

2016

Falls and Related Injuries Based on Surveillance Data: U.S. Hospital Emergency Departments

George K. Quarranttey
Walden University

Follow this and additional works at: <https://scholarworks.waldenu.edu/dissertations>

 Part of the [Databases and Information Systems Commons](#), and the [Health and Medical Administration Commons](#)

This Dissertation is brought to you for free and open access by the Walden Dissertations and Doctoral Studies Collection at ScholarWorks. It has been accepted for inclusion in Walden Dissertations and Doctoral Studies by an authorized administrator of ScholarWorks. For more information, please contact ScholarWorks@waldenu.edu.

Walden University

College of Health Sciences

This is to certify that the doctoral dissertation by

George Quarrantey

has been found to be complete and satisfactory in all respects,
and that any and all revisions required by
the review committee have been made.

Review Committee

Dr. Aaron Mendelsohn, Committee Chairperson, Public Health Faculty

Dr. Shingairai Feresu, Committee Member, Public Health Faculty

Dr. Gudeta Fufaa, University Reviewer, Public Health Faculty

Chief Academic Officer

Eric Riedel, Ph.D.

Walden University

2016

Abstract

Falls and Related Injuries Based on Surveillance Data: U.S. Hospital Emergency

Departments

by

George K. Quarrantey

MS, Colorado Technical University, 2006

MS, Montclair State University, 2004

BS, University of Ghana, 1994

Dissertation Submitted in Partial Fulfillment of the

Requirements for the Degree of

Doctor of Philosophy

Public Health

Walden University

February 2016

Abstract

Falls can lead to unintentional injuries and possibly death, making falls an important public health problem in terms of related health care cost, incurred disabilities, and years of life lost. Approximately 1 in every 3 Americans ages 65 years and older is at risk of falling at least once every year. Children, young adults, and middle-aged adults are also vulnerable to falls. The purpose of this study was to examine the epidemiology of falls and fall-related injuries using surveillance data from nationally representative samples of hospital emergency departments in United States. The study was guided by a social-ecological model on the premise that multiple levels of risk factors affect health. Using a cross-sectional study and archival data from NEISS-AIP between 2009 and 2011, the result of multiple logistic regression indicated that age, gender, race and body part affected were significantly associated with hospitalization due to falls ($p < .001$) and incident locale independently predicted hospitalization due to falls in which hospitalization due to falls was considered a proxy measure of fall severity. The odds in each of the groups for fall injuries were (a) older adults versus children, 1.07 (95% CI: 1.05–1.08); (b) males versus females, 1.23 (95% CI: 1.21–1.26); (c) Blacks versus Whites, 2.12 (95% CI: 2.11–2.13); (d) body part extremities versus head area, 0.98 (95% CI: 0.97–0.99); and (e) outside home versus inside home, 1.14 (95% CI: 1.13–1.15). The results of this study may be important in forming and implementing age-specific prevention strategies and specialized safety training programs for all age groups, thereby reducing deaths, disabilities, and considerable health care cost associated with hospitalization due to fall-related injuries.

Falls and Related Injuries Based on Surveillance Data: U.S. Hospital Emergency

Departments

by

George K. Quarranttey

MS, Colorado Technical University, 2006

MS, Montclair State University, 2004

BS, University of Ghana, 1994

Dissertation Submitted in Partial Fulfillment of the

Requirements for the Degree of

Doctor of Philosophy

Public Health

Walden University

February 2016

Dedication

I dedicated this dissertation to my beloved wife, Perpetual, and kids: George, Gabriel, Gina, and Anthony for supporting me when the going was tough. This dedication will not be completed unless I mention my parents, Regina and late Jacob, and my late uncle Gabriel who taught me the art of hard work, perseverance, and endurance.

Acknowledgments

Pursuing an academic excellence never comes without several challenges and hurdles along the journey. This pursuance is not an exception. Although challenging, I could not have reached my goals without the encouragements and unflinching supports I received from family, friends, and committee members.

My solemn gratitude goes to Dr. Mendelsohn, my committee chair, who guided and supported me throughout the development of each milestone one at a time to produce this piece of dissertation. Dr. Mendelsohn's dedication and commitment are superbly appreciated throughout the process. I also want to thank and acknowledge the committee member, Dr. Feresu for her guidance, encouragement, and enormous help during my application of statistical analysis. My acknowledgment will not be completed unless I express my thankfulness to the Walden University Writing Center for helping out during the initial editing of the dissertation piece.

Table of Contents

List of Tables	v
List of Figures	vi
Chapter 1: Introduction to the Study.....	1
Background	3
Problem Statement	9
Purpose of the Study	10
Research Questions and Hypotheses	11
Theoretical and Conceptual Frameworks for the Study	13
Nature of the Study	15
Definition of Terms.....	17
Assumptions.....	18
Scope and Delimitations	20
Limitations	21
Significance of the Study	22
Summary	22
Chapter 2: Literature Review	25
Introduction.....	25
Literature Search Strategy.....	25
Public Health Mission and Falls	26
Theoretical Foundation	28
Conceptual Framework of Falls.....	30

The Known Epidemiology of Falls.....	33
Fall-Related Injuries and Mortality.....	37
Effect of Falls and FRIs on Communities and Health Care Systems	39
Perceived Causes and Environmental Factors of Falls.....	41
Fall-Related Injuries and Emergency Departments Visits.....	43
Fall-Related Injuries and Surveillance Systems	47
Summary and Conclusion.....	48
Chapter 3: Research Method.....	50
Introduction.....	50
Research Design and Rationale	51
Methodology.....	52
Population.....	52
Sampling and Sampling Procedures	53
Instrumentation and Operational Constructs	55
Weighting Functions and National Estimates.....	58
Overall Annual National Estimates Based on Cases	59
Weighting Functions.....	60
Data Source and Data Collection.....	63
Data Elements Collected.....	66
Variables and Coding.....	67
Outcome Measures.....	67
Independent Variables	68

Sample Size Calculation	69
Research Questions and Hypotheses	70
Data Analysis and Threats of Data Validity	71
Ethical Procedures	73
Summary	73
Chapter 4: Results	76
Introduction.....	76
Univariable (Descriptive) Analyses	76
Demographic Variables (Age, Gender, and Race).....	76
Body Part Affected	79
Incident Locale.....	79
Hospitalization	79
Summary	86
Chapter 5: Discussion, Conclusions, and Recommendations	88
Introduction.....	88
Interpretation of the Findings.....	89
Limitations of the Study.....	91
Recommendations.....	93
Implications.....	94
Conclusion	96
References	98
Appendix A: Data	1166

Appendix B: Probability	119
Appendix C: Equation 1.....	120
Appendix D: Equation 2	121
Appendix E: National Estimate of Injuries from the NEISS-AIP	122
Appendix F: NEISS-AIP VARIANCE.....	123

List of Tables

Table 1. Patient Characteristics and Frequency Distr. of the Weighted Study Sample....	78
Table 2. The Rate of Falls: Number of Cases per Annual Population Estimates of Patients Treated in Hospital EDs by Age in United States, 2009–2011.....	81
Table 3. Simple Logistic Regression: Unadjusted Analysis.....	83
Table 4. Multiple Logistic Regression: Adjusted Analysis	85

List of Figures

Figure 1. Social-ecological model of health.	15
Figure 2. U.S. CPSC NEISS participating hospitals.....	55
Figure 3. NEISS body part diagram.....	57

Chapter 1: Introduction to the Study

Fall-related injury (FRI) imposes a considerable mortality and morbidity burden on people of all ages in the United States. Falls and related injury are preventable public health issues. Injuries resulting from fall create large economic challenges including loss of productivity among individuals and families. The fall rate and the risk of death from falls in older adults are high. One third of older adults older than 65 years will fall every year (Cummings & Nevitt, 1994; Oliver, Healey, & Haines, 2010). Sattin et al., (1990) reported that the number of falls increases exponentially as older-adults age.

Few studies have examined falls; FRIs; and the risk of hospitalization for children, youth, and young adults of varying ages. Stevens, Haas, and Haileyesus (2011) provided evidence that children and middle-aged adults have a high incidence of unintentional bathroom injuries due to fall. These falls often result into high health care cost for the family and society.

With regard to pediatric fall incidents, Harris, Rochette, and Smith (2011) reported an increase in FRIs from window falls. There are fewer studies on pediatric and middle-aged adults regarding falls and FRIs compared with studies on older adults. I identified only one study in literature that compared falls and FRIs among different ages but none is known to exist that compared fall rates among different ages at the national level (Talbot, Musiol, Witham, & Metter, 2005). Talbot et al., provided insight on perceived cause, environmental influences, and types of FRIs among the young, middle-aged, and seniors.

The current study addressed the gap in literature on the trend of falls and

hospitalization among all ages in the nation. The current study may effect social change by providing such information. Public health officials will understand the mechanism of falls, FRIs, and the epidemiology of falls in various ED settings. Officials will better develop and implement interventions for targeted populations of a specific age to improve the quality of life and enhance life expectancy (U.S. Department of Health and Human Services, 2000). I looked at the epidemiology of falls and FRIs of all ages as treated and reported at the EDs of the nationally representative hospitals.

Falls are the mechanism of FRIs of all ages and will influence hospitalization at certain situations. The type of injuries determines the duration of the hospitalization. However, falls are known to be the leading cause of death and disability especially for people older than 65 years in the United States (Sleet, Moffett, & Stevens, 2008). In 2005, approximately 15,000 older adults died from FRIs even though 2 million people were treated in the nationally representative hospitals at the emergency departments, whereas 26% were hospitalized for FRIs (Sleet et al., 2008). Stevens and Sogolow (2005) found that older adults are at high risk of FRIs and are vulnerable to disability and even death. Stevens and Sogolow explained the recurrence of falls and the hospitalizations that follows among older adults, although, elderly falls are common and increase with age, children and middle-aged adults also fall and are hospitalized with different outcomes (Talbot et al., 2005). The outcomes of falls are a financial burden and are experienced by individuals, families, and health institutions (Banthin, Cunningham, & Bernard, 2008). The detail dynamics of FRIs and hospitalizations are addressed in Chapter 2. I looked at how falls influence hospitalization due to FRIs.

I examined the national trends on falls and FRIs of all ages using the archival datasets from the National Electronic Injury Surveillance System (NEISS) nationally representative hospitals at the emergency department visits. When the trend of falls and FRIs of all ages are known to the policymakers and health care providers, public health laws or policy changes can be enacted, which can lead to social change benefiting those at risk of falls. The risk factors of falls and FRIs are addressed later in the current chapter and in further detail in Chapter 2.

