0 ; $84)
Vermont	$1,070	9.6	$1,408	$313	$28 ($0 ; $60)
Virginia	$5,480	8	$6,903	$1,532	$136 ($0 ; $295)
Washington	$5,979	7.4	$7,406	$1,644	$146 ($0 ; $316)
West Virginia	$2,331	7.3	$2,880	$639	$57 ($0 ; $123)
Wisconsin	$6,703	7.6	$8,351	$1,854	$165 ($0 ; $356)
Wyoming	$510	9.8	$676	$150	$13 ($0 ; $29)
NATIONAL	**$345,669**	**----**	**$435,696**	**$96,724**	**$8,599 ($0 : $18,600)**

[1] Obtained from National Health Expenditure Report from CMS by payer type for 2009

[2] Growth as reported by health expenditure report

[3] Proportion of older adults obtained from age-gender national health expenditure report for 2012

[4] Proportion of spending attributable to older adult falls obtained from "Economic Burden of Falls" by Florence et al. in press

Table 3: Private Insurance total personal healthcare spending attributable to older adult falls by state, US, 2012

State	Private ins. spending from NHEA, 2009, millions[1]	Average Annual% Growth in private ins spending [2]	Private insurance spending for 2012, millions	Private insurance spending attributable to older adults (14.2%), 2012, millions [3]	Private insurance spending attributable to older adult falls 5.01%, (95% CI) (1.17% ; 8.84%) , 2012, million [4]
Alabama	$10,322	5.1	$11,998	$1,704	$85 ($20 ; $151)
Alaska	$2,340	7.8	$2,931	$416	$21 ($5 ; $37)
Arizona	$13,273	8.9	$17,123	$2,432	$122 ($28 ; $215)
Arkansas	$4,918	5.1	$5,707	$810	$41 ($9 ; $72)
California	$74,473	5.9	$88,534	$12,572	$630 ($147 ; $1,111)
Colorado	$11,979	7.3	$14,809	$2,103	$105 ($25 ; $186)
Connecticut	$10,391	4.8	$11,949	$1,697	$85 ($20 ; $150)
Delaware	$2,358	4.4	$2,685	$381	$19 ($4 ; $34)
DC	$3,050	6.3	$3,668	$521	$26 ($6 ; $46)
Florida	$36,145	5.7	$42,717	$6,066	$304($71 ; $536)
Georgia	$20,514	4.7	$23,541	$3,343	$167 ($39 ; $296)
Hawaii	$2,910	5.6	$3,427	$487	$24 ($6 ; $43)
Idaho	$3,172	7.8	$3,976	$565	$28 ($7 ; $50)
Illinois	$34,878	6.2	$41,756	$5,929	$297 ($69 ; $524)
Indiana	$14,821	3.6	$16,501	$2,343	$117 ($27 ; $207)
Iowa	$7,832	6.6	$9,499	$1,349	$68 ($16 ; $119)
Kansas	$5,869	4.0	$6,598	$937	$47 ($11 ; $83)
Kentucky	$9,730	7.2	$11,973	$1,700	$85 ($20 ; $150)
Louisiana	$9,241	6.7	$11,217	$1,593	$80 ($19 ; $141)
Maine	$3,174	5.5	$3,730	$530	$27 ($6 ; $47)
Maryland	$15,748	7.3	$19,470	$2,765	$139 ($32 ; $244)
Massachusetts	$20,356	6.3	$24,440	$3,470	$174 ($41 ; $307)
Michigan	$24,324	3.0	$26,571	$3,773	$189 ($44 ; $334)
Minnesota	$13,516	5.3	$15,764	$2,238	$112 ($26 ; $198)
Mississippi	$4,954	4.5	$5,657	$803	$40 ($9 ; $71)
Missouri	$13,770	6.5	$16,639	$2,363	$118 ($28 ; $209)
Montana	$1,803	4.9	$2,079	$295	$15 ($3 ; $26)
Nebraska	$5,573	8.3	$7,076	$1,005	$50 ($12 ; $89)
Nevada	$6,470	10.0	$8,605	$1,222	$61 ($14 ; $108)
N. Hampshire	$3,974	7.0	$4,864	$691	$35 ($8 ; $61)
New Jersey	$23,105	5.2	$26,872	$3,816	$191 ($45 ; $337)
New Mexico	$3,211	4.2	$3,636	$516	$26 ($6 ; $46)
New York	$53,997	6.9	$65,932	$9,362	$469 ($110 ; $828)
N. Carolina	$19,975	7.7	$24,938	$3,541	$177 ($41 ; $313)
North Dakota	$1,965	8.8	$2,531	$359	$18 ($4 ; $32)
Ohio	$28,407	4.7	$32,643	$4,635	$232 ($54 ; $410)
Oklahoma	$8,098	8.2	$10,256	$1,456	$73 ($17 ; $129)
Oregon	$9,675	8.4	$12,332	$1,751	$88 ($20 ; $155)
Pennsylvania	$30,858	4.3	$35,056	$4,978	$249 ($58 ; $440)
Rhode Island	$2,699	5.5	$3,172	$450	$23 ($5 ; $40)