I also examined the epidemiology of falls and FRIs among children, youth, middle-aged, and older adults treated at the nationally representative hospitals at the emergency departments in United States and its territories. In the current chapter, I included an overview of background information on falls and FRIs for all ages. A more in-depth discussion is addressed in the literature review of Chapter 2. In addition, I also included a problem statement and purpose of the study; specific research questions and hypotheses derived; the theoretical and conceptual framework that guided the inquiry; the nature of the study and the definitions of major terms used in the study; assumptions, scope and delimitations; limitations, significance of the study, and the summary of the chapter.

Background

Falls are the mechanisms that precede FRIs and hospitalizations. Although FRIs are the leading cause of disability and death for older adults, long-term hospitalizations due to falls expose individuals and institutions to unnecessary financial obligations

(Abrahamsen et al., 2009). For example, current changes in Medicare payment disallow reimbursement to hospitals for hospital-occurred FRIs, placing financial burdens of potential preventable morbidity on the hospitals. In addition, injuries from falls also impose substantial emotional, psychological, and physiological burdens on individuals of all ages.

However, fewer studies are available to compare the extent of the injurious challenges on population health across strata of ages (Owens et al., 2009; Quigley et al., 2012). In Healthy People 2010 (2005), injury prevention was one of the 10 leading health indicators in population health, of which falls are targeted for injury prevention. The population health will improve when falls reduce among different population groups with a corresponding decrease in the rate of FRIs and hospitalization.

Assessing population health for injury prevention will require health promotional strategies by developing effective health policies, providing services, and offering programs. Every population is at risk of falls and FRIs. To improve the quality of life, access to quality care, and expanding life expectation for all people of all ages in the United States, certain promotional strategies to reduce risk, disability, and death due to falls must be adopted. The preventive strategies can be universal or case-specific interventions (McCarter-Bayer et al., 2005). A review of the literature on fall preventive strategies is in Chapter 2. The current study fills the gap in the literature by comparing preventive strategies of falls, FRIs, and the risk of hospitalization due to fall for all age populations.

Successful strategies to prevent falls will require public health professionals,

researchers, health institutions, and governmental agencies to collaborate with health synergies to develop preventable interventions against falls and FRIs (Health People 2010, 2005). Collaboration is aligned with the Institute of Medicine's (1988) characterization of public health mission in which society's interest precedes individualism. The fall strategies and health collaborations constitute the core functions of public health in assessment, policy development, and assurance. Underlying the strategies are ways to educate the population against the incidence of FRIs and the number of persons visiting the EDs of the national participating hospitals due to falls and FRIs.

Nnodim and Alexander (2005) defined a *fall* as an event in which an individual inadvertently comes to rest on a lower-than-usual level in the absence of an overwhelming force, syncope, or stroke. As a sign of effective mobility, a strong balance is always needed. A fall will occur when a balance is compromised due to any risk factor. There is higher risk of falls in all age groups with corresponding increase in the risk factors for falls. A child with a genetic abnormality of the lower limbs may struggle with balance. The young and middle-aged adults with either sporadic or addicted drug- or alcohol- usage may have limited balance and mobility confidence when under the influence. As a result, these people will have a high risk of falling. For any group, older adults and children in particular, a fall increases the fear level of mobility, restricts the activity, and reduces the balance confidence. Children falling down on skiing the first time may be influenced by fear on the second attempt. On the other hand, older adults falling down from a staircase or on a bathtub may restrict further activity and may

generate reduce confidence in balance.

Falls do not result from a single cause, but multiple risk factors including those that are intrinsic (individual behavior or characteristic) and extrinsic (relating to the environment) contribute to the cause of a fall. For example, there are higher risks of falls for individuals with weak muscles at the lower limbs and those who have a history of unstable balance due to previous injury (intrinsic); and moving on certain surfaces covered with icy, snowy, and muddy conditions (environment). More than 300 risk factors have been identified and associated with falls (Tinetti, Gordon, Sogolow, Lapin, & Bradley, 2006). Another example is that, a child with a genetic abnormality (intrinsic) and learning disability (intrinsic) may fall if suddenly self-balance and mobility are lost to a poor wiring floor (environment). A more detail descriptions of the intrinsic and extrinsic will be addressed in Chapter 2.

Potential risk factors for falls and FRIs include the following: age, gender, race, (Helmkamp, & Carter, 2009; Helmkamp, Bixler, Kaplan, & Hall, 2008; Oliver et al., 2010) and the environment (Rosen, Mack, & Noonan, 2013; Talbot, Musiol, Witham, & Metter, 2005). These risk factors may influence hospitalization. The factors can serve as dependent and independent variables of fall. For example, children, young, and middle-age adults may use the upper limbs to cushion falls and may suffer upper limbs, such as wrists and hands, injuries. On the other hand, older adults, may use lower limbs to brace for balance and upper limbs to cushion falls. However, weaker limbs due to advanced aging, often may result into hip-related injuries. Although many reports exist on falls in older adults (CDC, 2006b; Oliver et al., 2010), there is paucity of information on falls

among children, younger adults, and middle-aged adults (Talbot et al., 2005). In addition, falls in certain demographic groups may not be well understood (Talbot et al., 2005), despite the fact that falls in older adults are known (Schiller, Kramarow, & Dey, 2007; Owens et al., 2009).

Several risk factors are the characteristics of individuals with frequent exposure to falls. One third of Americans aged 65 years or older experience unintentional falls every year, a figure that rises steadily with increasing age (Steven et al., 2008; Tinetti et al., 1988). Other research suggested that half of these falls are recurrent, and one in every two falls is believed to be unreported or unnoticed by the health care providers (Rubenstein & Josephson, 2006). In 2005 alone, a total of 15,800 older persons aged 65 years or older died as a result of falls injuries (CDC, 2007). The CDC also reported that the older adult population is the fastest growing at 13% in the 1990s, and it is estimated to reach 23% by 2050. As a result, older adult population may increase in falls in the future (Yeoh, Lockhart, & Wu, 2013). Understanding how the risk factors expose individuals to falls integrates better into preventive interventions. For example, unintentional falls sometimes happen at homes, outside or surrounding homes, workplaces, sporting events, recreational facilities, hospitals, and community dwelling facilities. The exposure of young, middle-aged, and older adults to falls will include the following: slipping from a wet floor, imbalances of feet due to medication previously administered, running into objects, and being pushed or stroked by someone (Adams et al., 2005; CDC, 2006; Zielinski et al., 2012). Intentional falls, on the other hand, relate to falling voluntarily from heights: bridges or balconies to the ground in urban centers,

skiing downhill, and mountain biking (Aleman & Meyers, 2010; Deits et al., 2010; McLean & Tyroch, 2012; Shields, Burkett, & Smith, 2011). I explored the relationship between FRIs and the risk factors that may lead to falls and hospitalization for all ages.

Fall types are significant in understanding the dynamics of falls because individuals and institutions are involved. Families will want to know whether falls of participating children or young adults in sporting or recreational events are unintentional. Institutions will be interested in knowing whether an employee's fall during working hours is intentional. The state public health care official will investigate whether the older adult falls at the nursing home is unintentional or intentional. In all these scenarios, the interest in the cost of care for the injured and the preventive interventions to reduce the cost are at stake.

Understanding the epidemiology of falls, FRIs, and hospitalization is necessary as a lasting prevention intervention is the objective. Discharged data obtained from presiding emergency departments as a nationally representative sample from all participating hospitals will help to explain how multiple risk factors interplay to cause a fall. The pattern of whom, where, how, and why falls occurred can be the stepping stone in implementing evidence-based interventions to reduce falls and when FRIs occurred ways to reduce the severity may be explored. Inquiry on falls and FRIs provide a better way of understanding the perceived causes of falls by the fallers and those who may be helping to manage and prevent falls.

Falls in older adults were characterized by many authors with different reports and views extensively in the literature yet little were compared and reported on other

aged groups. For an example, Stevens et al., (2008) investigated causes and costs in falls and FRIs in the older adults thereby deriving trends from the risk factors of falls, and they suggested prevention strategies to reduce fall injuries at hospitals settings. However, there exists a paucity of research on FRIs when compared with different age groups: including children, the young, and middle-aged adults for falls estimates at the national level (Talbot et al., 2005). The current research will fill that gap to investigate the national trends of falls to include the children, youth, the middle-age, and older adults. Knowing the trend of falls, FRIs, and hospitalization nationally may provide policymakers, health providers, health officials, and health educators the strategies to develop and implement interventions on targeted populations to reduce the incidence of falls. Such implementation will encourage a social change and drive one of the primary objections of Healthy People 2010 to reduce public injuries.

Problem Statement

The problem addressed in this study is that although falls and FRIs in older adults have been reported extensively in literature, little attention has been given to fall in other aged groups. The rate of falls in the older adults is known; but, the relationship between age and the circumstances leading to falls and FRIs in children, young and middle-aged adults are less characterized in the literature. The relationship between age, gender, race, incident locale, and the body part affected leading to hospitalization are unknown in children, youth, and middle-aged adults.

Falls and FRIs are a burden to individuals, communities, and the health care system in general. Falls are sometimes debilitating to individuals as those experiencing

falls may not be able to return to their normal lifestyle and may suffer significant morbidity and even death (Adams et al., 2005; CDC, 2006b). Falls imposed substantial financial burden and increased medical cost on individuals and institutions. The direct medical cost of FRIs among the older adults is approximately \$20 billion annually, and it is expected to increase substantially over the next decade as the population ages (Stevens, 2006). The figure excludes the medical costs of children, the young, and middle-aged adults because little information exists in literature. However, the falls of the young and the middle-aged adults of all ages range from moderate to severe including lacerations, head trauma, and wrist dislocations among other significant injuries (CDC, 2005; Stevens, 2006). Receiving services on these incidents can be at a higher cost. The hip fracture is an injury typical with the older adults and the cost of recovery is enormous.

The problem in view, in this study, is that although the cause and effect of older adults on falls are known, the relationship between FRIs and hospitalization, and age of children, young and middle-aged adults are not adequately represented in the literature. Schiller et al., (2007) examined falls triggering ED visits among older persons, but the study did not examine falls in children, the young and middle-aged adults. This work will attempt to fill the gap in literature by examining falls in all age groups as reported by the participating hospitals in the United States.

Purpose of the Study

This project is unique because it addresses an under-researched area, namely predictors of falls and the subsequent unintentional fall injuries across all age groups as treated at a nationally representative sample of hospital emergency departments in United

States. The gap in the literature is that there has been limited work done examining the epidemiology of falls and FRIs on all age groups, particularly at the national level. Understanding factors that affect falls and FRIs are an integral part of developing programs, services, and policies that ensure people are taking safety measures to reduce disabilities due to FRIs and to engage in a healthy lifestyle. Public health officials may develop fall interventions for targeted populations when frequency, circumstances, and persons affected by falls are known. The implementation of the interventions may lead to social change. The ultimate goal of this quantitative study is to analyze information obtained from the nationally representative sample of the hospital emergency departments on falls and FRIs. The study may help health officials and policymakers as a point of reference on the occurrence of falls, and how it can reduce the public health burden due to injuries.

Research Questions and Hypotheses

There are two research questions associated with the main purpose within the methodology of the research study and five statistical hypotheses were tested.

Question 1. What is the rate of falls among representative sample of hospital emergency departments (EDs) in the United States, overall and by age groups (< or = 19, 20–34, 35–64, and 65+) between 2009 and 2011 time period?

Question 2. What factors (age, gender, race, incident locale, and primary body part affected) are independently associated with hospitalization among persons presenting to a representative sample of hospital EDs in the United States?

Hypothesis Question 2a: H_0 : There is no association between age (categorized groups) and the hospitalization among persons presenting to a representative sample of hospital EDs in the United States. H_A : There is an association between age (categorized groups) and the hospitalization among persons presenting to a representative sample of hospital EDs in the United States

Hypothesis Question 2b: H_0 : There is no association between gender and the hospitalization among persons presenting to the representative sample of hospital EDs in the United States H_A : There is an association between gender and the hospitalization among persons presenting to a representative sample of hospital EDs in the United States.

Hypothesis Question 2c: H_0 : There is no association between race and the hospitalization among persons presenting to a representative sample of hospital EDs in the United States H_A : There is an association between race and the hospitalization among persons presenting to representative sample of hospital EDs in the United States.

Hypothesis Question 2d: H_0 : There is no association between incident locale and the hospitalization among persons presenting to a representative sample of hospital EDs in the United States H_A : There is an association between incident locale and the hospitalization among persons presenting to representative sample of hospital EDs in the United States.

Hypothesis Question 2e: H_0 : There is no association between primary body part affected and the hospitalization among persons presenting to a representative sample of hospital EDs in the United States H_A : There is an association between primary body part

affected and the hospitalization among persons presenting to a representative sample of hospital EDs in the United States.

Theoretical and Conceptual Frameworks for the Study

One of the theoretical frameworks that can ground this study is the Neuman system model (Nursing Theory, 2011). In this theory, Neuman examined ways in which systems interact and lead to certain consequences. The cause of falls relates to the individual interacting with the environment, intrinsic, extrinsic and situational factors (Close et al., 2005). Each individual is constantly exposed to intrinsic and extrinsic factors. Neuman's model posits the relationship that exists in persons and their environment along with the stressors that work against the body's line of defense. However, there has been fewer applications of this theory in the research world. A more widely applicable and preferred theoretical framework that rightly fits into this research will be the social ecological model (SEM).

Unlike Neuman's model, which focuses on individual line of defense, SEM is a preferred model for this study as it provides an understanding of how multiple risk factors work to influence individual characteristics, behaviors, and susceptibility to falls. The model is applicable to many public health engagements (Stokols, 1996). This theory is suitable and it grounds the current research than any, considering that falls events involve Multi-factorial forces leading to the occurrence of falls and FRIs. The SEM was used by McLeroy, Bibeau, Steckler, and Glanz (1988) to describe five levels of determinants ranging from individual characteristics to societal conditions (p. 355). The SEM was also adapted by the CDC to promote healthy lifestyles and to broaden the understanding of

many health determinants. This is a system model that includes multiple layers of influence into multilevel approach for health-related issues involving prevention and interventions (Naaldenberg et al., 2009). In Chapter 2, we explained an in-depth concept of SEM and its application to the current study although the level of measurement of the model in the study is well elaborated in Chapter 3.

The SEM was used in many researches as evidence-based applications similar to understanding falls and the multiple risk factors that can lead to falls including nature of environment, the age of the faller, social, economic, structures involved, previous history of the faller, and the communities the faller lives. Similarly, Dahlgren and Whitehead (1991) developed a model on the determinants of health which included individual characteristics, individual lifestyle factors, living and working conditions, social and community networks, and societal condition factors as shown in Figure 1. The conceptual model was then cited by the Institute of Medicine (2003, p. 52) in health and policy related studies. This conceptual model, SEM, has become an *ex facto* in similar health intervention projects, and it is the basis to ground the current study as depicted below:

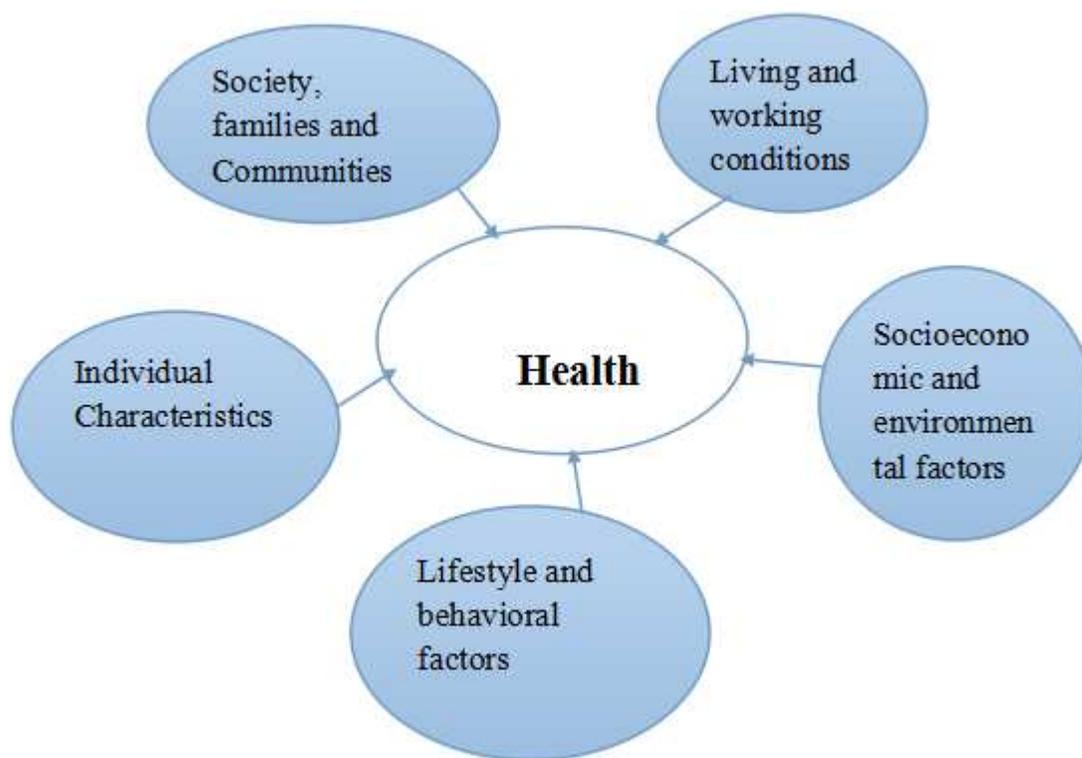


Figure 1. Socioecological model of health.

The SEM in the current study will, therefore, provide the conceptual and epidemiological frameworks in understanding the rate of falls and the characteristics on adverse fall events, and treatments received by patients during visits to the hospital emergency department in the United States. In addition, this model can also be applied in investigating the fall-related factors that are associated with a hospitalization among individuals experiencing falls and presenting to hospital emergency departments.

Nature of the Study

The nature of this study was based on a quantitative method I used this methodology to test the relationship between falls necessitating ED visits in U.S. hospitals with respect to age and gender and circumstance of the fall I applied the

premise of the SEM as an integral part of how children, middle-aged and the older adults become responsive to adequate quality of life, physiological and psychological needs from the health providers, and how living and working conditions affect health in the midst of falls (Callista, 2011).

There are many risk factors that influence individual behaviors and characteristics in the occurrence of falls and FRIs I selected the SEM design for this study because we can better understand and explain through the prism of the design the multidimensional cause and effect of falls and FRIs. The rationale for using SEM for this study is that public health engagements have used the design to look more closely at public health issues, each of these issues are caused by multiple factors. Public health officials when designing a fall intervention program, through the lens of the SEM design, incorporate multiple factors of falls and how FRIs affect individual, society, and community. The study then holds consistency in the match between the design used and the gap intended to fill.

We used data from the National Electronic Injury Surveillance System – All Injury Program (NEISS-AIP) in the analysis. The NEISS-AIP is an expansion of the Consumer Product Safety Commission’s (CPSC) National Electronic Injury Surveillance System (NEISS) which was established to monitor consumer-product related injuries. NEISS collects injury data from a nationally representative sample of U.S. hospital emergency departments (CDC, 2010; National Electronic Injury Surveillance System-All Injury Program, 2010). NEISS-AIP then uses a subsample of those emergency departments for its data collection. NEISS collects data from a sample of 100 hospitals

with the 24 hour emergency department services. Out of these 100 hospitals, NEISS-AIP collects data from 66 of these hospitals and about 500,000 injuries are reported annually. The variables on demographic information about the patient, details about the injury types, and where the patient goes after the ED visits are important of the analysis.

Definition of Terms

Fall: An unexpected event in which the individual comes to rest on the ground or on the floor or lower level (Lord, Sherrington, Hylton, & Close, 2007).

*FRI*s: Fall-related injuries (FRIs) are injuries received when a person descends abruptly due to the force of gravity and strikes a surface at the same or lower level (Stevens et al., 2011).

YPLL: The concept of years of potential life lost (YPLL) involves estimating the average time a person would have lived had he or she not died prematurely (Li, Ekwueme, Rim, & Tangka, 2010; Gardner, & Sanborn, 1990).

Healthy: Anyone with vigor of mind, body, or spirit is said to have an indication of good health (Mish et al., 1994, p. 535).

High risk for falling: Individuals who maintain sedentary lifestyle, are physically compromised, or who have recently experienced important life events (Marks & Allegrante, 2004).

Incident locale: The location where a fall or fall-related injury occurred to include injuries occurring at home and those outside home.

Injury: When the fall causes a limitation of regular activities for at least a day or a visit to a doctor (CDC, 2008).