S. Carolina	$9,415	5.8	$11,157	$1,584	$79 ($19 ; $140)
S. Dakota	$1,773	5.4	$2,076	$295	$15 ($3 ; $26)
Tennessee	$12,992	6.2	$15,562	$2,210	$111 ($26 ; $195)
Texas	$47,603	6.9	$58,208	$8,266	$414 ($97 ; $731)
Utah	$6,081	7.5	$7,563	$1,074	$54 ($13 ; $95)
Vermont	$1,637	6.4	$1,971	$280	$14 ($3 ; $25)
Virginia	$20,004	7.3	$24,736	$3,513	$176 ($41 ; $311)
Washington	$16,089	8.0	$20,284	$2,880	$144 ($34 ; $255)
West Virginia	$3,678	6.7	$4,468	$634	$32 ($7 ; $56)
Wisconsin	$17,626	7.4	$21,812	$3,097	$155 ($36 ; $274)
Wyoming	$1,402	7.7	$1,752	$249	$12 ($3 ; $22)
NATIONAL	**$712,165**	**-----**	**$852,462**	**$121,050**	**$6,065 ($1,416 ; $10,701)**

[1] Obtained from National Health Expenditure Report from CMS by payer type for 2009

[2] Growth as reported by health expenditure report

[3] Proportion of older adults obtained from age-gender national health expenditure report for 2012

[4] Proportion of spending attributable to older adult falls obtained from "Economic Burden of Falls" by Florence et al. in press

Table 4: All payer healthcare spending per state attributable to older adult falls, US, 2012

State	Medicare, million	Medicaid, millions	Private Ins, millions
Alabama	$513	$105	$85
Alaska	$38	$28	$21
Arizona	$556	$218	$122
Arkansas	$295	$85	$41
California	$3,219	$983	$630
Colorado	$345	$87	$105
Connecticut	$389	$133	$85
Delaware	$98	$29	$19
DC	$51	$37	$26
Florida	$2,544	$363	$304
Georgia	$764	$167	$167
Hawaii	$99	$29	$24
Idaho	$118	$32	$28
Illinois	$1,206	$353	$297
Indiana	$627	$138	$117
Iowa	$271	$69	$68
Kansas	$252	$56	$47
Kentucky	$462	$130	$85
Louisiana	$495	$149	$80
Maine	$149	$63	$27
Maryland	$560	$151	$139
Massachusetts	$729	$266	$174
Michigan	$1,128	$228	$189
Minnesota	$441	$165	$112
Mississippi	$338	$92	$40
Missouri	$608	$197	$118
Montana	$80	$21	$15
Nebraska	$162	$39	$50
Nevada	$232	$34	$61
N. Hampshire	$126	$34	$35
New Jersey	$990	$219	$191
New Mexico	$163	$79	$26
New York	$2,138	$1,124	$469
N. Carolina	$951	$277	$177
North Dakota	$53	$13	$18
Ohio	$1,219	$320	$232
Oklahoma	$382	$95	$73
Oregon	$320	$90	$88
Pennsylvania	$1,430	$395	$249
Rhode Island	$114	$43	$23
S. Carolina	$493	$119	$79
S. Dakota	$70	$16	$15
Tennessee	$671	$165	$111
Texas	$2,244	$577	$414
Utah	$153	$39	$54
Vermont	$62	$28	$14
Virginia	$632	$136	$176
Washington	$513	$146	$144
West Virginia	$223	$57	$32
Wisconsin	$510	$165	$155
Wyoming	$41	$13	$12
NATIONAL	**$30,265**	**$8,599**	**$6,065**

Table 5: Hospitalization cost for older adult fall injuries per state, US, 2012

STATE	Count of older adult with fall injury hospitalization[1]	Lifetime cost of fall injury hospitalization ($40,813)[2], 2012, million
Arizona (AZ)	14677	$599
Arkansas (AR)*	6595	$269
California (CA)*	54432	$2,222
Colorado (CO)	9499	$388
Florida (FL)*	51830	$2,115
Hawaii (HI)	2499	$102
Iowa (IA)*	6282	$256
Kentucky (KY)	8983	$367
Maine (ME)	3532	$144
Maryland (MD)	10461	$427
Massachusetts (MA)*	16259	$664
Michigan (MI)	17759	$725
Mississippi (MS)*	3695	$151
Nebraska (NE)*	4061	$166
Nevada (NV)	4960	$202
New Jersey (NJ)	19560	$798
New Mexico (NM)*	3445	$141
New York (NY)*	39579	$1,615
North Carolina (NC)	17353	$708
Oregon (OR)	6821	$278
Rhode Island (RI)	2622	$107
South Carolina (SC)	8368	$342
South Dakota (SD)	1630	$67
Utah (UT)*	3484	$142
Vermont (VT)*	1171	$48
Washington (WA)*	10904	$445
West Virginia (WV)	4179	$171
Wisconsin (WI)	12241	$500