NEISS-AIP: The National Electronic Injury Surveillance System All Injury Program (NEISS-AIP) is an expansion of the Consumer Product Safety Commission's (CPSC) National Electronic Injury Surveillance System (NEISS), used to monitor consumer-product related injuries. NEISS collects injuries data from nationally representative sample of U.S. hospital emergency departments.

Middle-aged adults: The operational definition of *middle-aged adults* to include persons' aged 36–64 years.

Older adults: The operational definition of *older adults* includes persons aged 65 or older.

Outpatient: A patient who seeks treatment at a hospital or other facility but whose care is normally for fewer than 24 hours and does not require an overnight stay in a hospital (Rider-Ellis & Love Hartley, 2004, p. 10).

Young adults: The operational definition of *young adults* includes persons aged 20–35 years.

Children and Youth: The operational definition of *children and youth* includes persons aged 0–19 years.

Inpatient: A hospital patient whose care requires greater than 24 hours of care and necessitates an overnight stay (Rider-Ellis & Love Hartley, 2004, p. 10).

Assumptions

In this study, we used NEISS-AIP public data as the secondary source of data. The NEISS-AIP data are the datasets collected at the nationally representative sample of EDs of the participating hospitals. Although NEISS-AIP data are used to investigate

consumer products and safety issues, we assumed that the people treated in the participating hospitals voluntarily provided information which constitute the discharged data, information are later coded, and transmitted into the NEISS system. The patients are part of the sample representing the noninstitutionalized population of persons who visit the EDs in the United States I also assumed that the data were taken voluntarily by trained officials from the patients at the time of entry over the duration of stay or hospitalization at the EDs.

Another assumption is that all noninstitutionalized patients communicated the falls and outcomes in English Language to the clinicians. The hospitals involved operated 24 hours each day and have resources always available at the respective EDs. Certain EDs are not part of the nationally representative sample of hospitals and NEISS-AIP will not receive dataset from these EDs. With the availability and adoption of the electronic health or medical records across the nation hospitals, data acquisition by officials at EDs has improved. Unintentional injuries were captured in NEISS-AIP data collection, however, fatal injuries although may have occurred in EDs records but were excluded in this study since NEISS-AIP does not provide detail information on injuries resulting to deaths.

The use of secondary source of data in a research study brings several options to variable selection and as a structured dataset the information can be slice and dice for further analysis. As a structured data source, one assumption I have is that information collected is based on the predetermined codes or data fields established when the instruments were prepared. The research purposes and questions to investigate are

depended on the instruments used for the data collections and the data derivatives (Simon, & Goes, 2013). The NEISS-AIP public data are derived from a sample of 100 hospitals operated with 24 hour emergency department services. The NEISS-AIP data are collected from 66 of these participating hospitals with the assumption that each hospital adheres to the guidelines established by the CDC working through individual state Health Departments. The subset of these hospitals includes inner city trauma centers, urban hospitals, and suburban children hospitals.

The sequence of data flow following a patient's visit to a hospital due to FRIs includes ED records, code abstracts, effective code and extracted datasets for injury related cases. The coded data and metadata are transmitted to the NEISS-AIP distributive systems. The assumption is that the quality assurance coders may then have reviewed the transmitted data loading and complete the coding with accuracy. As a result, data collected, will be consistent across the board and are weighted to produce national estimates I also assumed that the data collected from the respondents or patients are accurate and truthful. A final assumption is that all the national representative sample of the EDs provided accurate datasets to the NEISS-AIP.

Scope and Delimitations

The scope of this study included falls and FRIs of children, youth, middle-aged and older adults reported and treated at the participating EDs across the United States. The non-institutionalized patients of falls provide information voluntarily on arrival at the EDs due to falls and FRIs irrespective of age, gender and the circumstances that led to fall injuries. This study will exclude all falls and FRIs that occurred but were neither

reported nor treated at the participating EDs of representative hospitals but was only reported at doctor's office.

This research study is based on a cross-sectional design and analysis by using NEISS datasets between 2009 and 2011. The NEISS database however, does not include certain coded variables such as preexisting medical conditions, evidence of those factors that influence the need for hospitalization, long-term mobility or disability, and injury severity. These variables and other potential control variables may not be included in the statistical analysis. Follow up of subjects to confirm any relevant medical history may not be feasible since subjects are liable to significant recall bias given the time the event occurred. Generalizing to the U.S. population may be limited to selection bias because those treated at the ED may differ from the general U.S. population.

Limitations

Like any other study, the current study is not without limitations. One of the limitations is that the study addresses only falls and FRIs treated only at hospital EDs in the United States. The hospital EDs that we selected to participate are constituents of the nationally representative sample of 100 hospitals of which 66 centers are selected to participate I excluded from this study the datasets from the hospital EDs outside the participating hospitals Although NEISS-AIP datasets include only limited number of variables in the data acquisition, the system does not include injuries treated or reported at the physician's office or any outpatient settings, and those that did not require any medical attentions.

The NEISS-AIP coding systems have a fixed numbers of categories for both

primary parts of the body affected and the principal diagnosis type relevant to the consumer product related injury. Underreporting may occur in cases of multiple injuries. NEISS-AIP does not provide information on deaths that occurred after leaving the EDs, this study will not include deaths that occurred after treatments.

Significance of the Study

The significance of understanding the epidemiology of falls and FRIs at any age is paramount to addressing injury issues. The financial burdens and the quality of life of individuals and communities can better be understood when patterns of falls and injuries in children, young, middle-aged, and older adults are known (Banthin et al., 2008). There are intervention programs that may reduce the incidence of falls and FRIs; however, for each fall there are multiple risk factors. Individuals reducing risk factors for each occurrence of fall can reduce morbidity and mortality due to falls and FRIs (Coussement et al., 2008). In Chapter 2, we discussed how multiple risk factors can influence individual characteristics thereby promoting behavior changes.

There are about 300 risk factors that could lead to falls (Tinetti et al., 2006), and it makes sense to use a multifactorial approach to research risks influencing behavior changes in individuals and communities to reduce falls and FRIs than focusing on individual risk-factor approach on falls. The age and gender of a person may influence the individual who is at risk of falling and subsequently with admission for hospitalization.

Summary

This chapter was an introduction to the study through an examination of the

epidemiology of falls and FRIs of patients treated at the national representative sample of hospital EDs in United States. In an overview, we discussed background information related to falls and FRIs based on what are known from the existing literature and research findings I also discussed the gap in the current research I addressed in the current study the problem statement, conceptual and theoretical frameworks that grounded the research study, research questions and hypotheses, the nature of the study, and the significance of the study. Also, I described the purpose of the study and what social changes may occur in communities and in the lives of individuals. In the sporting and recreational communities, children, the youth, and middle-aged adults may have a better understanding on fall-risks and the safety measures to adapt to prevent falls and hospitalization.

More than 300 risk factors exist for falls, preventing fall events, FRIs, and subsequent hospitalization are significant challenges to public health professionals and the hospitals they represent. It makes sense for any health institution to adapt a multifactorial approach of fall risks in preventing any form of falls in hospitals, health centers, and retirement communities. Financial burdens on individuals recovering from falls and disabilities are overwhelming. Many patients, young and old, will not be able to return to a normal lifestyle after FRIs and disabilities. This study may explore on how age and gender of patients may influence individuals with risk of falling, FRIs, and subsequent hospitalization.

In Chapter 2, I described in-depth the existing research on falls and FRIs, the theoretical constructs and concepts used in the study, and the method used in the study of

falls and FRIs to align with the research questions. In addition, I discussed the known epidemiology of falls and FRIs although I described the effect of falls and injuries on communities and health care systems. Finally, I underscored the importance of patient emergency department visits and the significance of surveillance systems.

Chapter 2: Literature Review

Introduction

In this study, I explored the known epidemiology of falls and related injuries presenting to a nationally representative sample of hospital emergency departments in the United States. The information obtained from this study may provide a better understanding of the nature of falls and may lead to developing targeted interventions for reducing FRIs. The focus of this study was on understanding the patterns, causes, and health effects of falls and FRIs across different age groups.

In this chapter, I provide a review of literature relating to the health burden individuals experience, the demands on health care, and the costs on society due to falls and FRI. The chapter is divided into 12 sections, including an introduction, literature search strategy, public health mission and falls, sections on the theoretical foundation, and the conceptual framework applicable to the study. In addition, I elaborated on the known epidemiology of falls and FRIs, the effect of falls and FRIs on communities and the health care system, and perceived causes and environmental factors of falls I discussed FRIs and emergency department visits and FRIs and surveillance systems.

Literature Search Strategy

A majority of the literature I referenced in this chapter came from a review of peer-reviewed literature in the electronic databases available through the Walden University Library. To obtain literature, I conducted a comprehensive search in the Academic Search Complete database using keywords or combination of keywords of *falls* and *FRIs* from 2006 to 2014, which returned 436 citations with full text I further

refined and filtered the results by selecting reference available, peer-reviewed, and academic journals to obtain 19 citations. Other useful databases I reviewed included CINAHL Plus with Full Text, Cochrane Library, EBSCOhost, EMBASE, Google Scholar, United States Library of Congress, Health and Medical Complete, Health Sources: Nursing and Academic Edition, MEDLINE, Nursing and Allied Health Source, OVID, ProQuest, PubMed, SAGE Full-Text Collections, SocINDEX with full text, and Science Direct and Wiley Interscience.

Other pertinent sources from the Internet included social and medical institutions, the Centers for Disease Control and Preventive (CDC), and the Institute of Medicine. Additional combination of keywords and terms for the search were *falls, injuries, older, children, age, hospitals, emergency departments and surveillances* I reviewed *middle-aged falls and injuries, hospitalization due to falls, emergency departments in the United States, community dwelling of older, inpatient, and outpatient falls* I also reviewed literature on the theoretical framework that grounded the studies and the methodology as an extension of the problem statement introduced in the first chapter. In addition, I referenced lists of research articles and journals pertaining to this study to identify additional literature.

Public Health Mission and Falls

Discussions on health care frequently include factors adversely affecting the health of people in the United States and the evidence-based interventions that are applicable to improve the quality of life and enhanced life expectancy. The Institute of Medicine (IOM, 1988) characterized the public health's mission as "fulfilling society's

interest in assuring conditions in which people can be healthy” (p. 7). With this mission in mind, it is important to consider conditions that influence health and wellness although underscoring the broad scope of public health burdens due to social, political, economic, and medical factors affecting health and illness. Underlining the mission are the three core functions of public health: assessment, policy development, and assurance to the population. These core functions provide a platform for public health epidemiologists to operate in unison with medical professionals. As a result, public health systems are consistent with what medical care systems generally ascribe to as involving the diagnosis and treatment of individuals at the tertiary level. However, the public health systems are concerned with group interventions and preventions at the primary level.

Communities and health care systems should be concerned about FRIs (Quigley et al., 2012). Public health workers who are aware of FRIs may help to formulate research, carry out strategies to prevent FRIs, and provide interventions for the population affected by FRIs (Sterling, O’Conner, & Bonadies, 2001). Falls among older adults have been examined in the literature; however, few researchers have reported on children and young- and middle-aged adults (Talbot et al., 2005).

Both intentional and unintentional falls have created a public health burden on individuals, communities, and health care systems (Schiller et al., 2007; Thomas et al., 2008). Scholars have examined the burden of pediatric falls and the increasing economic burden of injuries from middle-aged and older adult falls (Boye et al., 2012; Harris et al., 2011; Roudsari et al., 2005; Steven et al., 2011; Zielinski, Rochette, & Smith, 2012). Fatal and nonfatal injuries continue to exacerbate the growing cost of health care as

mortality and morbidity have increased in the United States (Quigley et al., 2012; Stevens et al., 2006) although older falls are common and increase with age, children and middle-aged adults fall with different outcomes (Talbot et al., 2005). In 2008, nearly 21.8 million persons older than 15 years sustained nonfatal, unintentional injuries with lifetime medical costs of more than \$67.3 billion (Stevens et al., 2011). Fall outcomes can be debilitating, leading to traumatic brain injuries (TBIs) (Hartholt et al., 2011; Thomas et al., 2008).

Theoretical Foundation

Proponents of the Roy adaptation model focus on individuals as biopsychosocial beings who continue to adapt and adjust to the internal and external stimuli, whereas the Neuman systems model is focused on an individual line of defense and resistance that advances self-management (Merks et al., 2012; Ordin, Karayurt, & Wellard, 2013). Neither model includes factors that might influence health. The social ecological model (SEM), on the other hand, includes multiple bands of influences affecting the health of individuals. Multiple risk factors are contributors to each individual's health and exposure to falls (Willgoss, Yohannes, & Mitchell, 2010). This makes the SEM a preferred model for the current study as it provides an understanding of how multiple risk factors work to influence individual characteristics and susceptibility to falls. The model is applicable to many public health engagements (Stokols, 1996).

The SEM provides the theoretical framework that will ground this study. With this theoretical prism, the fundamental premise of public health burden, falls, is seen as a multidimensional engagement. Stokols (1992) suggested that social ecology should

include individual influence and interactions with environmental factors, including physical and social environmental features. In addition to the concept that several determinants affect an individual's health, SEM includes a multilevel approach by integrating individual characteristics with community, society, and physical environmental influences on health (Stokols, 2000). This model was founded on the principles that several determinants influence human wellbeing. The SEM was used by McLeroy, et al., (1988), to describe five levels of determinants ranging from individual characteristics to societal conditions (p. 355). Dahlgren and Whitehead (1991) developed a similar model of SEM and integrated all determinants of health: individual lifestyle and characteristics, living and working conditions, social and community network, and societal conditional factors.

The SEM was also adapted by the CDC for health promotions and to broaden the understanding of many health determinants. This is a system model that includes multiple layers of influence into multilevel approach on health-related issues involving preventions and interventions (Naaldenberg et al., 2009). At the core of the SEM is the individual characteristics surrounded by other four bands of influence which represent interpersonal, organization, community, and policy levels. To help maximize synergies of intervention and prevention for the greatest impact, the CDC implemented many activities using these five levels of influences. The CDC developed many programs and many health organizations with the SEM concept in view. The CDC's Colorectal Cancer Control Program's (CRCCP's), the Eat Healthy Foods in Baltimore, Violence Prevention, Adolescent Smoking, and Healthy Campus 2020 Programs are among some of the

programs that include an SEM model (Blum, McNeely, & Nonnemaker, 2002; CDC, 2013a; Hochman, & Kernan, 2011). This model provides a theoretical framework through which falls and FRIs can be examined to better understand how various risk factors of falls influence individual characteristics I used the SEM model to examine the causes, impacts, and interventions of fall and FRIs in a multidimensional matter.

Conceptual Framework of Falls

Every health burden has determinants that influence health outcomes. The causes of any chronic disease are multifactorial and the higher the risk factors, the more the susceptibilities to the disease. The SEM is capable of integrating the health determinants with multilayer influences into a multilevel approach that can reduce the occurrence of fall. The SEM system includes influences from the following levels: intrapersonal, interpersonal, organizational, community, and public policy.

The five layers of SEM will provide a theoretical lens for this study. Public health workers will benefit from the use of the multilayer approach to examine FRIs to facilitate a change of individual behaviors or attitudes to improve the quality of life. This model is applicable to falls and FRIs as many determinants and influences are involved. Sound behavior practices and healthy lifestyles promote physical wellbeing and reduce morbidity and mortality at community levels. A fall is a public health burden that affects all ages. A fatal injury from a fall can be debilitating to the lives of individuals and communities. There are many risk factors that influence the behavior of individuals (Naaldenberg et al., 2009; Willgoss et al., 2010) I used the SEM to unveil the reasons

why people are falling, age differences in falls, and where the falls and FRIs are most occurring (Harris et al., 2011; Steven et al., 2011).

SEM can be used as an integrator between health determinants and health influences. Health influences can come from individuals, organizations or institutions, communities, and public policies. The CDC (2013a) considered the structure of SEM as an onion with the innermost part representing individual or intrapersonal characteristics. At that level, individuals are influenced from their internal determinants: Skills, attitudes, beliefs, and behaviors. The SEM is used to highlight the importance of receiving high-quality health services or programs to help individuals and communities practice healthy lifestyles (CDC, 2013a). The application of SEM on cancer intervention underscored the need for providing information on exposure to cancer screening, the intent to screen, risks for not screening, accessible and affordable screening, and understanding the diagnosis and treatment in the CRCCP. Hochman and Kernan (2011) used the SEM to evaluate a nutrition program's sphere of influence. According to the SEM, many external forces influence each individual characteristic or choice. To facilitate any behavior change at an intrapersonal level, it is important to be mindful of these external forces. If a patient falls and is brought to the emergency room due to alcohol or drug addiction, it is important to consider other factors influencing the substance abuse. Those contributing factors are the external forces that should be considered with for any intervention.

The CDC (2013a) believed that the interpersonal layer of influences is affected an individual externally. This interpersonal layer is considered the first of those external forces that often work against individual characteristics. Families and friends are the

primary social groups that interact and influence any person's behavior or attitude. Other groups that influence an individual's behavior include health care providers, community health workers, and patient navigators, serving as potential source of support through interpersonal messaging. In the interpersonal relationship, there are those in the social role who are posited as decision-makers. In a program to prevent pediatric falls and FRIs, parents of the children who are the decision-makers must be aligned within any health intervention program (CDC, 2013a). According to the CDC (2013b), SEM was used to make recommendation to patients on cancer screening and receiving reminders of the need for cancer screening. Similarly in this study, organizations and institutions can provide information on the risks and necessary preventive measures to influence individual behavior or attitude towards the incidence of falls and FRIs.

The CDC (2013a) SEM structure has the third band in the interpersonal level as organizational. This external force is intended to influence the behavior and attitude change of individuals from the organizational system. Organization groups that can influence behavior include employers and their workplaces, local health departments, health care systems, health care plans, and organizational support systems. According to the CDC (2013b) organizations underscore the encouragement of health coverage and expansion of benefits for screening and adopting workplace policies that will support preventive care. Organizations also sponsor recreational facility or sporting events (CDC, 2013a).

Communities are the fourth band that can influence individual behavior at the organizational level. Communities can facilitate individual behavior change by

encouraging participation in community events. Community institutions that can influence individual behavior include community advocacy groups, media, and health departments. The CRCCP emphasized coalitions and collaborations to promote cancer screening, conducting public awareness and educational campaigns on cancer screening (CDC, 2013b). These institutions can also play a role in preventing or reducing falls and FRIs.

Policy level is the fifth level in the SEM that can influence individual behavior. The focus of SEM at this level is to allow governments to implement policies for healthy changes in behavior and attitudes to benefit individuals (CDC, 2013a). The federal, state, local, and tribal governments can encourage healthy behaviors in individuals. The CDC (2013b) highlighted the need for health policy decisions for the public by providing insurance mandates for cancer screening. These governments are vital to mitigating the burden of falls and FRIs on the public health.

The Known Epidemiology of Falls

It is important to identify which events do and do not count as falls. The Kellogg International Work Group (1987) defined *falls* “as a disease entity recorded in Index Medicus and in the International Classification of Diseases Xth Revision” (p. 1). The United States is required to use the International Classification of Diseases (ICD) to classify diseases and injuries under the agreement with the World Health Organization (WHO). However, the classification does not explain how falls and FRIs are different from other types of diseases (Tinetti, 2008). The classification of falls and FRIs as a

disease entity gives the epidemiologists basis for inquiries into how, who, why, and where people are falling.

According to Talbot et al., (2005), falls and FRIs were among host of public health burdens that have seen an increase in occurrence among the older population. One third of the older population in the United States falls at least once every year (Stevens et al., 2006). Falls have different meanings to different groups of a population. The perceptions of older adults and health care providers on falls are on outcomes whereas researchers focus on the events of falls itself (Rubenstein et al., 1990; Zecevic et al., 2006). A fall can occur at home, workplace, hospital, nursing homes, assisted living and community dwelling facilities, recreational or sporting facilities, and even at school. Events taking place in each of these environments pose risks of FRIs for any person, irrespective of age and gender. The FRIs can lead to other disabilities, including not being about to carry out daily living activities (Yeoh, Lockhart, & Wu, 2013).

Falls increase with increasing age in all population groups (Boye et al., 2012; Talbot et al., 2005). The most vulnerable groups to falls are the older adults and children (Harris et al., 2011; Schiller et al., 2007). Although a third of the older adults over 64 years of age falls once every year, 50% of those falls are recurrent and the older falls are more reported than any other groups (Mack et al., 2013; Schaffer et al., 2011; Zecevic et al., 2006). As life expectancy has increased from 75 in 1990 to 79 in 2009, it was estimated that the number of U.S. adults 65 years of age and older will double by 2050 (Boye et al., 2012). This increases will likely lead to an increase in the number of falls in the older population in the future.