* With readmission of fall-related injury excluded

[1] Obtained from HCUP-SID for unintentional fall injury diagnosis and E-code

[2] Lifetime cost from WISQARS 2010$ using 2011 count indexed to 2012$

Table 6: Emergency department treated and released costs for older adult fall injuries per state, US, 2012

STATE	Count of older adult with fall injury ED visit[1]	Lifetime cost of ED treated and released fall injury ($3,119)[2], 2012, million
Arizona (AZ)	33357	$104
California (CA)*	147254	$459
Florida (FL)*	116208	$362
Iowa (IA)*	19582	$61
Kentucky (KY)	27495	$86
Maine (ME)	13178	$41
Maryland (MD)	28061	$88
Massachusetts (MA) *	39409	$123
Nebraska (NE)*	8971	$28
Nevada (NV)	10547	$33
New Jersey (NJ)	44953	$140
New York (NY)*	86511	$270
North Carolina (NC)	56151	$175
Rhode Island (RI)	8322	$26
South Carolina (SC)	28394	$89
Utah (UT)*	9213	$29
Vermont (VT)*	4438	$14
Wisconsin (WI)	30005	$94

* With readmission of fall-related injury excluded

[1] Obtained from HCUP-SEDD for unintentional fall injury diagnosis and E-code

[2] Lifetime cost from WISQARS 2010$ using 2011 count indexed to 2012$

Table 7: Comparison of two methods of estimating state level medical costs for older adult falls, US, 2012

STATE	Lifetime costs from 'counts applied to cost'[1] method for older adult fall injuries, 2012, million	Healthcare spending attributable to older adult falls, 2012, million (95% CI)	% Difference
Arizona (AZ)	$703	$895 ($229 ; $1598)	21%
California (CA)*	$2,681	$4,832 ($1310 ; $8519)	45%
Florida (FL)*	$2,478	$3,211 ($990 ; $5949)	23%
Iowa (IA)*	$317	$407 ($114 ; $712)	22%
Kentucky (KY)	$453	$678 ($187 ; $1,190)	33%
Maine (ME)	$185	$239 ($60 ; $427)	22%
Maryland (MD)	$514	$849 ($234 ; $1,489)	39%
Massachusetts (MA) *	$786	$1,169 ($304 ; $2,079	33%
Nebraska (NE) *	$194	$252 ($71 ; $440)	23%
Nevada (NV)	$235	$327 ($98 ; $562)	28%
New Jersey (NJ)	$939	$1,401 ($403 ; $2436)	33%
New York (NY) *	$1,885	$3,731 ($882; $6,767)	49%
North Carolina (NC)	$883	$1,406 ($384 ; $2,473)	37%
Rhode Island (RI)	$133	$179 ($46 ; $320)	26%
South Carolina (SC)	$430	$691 ($197 ; $1,204)	38%
Utah (UT) *	$171	$246 ($68 ; $430)	30%
Vermont (VT) *	$62	$104 ($25 ; $187)	41%
Wisconsin (WI)	$593	$830 ($120 ; $1,466	28%

* Readmission excluded for fall injury

[1] Older adults age 65 and older. Source: HCUP SID and SEDD for 2011counts, WISQARS cost of Injury report 2010$ indexed to 2012$

Figure 1: IRB

Institutional Review Board

August 24, 2016

Yara Haddad
School of Public Health

RE: Determination: No IRB Review Required
Title: *COST ESTIMATION OF THE HEALTHCARE ECONOMIC BURDEN OF NON-FATAL OLDER ADULT FALLS USING THREE DIFFERENT METHODS: A STATE SPECIFIC PERSPECTIVE*
PI: Yara Haddad

Dear Ms. Haddad:

Thank you for requesting a determination from our office about the above-referenced project. Based on our review of the materials you provided, we have determined that it does not require IRB review because it does not meet the definition of research with "human subjects" as set forth in Emory policies and procedures and federal rules, if applicable. Specifically, in this project, you will use a fully de-identified dataset to estimate the cost of non-fatal fall injury in older adults for the states with the highest incidence of falls as reported by BRFSS.

Please note that this determination does not mean that you cannot publish the results. This determination could be affected by substantive changes in the study design or identifiability of data. If the project changes in any substantive way, please contact our office for clarification.

Thank you for consulting the IRB.

Sincerely,

Anisha Easley, MPH
Research Protocol Analyst

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Ver. 1/17/2014

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