Many children, on the other hand, are also falling either due to certain genetic abnormalities or through recreational activities (Zielinski et al., 2012). Parents want their children to be safe, secure, and help them to reach their full potential. Knowing how to prevent child injury, like falls, will help parents reach goal. Most pediatric falls occur during outdoor activities like participating in sports, playing in the pool, or playing in playground events and backyard or driveway games (De Roo, Chounthirath, & Smith 2013; Schaffer et al., 2011). Children and middle-aged adults also represent a population that falls when they are in groups for occupational and recreational activities (Aleman & Meyers, 2010; Stevens et al., 2011). Middle-aged adults are falling because of active involvement in snow shoveling, biking, hiking, jogging, industrial working, horse riding (equestrian), ice hockey and football games, excessive liquor drinking, and illicit drug usage (De Roo et al., 2013; Deits et al., 2010; Watson, Shields, & Smith 2011). Mountain and rock climbing, swimming, and walking pets are also present risks for middle-aged adults falling (Smith, 2006).

Different population are falling either by intentional or unintentional means. For children and older adults, most of their falls are unintentional (Mack et al., 2013; Zielinski et al., 2012). Reasons for an unintentional fall include slipping from a wet floor, imbalances of feet due to medication previously administered, running into objects, and being pushed or stroked by someone. Intentional falls, on the other hand, are related to falling voluntarily from bridges or balconies in urban centers, skiing downhill, and mountain biking (Aleman & Meyers, 2010; Deits et al., 2010; McLean & Tyroch, 2012; Shields, et al., 2011). Understanding the intent and types of falls allow health

professionals information on how to address FRI issues with intervention programs.

Whereas the older population and health care providers focus on the result of falling as FRIs, researchers are mindful about fall events (Zecevic et al., 2006). Differences exist between the reason for falling as reported by seniors and the risk factors for falling identified in the research literature.

There are falls that are only witnessed by the faller and, depending on the extent of the FRIs, a decision was made whether or not to report the fall at the emergency department. The pediatric and geriatric populations are at a higher risk for falls (Noonan, Stevens, & Baldwin, 2011). Most of the falls are unreported at emergency departments, especially when the outcomes are nonfatal, are not witnessed by any caregiver, and do not show any visible injuries (Owens et al., 2009). Other instances of falls where witnesses are involved, depending on the level of fatality, are reported at the emergency department (Wagner, Richards, & Oliver, 2003).

Morse (2002) classified falls into three categories: accidental, unanticipated physiological, and anticipated physiological falls. In accidental falls, the faller is often taken by surprise. It occurs during diving or jumping into water, from playground equipment, into storm drain or manholes, from a ladder, scaffolding, or through a roof. Also, accidental falls occur on escalators, stairs, steps, and sidewalk curbs. Unanticipated physiological falls refer to those falls occurring because of physiological issues not yet identified by the fall risk tool or the health professional. These types of falls include fainting, seizure, and pathological hip fracture. The anticipated physiological falls occur in individuals already flagged as being at risk for falling. An individual with an impaired

gait is at a high risk to fall and is expected to fall again. The known epidemiology of falls is based on the use of ICD in the classification of falls and FRIs as a disease” the population that is at risk of falls, the accidental and intentional falls, and environmental risk factors. In understanding the basis of falls, epidemiologists can help to enhance safety in hospitals, recreational groups, at homes, schools, and workplaces through protective and preventive strategies.

Fall-Related Injuries and Mortality

Falls and FRIs are preventable. To prevent FRIs, certain protective and preventative strategies need to be adopted. In protective strategies, the health professional provides immediate action to protect the individuals from FRI. In hospital environments, patients with a recurrent history of falls are admitted for closer observation or may be wearing hip protectors as a protective strategy. Preventative strategies, on the other hand, involve health professionals ensuring that individuals have the proper safety against a fall by providing walking aids and access to medical assessment. The mortality and morbidity for the older adults due to falls and FRIs has increased (Quigley et al., 2012). Due to the increased awareness of this health problem, many intervention programs have been created to reduce the rate of falls.

In 2006, emergency department visits for injurious falls among older adults were over 2.1 million, accounting for one in 10 emergency department visits among patients 65 years of age and older (Owen et al., 2009). Although there is limited literature on children and middle age falling, between 1990 and 2000, about 147 children ages 14 and younger died from playground-related injuries (Owen et al., 2009). Among them, 82 or

56% died from strangulation and 31 or 20% died from falls on the playground surfaces and most of these deaths occurred on home playgrounds (Tinsworth & McDonald, 2001). Talbot et al., (2005) elaborated on falls in young, middle-aged, and older community-dwelling adults in the Baltimore Longitudinal Study on Aging. However, Talbot et al.'s study was limited in scope and Talbot et al., did not examine FRIs with mortality and morbidity rates.

The FRIs are fatal or nonfatal injuries that result from falls. Of the one third of all the older adults who fall each year in the United States, 10% to 20% of the falls caused fatal injuries such as hip fractures and head traumas (Hausdorff, Rios, & Edelber, 2001). Fatal injuries and some nonfatal injuries can be life-threatening, depending on the age of the faller. Nonfatal injuries, on the other hand, are associated with a decrease in functioning and a loss of independence (Ellis & Trent, 2001; Scuffham, Chaplin, & Legood, 2003). Also, nonfatal FRI incidences include injuries that result in hospitalization from survival to discharge and injuries that require medical attention without hospitalization. Those without hospitalization from emergency department visits are included in office-based visits or hospital outpatient visits.

The morbidity and mortality of older adults due to falls and FRIs has increased (Quigley et al., 2012). There is a paucity of literature on mortality rates for young- and middle-aged adults. The severity of FRIs, the age of a patient, the type of health care accessible, the environment, the lifestyle, and the nature of care provided by the caregivers influences the morbidity and mortality rate. The health problem posed by falls and FRIs can be mitigated through understanding the mortality and morbidity rates and

by implementing a preventive intervention to reduce the incidence of falls and FRIs in communities.

Effect of Falls and FRIs on Communities and Health Care Systems

There are many events and activities that are planned with community involvement. In sport, there are different communities, each of which is guided and influenced by a set of values, culture, beliefs, needs, and risks. These attributes define the identity of individuals in a community. Some individuals within a community become role models who inspire others. Different activities are planned based on the seasonal changes. A fatal injury due to fall of an equestrian not only affects the individual involved but also the community. There are certain communities that are well-integrated into a society to be a better recipient of services, like community dwellers of the older population. Other communities are associated with entertainment, occupations, education, religion, and working-classes. The health care system supports these communities in their health needs.

The cost of hospital care in 2006 following emergency department visits for an injurious fall among the elderly community totaled \$6.8 billion (Owen et al., 2009). The cost of falls and FRIs in United States for older adults continues to be a burden on the health care system. Stevens et al., (2006) estimated that in 2000, the medical costs totaled \$2 billion for fatal and \$19 billion for nonfatal injuries among the older community. Of the nonfatal injury costs, \$12 billion or 63% were for hospitalizations, 21% (4 billion) were for emergency department visits, and 16% (3 billion) were for treatment in outpatient settings (Stevens et al., 2006). Medical expenditures for females, who

comprise 58% of the older adult population, were 2-3 times higher than for men for all medical treatment settings (Stevens et al., 2006). Fractures accounted for just 35% of nonfatal injuries but 61% of costs (Stevens et al., 2006). Hospitals have resources to use to treat those who suffer from an FRI, even those without medical insurance. Many communities depend on government assistance for administration; retirement community, nursing home, and assisted-living dwellers. Understanding the dynamics of health care costs due to injurious falls can help individuals in the long term to plan for the expense of FRIs.

FRIs pose medical costs to communities and health care systems. Stevens et al., (2011) estimated that in 2008, approximately 21.8 million persons with age ≥ 15 years sustained nonfatal, unintentional injuries, resulting in approximately \$67.3 billion in lifetime medical costs. The lifetime medical costs of the older are a burden for the dependent family, community, and the government. The cost is not only applicable to the older population but to children. Playground-related injuries among children ages 14 and younger cost an estimated \$1.2 billion in 1995 (Mack, Sacks, & Thompson, 2000; Office of Technology Assessment, 1995). In most urban environments, playgrounds are locations where parents and children spend leisure time; yet, they are also a source of injurious falls injuries. A child with genetic disabilities depends on the family and the community to thrive. The lifetime medical costs of the older- and middle-aged adults and children are a burden to parents and communities (Inouye, Brown, & Tinetti, 2009; Phelan, Khoury, Kalkwarf, & Lanphear, 2001).

The impact of fall and FRIs on families and communities can be overwhelming, particularly when a sole financial provider sustains a fatal fall injury or nonfatal injury (Hausdorff et al., 2001). The loss of productivity of the faller and the caregiver, the cost of care, and the reduced life style of the family due to financial constraints are immeasurable. A community might depend on a faller who is an athlete or an equestrian, a basketball player, or a football or a baseball player; an athlete who sustains a fatal injury due to fall can be devastating.

Perceived Causes and Environmental Factors of Falls

Talbot et al., (2005) examined the significance of falls and FRIs in children and middle-aged and older adults. Talbot et al., attributed the cause of most falls to be from accidents, which included slipping on wet floor, stairs, missed steps or seat; being pushed or bumped; and bumping into objects such as furniture or equipment. Another cause of falls involves a sudden collapse on a floor by an individual who may be passing out due to an unknown medical condition. Dizziness associated with light-headedness, weakness, and paralyzes are other causes of falls (Willgoss et al., 2010). Other causes of falls include balance/gait impairment, like tripping or stumbling, a quick movement, or a loss of balance (Zielinski et al., 2012). As falls continue to be a public health problem, it is essential to consider other risk factors for falls such as the environment. Strategies that will include the behaviors of individuals, as well as medical and environmental risk factors that affect falling need to be considered. Environment factors are contributors to fall and FRIs. As falls and FRIs are risk factors for disability and frailty in older adults (Sterling et al., 2001) and children (Phelan et al., 2001), environmental factors that

prevent FRIs such as the restructuring of inside and outside homes, parks, public buildings, playgrounds, schools, and workplaces are receiving more attention. Different environment and seasons attracts different activities. Skiing and hiking are done during the winter seasons although gardening, mowing the lawn, and working around the home are done during the summer. These environmental factors pose risks to older, middle-aged adults, and children for falls and FRIs.

The environment is an essential constituent when fall-related activities occur. Environmental factors not only include the health determinants causing FRIs in and out of homes but also the genetic component of a human being, and the socioeconomic, cultural, and lifestyle aspects of a population. Other environments where FRIs can occur are workplaces, recreations, schools, roadsides, sports, and hospitals. Children, teenagers, the middle-aged, and the older adults live and work in different environments (Sterling et al., 2001; Wong et al., 2011). The level of interests in activities, needs, and accessibility establishes a person's relationship with the environment. In the event of participating in different activities, falls occur. The outcomes of falls are associated with the environment in which the event occurred (Band & Sundarajan, 2010; Oliver et al., 2010; Shields et al., 2011). The fatality of any FRI depends on the age of the faller and the environment where the fall occurred.

Falls and FRIs occur at homes in bathrooms, staircases, living rooms, balconies, and hardwood floors. Some of the events leading to falls and FRIs within an environment include ladder climbing for maintenance work, sporting, snow-shoveling, mountain climbing, dirt biking, and ice skating. Talbot et al., (2005) described how wet surfaces or

slippery footwear and uneven or indistinguishable surfaces in terms of height and colors can cause nonfatal or fatal injuries. Objects on floor surfaces can cause an individual to trip or slide on floors. According to Lucas, Woodward, and Lincoln (2013), broken furniture/stairs/steps/railings can lead to FRIs. Lucas et al., claimed that these types of home injuries are due to poor or unstable environmental structures. Other injuries can occur due to bumping into someone on icy surfaces, without eyeglasses, or in the darkness (Zielinski et al., 2012). There is an association between the cause of FRIs and the environment. Understanding how the environment can play a role in FRIs and the measures needed to reduce falls is paramount to implementing any preventive intervention.

Fall-Related Injuries and Emergency Departments Visits

Emergency departments are set up to provide health emergency services and treatments to persons in need of medical care. Individuals visit emergency departments when immediate attention is required, like in the incidence of an FRI. Both fatal and nonfatal FRIs are reported through patient information provided at the time of emergency department visit. In 2006, the emergency department visits of older adults for injurious falls were more than 2.1 million, accounting for one in 10 emergency department visits among patients of aged 65 years; the cost of hospital care totaled \$6.8 billion (Owen et al., 2009). Many of the falls in older adults are recurrent and the emergency department visits are more regular compared to other populations, explaining the high hospital cost. It is important to know how patient emergency department visits affect morbidity due to

FRI and whether health care providers educate communities on falls to reduce the FRI rates.

Hospital emergency medical services are integral part of the U.S. health care system. Emergency departments provide care for patients in need of emergency health care (CDC-NCHS, 2013). In 2010, there were 130 million emergency department visits which accounted for 4% of all health care spending in the United States (CDC-NCHS, 2013).

The health care cost incurred by low-income citizens and seniors are borne by Medicaid and Medicare programs. Emergency rooms are also considered by some communities as a safety net provider for patients who are without any alternate choice for place of care or source of care after regular office hours within health care providers are not available (Kellerman & Martinez, 2011). According to the Institute of Medicine (2007), one characteristic of emergency rooms is overcrowding and long waiting to receive care. Although the percentage of patients visiting emergency departments each year has been stable, there had been an increase in total number of visits to emergency departments by 34% between 1995 and 2010, from 97 million to 130 million visits (Government Accountability Office [GAO], 2009). Some emergency department visits result from paramedics bringing in fallers into the hospital as a part of ambulatory care.

There are a variety of reasons why patients visit emergency departments instead of receiving care at the doctor's office, including patient insurance status, perception about the urgency of the situation, and the available source of health care. Individuals without health insurance and primary care physicians are more likely to visit emergency

departments when suffering from fatal FRIs. Depending on the time of the FRI occurrence, many people will prefer emergency department visits to waiting until the next morning to see the physician. The perception of urgency due to FRI varies with different population. What older adults consider urgency may not be the case with young- and middle-aged. When the nearest emergency department is far from patients, residency alternate treatments are sought elsewhere. Cunningham and May (2003) claimed that some patients use emergency departments as a primary source of care. However, to use an emergency department as a sole source of care may not be effective because it is not designed to accommodate cares that are not emergency-related. Emergency departments lack continuity and coordination of care and follow-up apart from poor patient satisfaction due to a long waiting time. Nevertheless, emergency departments strive to reduce mortality and morbidity due to FRIs.

Communities, irrespective of the population groups, tap into emergency departments for medical services. Emergency departments are most commonly used among children under 6 years of age (24%) and for adults aged 75 and older (27%; Luo, Liu, Frush, & Hey, 2003). There are no differences in the percentages of adults aged 18-64 and aged 64-74 because each reported at least one visit (20%) in the year (Garcia, Bernstein, & Bush, 2010). Recurrences of emergency department visits are higher among young children and older adults (9%), which may be due to the prevalence of falls in these population groups (CDC-NCHS, 2013, p. 46).

Diagnosis of common causes for emergency department visits between 2008 and 2010 were higher for falls, which creates a financial burden for families, communities,

and U.S. Government (Hartholt et al., 2011; Hedstrom et al., 2010). Fall-related injuries can also be costly due to lost productivity although the fatal injuries resulting in emergency department visits are often more serious, approximately 30 million visits had an injury classified as the primary diagnosis; some nonfatal injuries were treated at physician offices (Peppe et al., 2007; Tang et al., 2010). Among children, 10% of emergency department visits are due to falls; for adults aged 18-64, 6% of all emergency department visits are due to falls; however, no difference in the percentage of visits from falls exist between males and females (CDC-NCHS, 2013).

At discharge, emergency departments must provide information and guidance to patients. In 2009-2010, 81% of patients in the emergency department were discharged for follow-up care as needed, 16% of patients were admitted to the hospital, 2% of patients left without finishing the visit, and less than 1% of patients died (Calder et al., 2012). Calder et al., claimed that the discharge status is one of the most important decisions made during emergency department visits. Emergency department discharge statuses are classified in one of four ways: the patient dies in or upon arrival at the emergency department, the patient is admitted or transferred to a hospital, the patient is released and is advised to seek follow-up care as needed, or the patient leaves without completing the visit.

The most common discharge disposition is a patient being recommended for a follow-up. The emergency department visit resulting in hospital admission increases with age (Calder et al., 2012). Calder et al., revealed that between 2009-2010, 5% of visits by children resulted in an admission compared with 42% of the number of visits by adults 65

years and older. Calder et al., emphasized that the percentage of discharge by follow-up was higher for children (92%), working-aged adults (87% for those aged 18–44 and 75% for those aged 45–64) than for older adults who accounted for 57%. The emergency department diagnosis and discharge status provide information that can be used in an intervention against FRIs.

Fall-Related Injuries and Surveillance Systems

The public health surveillance systems are an ongoing, systematic collection of analysis and interpretation of health-related data for use in planning, implementation, and evaluation of public health practice (Thacker & Berkelman, 1988). On July 1, 2000, the National Electronic Injury Surveillance System (NEISS) expanded to provide nationally-representative sample data on all nonfatal injuries treated in U.S. emergency departments (as cited in CDC, 2001). Prior to the expansion, NEISS monitored only emergency department-treated consumer product-related injuries (as cited in Quinlan et al., 1999). After the expansion of the NEISS, a national estimate of emergency department-treated, nonfatal injuries by all types and causes was generated. The NEISS-AIP provides data on falls and FRIs as presented in the emergency department. Surveillance systems address the need for real-time or near-real-time data for analysis and dissemination of the information to the public.

All nonfatal injuries are characterized or classified by age and sex of injured person, location where injury occurred (home, workplace); the intent (e.g., assault, unintentional injury, and intentionally self-inflicted injury); and diagnosis through the NEISS data collection, extraction, and storage. The leading cause of nonfatal injuries

treated in U.S. hospital emergency departments by age group is falls (CDC, 2009). Among all injuries, falls are classified as one of the mechanisms of injuries rather than the intent of injury. The body part affected and whether or not the injured person was hospitalized or treated and released is also specified (CDC, 2009; Quinlan et al., 1999). These parameters enable the systematic collection of information on falls.

A surveillance system can provide the public with information on the extent of the FRIs by collecting and analyzing data to provide information about the underlying patterns of FRIs. A surveillance system will also help public health workers to address the cause of the problem and the strategies to formulate to prevent falls and FRIs in all populations. A surveillance system will help public health officials and policy-makers in developing evidence based interventions on a large scale at local and state levels. The characteristics of the NEISS-AIP in data collection and analysis are the reasons why its database is selected as the source of data for this study.

Summary and Conclusion

This chapter was a review of the methods and strategies to identify falls and FRIs, the theoretical and conceptual framework that grounds the study, and the known epidemiology of falls. There are many research articles on falls and FRIs of seniors 65 years of age and older; yet, everyone is at risk of falling, regardless of age. There has not been research at the national level comparing the falls and FRIs of different age groups. This research is important because it will allow public health professional to know the trend in falls and FRIs.

Falls affect not only older adults but also children. Young- and middle-age adults are also vulnerable to falls. Falls are known to result in psycho-social and physical morbidity, affecting daily living, social isolation, changes in health status, and increased hospitalization. Falls lead to increased mortality, morbidity, and premature nursing home admissions in the older population. Retrospective data from a nationally-representative sample of emergency department visits in United States will be analyzed to conduct a multidisciplinary assessment of the patients who fall to reduce the number of hospital admissions, morbidity, and mortality.

The SEM is selected to ground the study because of the multidimensional approach it provides. The structure of the SEM involves multilevel factors that influence individual characteristics, the interpersonal, organizational, communities, and policy factors. The SEM will provide a framework to evaluate falls and FRIs reported in U.S. emergency departments. The methodology will be examined in Chapter 3.

Chapter 3: Research Method

Introduction

In the previous chapter, I discussed the theoretical framework that grounded the study and I described the scope of the literature I reviewed on falls and related injuries I briefly highlighted the methodology appropriate for this research study. The current chapter includes a discussion of the research design and approach, methodology, instruments and materials, research questions and hypotheses, source of data, the data analysis plan, and study variables and coding I used the secondary data from NEISS database to test the hypotheses and answer the research questions. The NEISS-AIP database contains injury records that are reported at NEISS participating hospitals during patients ED visits throughout the United States and its territories. Researchers use these data to conduct investigations on public health injuries.

In the current chapter, I describe the research design and rationale, research method used to address problem statement of the study, methodology, instrumentation, and operational constructs of the study I describe the mechanism and the role of NEISS hospitals in providing NEISS-AIP data, the sample data, and the collection procedures of the datasets, as well as how the data are made available for public consumption I describe the dependent and independent variables, weighting functions used in computing the national estimate, threads of data validity, and the ethical procedures to include subjects protections and rights I list the research questions and the hypotheses of the study and conclude the chapter with a summary.

Research Design and Rationale

The main purpose of the study was to determine whether there are associations between age, gender, race, body part affected, and incident locale (independent variables) and hospitalization (dependent variable). Hospitalization serves as a surrogate for severity; that is, more severe falls are more likely to result in hospitalization. Researchers are interested in studying severity of falls, which sometimes result into injuries and hospitalizations. The behaviors and characteristics of children, as well as young, middle-aged, and older adults, influence the severity of falls, which may lead to injuries and hospitalizations (Ikeda et al., 2002; Simon et al., 2002). In this study, I used a cross-sectional design to determine the prevalence of the outcome of interest (hospitalization, which, as noted, will serve as a proxy for severity of falls) and the corresponding variables that are associated with the presence or absence of the outcome of interest for a given population (Gotsch et al., 2002a; Levin, 2006; McLoughlin et al., 2002). The design provided a way to determine other individual characteristics, such as a set of risk factors and behaviors that give information on the outcome of interest at a specific point in time I also estimated the prevalence of fall by different groups as well as prevalence of odds ratios to estimate the risk by socio-demographic characteristics I also estimated the prevalence of fall by different groups, as well as prevalence odds ratios to estimate the risk by socio-demographic characteristics.

In the current study, I used the NEISS-AIP archival data source between 2009 and 2011 for a quantitative cross-sectional study. This period was selected to ensure adequate sample size for the multivariable analyses (especially given that the numbers in

certain subgroups could be small) I did not expect the epidemiology of falls to vary across this short period. I assumed that it was reasonable to combine the data across these years. The cross-sectional approach was suitable for this study because of its advantages compared with other designs, and it was chosen to address the research questions. The cross-sectional approach was useful because, with it, I was able to generalize to a large population from the representative sample I did not deal with recall bias as data are assessed from a single point. In addition, the cross-sectional inquiry I conducted was relatively inexpensive, requires little time to conduct, and many outcomes and risk factors can be derived (Gotsch et al., 200b; Levin, 2006; Levin, 2006; Rothman & Greenland, 1998, pp. 7576).

In this current study age, gender, race, body part affected, and incident locale of the respondents were known prior to the outcome of interest (hospitalization). However, hospitalization served as a surrogate for severity of falls. The socio-demographic risk factors inherent in the respondents included age, gender, race, body part affected, and incident locale of falls. The data were collected as part of routine clinical care and through medical record data; therefore, the current study did not have low response rates usually found with surveys.

Methodology

Population

The population from, which I drew the study sample was from the NEISS-AIP hospitals. The NEISS-AIP collects data related to nonfatal injuries from the probability sample of more than 5,300 hospitals in the United States and its territories (CPSC, n.d.)

although the sampling method included available hospitals characterized by size and type, the respondents for this study were children and young-aged adults, middle-aged adults, and older adults who sought health services and were treated at the NEISS-AIP hospital emergency departments in the United States and its territories for FRIs.

Of those who sought care from an emergency department visit, some were admitted and hospitalized, whereas others were discharged/not hospitalized. I examined factors associated with whether the patient was hospitalized, with hospitalization as a proxy for the severity of falls. The population that reported falls and FRIs at the doctor's offices or other health centers, such as psychiatric and penal institutions, were excluded from the study.

Sampling and Sampling Procedures

There is a daily data collection from a nationally representative sample of 66 of 100 NEISS-AIP hospitals. The NEISS-AIP hospitals are selected as a stratified probability sample of U.S. hospitals that have at least six beds and run schedule of 24-hour emergency service (CPSC, 2002). The hospitals of psychiatric and penal institutions were excluded from the sampling frame and the NEISS-AIP samplings were categorized into five strata according to the number of hospital ED visits in size and type per given year. Four of the five strata represent different levels of hospital size such as small, medium, large, and very large. The fifth stratum constitutes of the children's hospitals. Thirty-one hospitals are in the small stratum, nine are in medium stratum, six are in large stratum, 15 are in very large stratum, and five hospitals are in children's stratum (CPSC, 2000; 2001).

I selected the NEISS-AIP database for this study because it provides data on hospitalization status from different arrays of national sample of hospitals compare with databases that host a single institutional data. The sampling frame covers diverse geographical areas making the study results more generalizable than if it is from a single health center. If an elected hospital decides unwillingly to participate in the provision of data, the CPSC works with Wetstat Inc. for a replacing hospital. Wetstat also provides guideline in the selection and replacement of a closed hospital, however, the replacement must have similar characteristics like geographical location, size, and pediatric / adult statuses as one being replaced (CPSC, 2001; 2002). All participating NEISS-AIP hospitals in the United States are shown in the Figure 2.

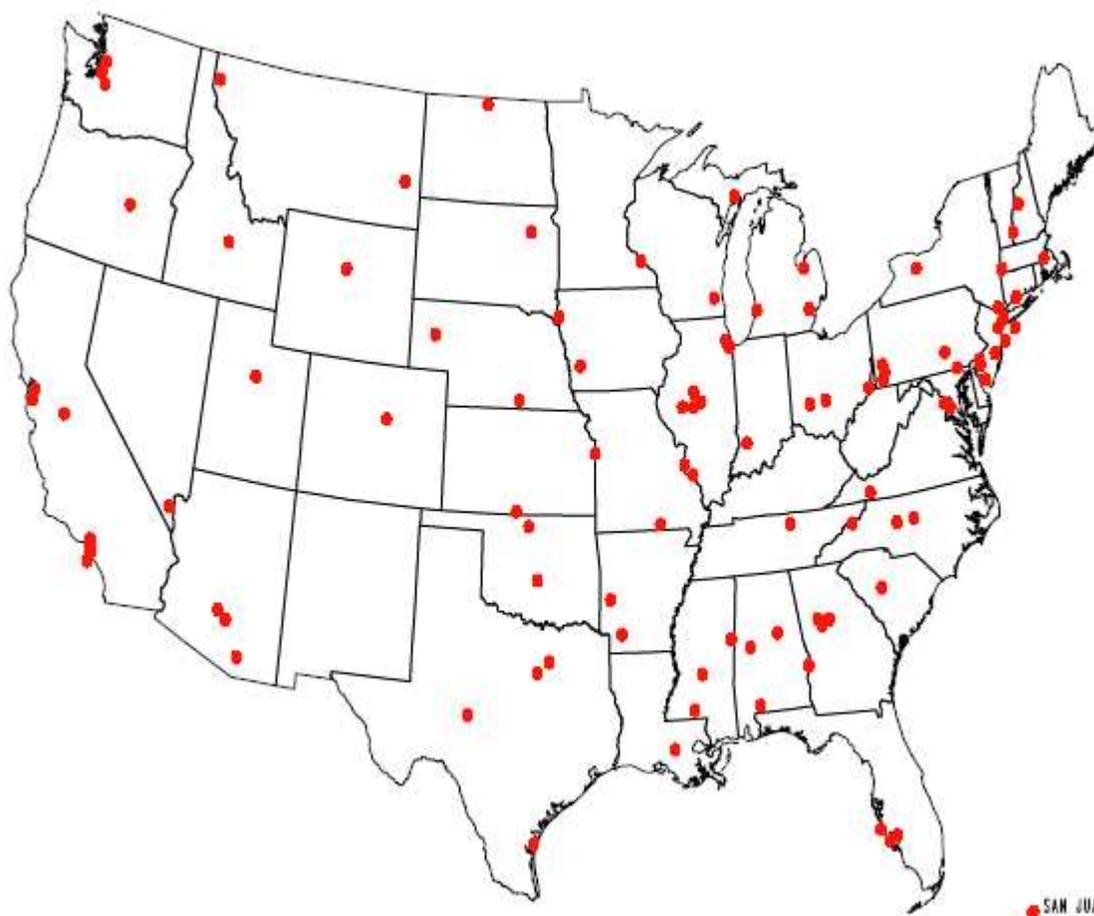


Figure 2. U.S. CPSC NEISS participating hospitals. From NEISS hospitals by CPSC, (2003). Reprinted as per the permission from CPSC website. Retrieved on March 10, 2014, from <http://www.cpsc.gov//PageFiles/106631/2001d023.pdf>

All incidents of injuries reported to NEISS-AIP are based on ED visits cases, hospital admissions, first time injury, and cases of transfer from another hospitals (CPSC, 2009a).

Instrumentation and Operational Constructs

The CPSC maintains NEISS database and has supported the system for over 40 years (CPSC, 2009a). The NEISS injury data used in this study were gathered from the

ED of 66 of 100 hospitals selected as a probability sample from all 5300+ hospitals with ED visits in U.S as also explained in the sampling procedure above (NEISS - Safety Policy, n.d.; CPSC, 2009a). In July 2000, the NEISS was expanded to collect data on all injuries and the system is called NEISS All Injury Program (NEISS-AIP). The NEISS-AIP ED data on injuries are gathered for either surveillance or investigation purposes. The surveillance data are used to make timely national estimates on consumer product-related injuries. The result of the analysis on surveillance sometimes serve as evidence of the need for further study on a particular product which may provide clues to the cause of the incidents, prevention of injuries, and deaths of the respondents. The investigation data on the other hand, help to guide decisions on product recalls, safety standards, and public awareness on a product (CPSC, 2009a).

Data collection begins when a patient visits the ED of a NEISS-AIP hospital with an injury (CPSC, n.d.; Shults, et al 2013). The clinicians at the hospital ED elicit critical information on the patient injury and enter the information into the patient's medical record. A NEISS-AIP hospital coders reviews all ED records daily and select those incidents and cases that meet the criteria for inclusion in NEISS (CPSC, 2009b; n.d.). The selected ED records are abstracted, transcribed, and transformed the codes onto a NEISS coding worksheet using the rules described in the coding manual to increase reliability and validity of information in the database. The NEISS-AIP coordinator also assigns a four-digit product code on recreational activities and products (CPSC, 2009a).

Conforming to the CPSC standards, the NEISS coordinators work with data variables as in the coding worksheet to include the date of treatment, case number,

patient's age, gender, race, incident locale, and the body part affected (Shults, et al 2013).

To standardize coding and reporting of anatomical location of body injuries, NEISS-AIP hospitals use the diagram of the injured body parts as shown in Figure 3.

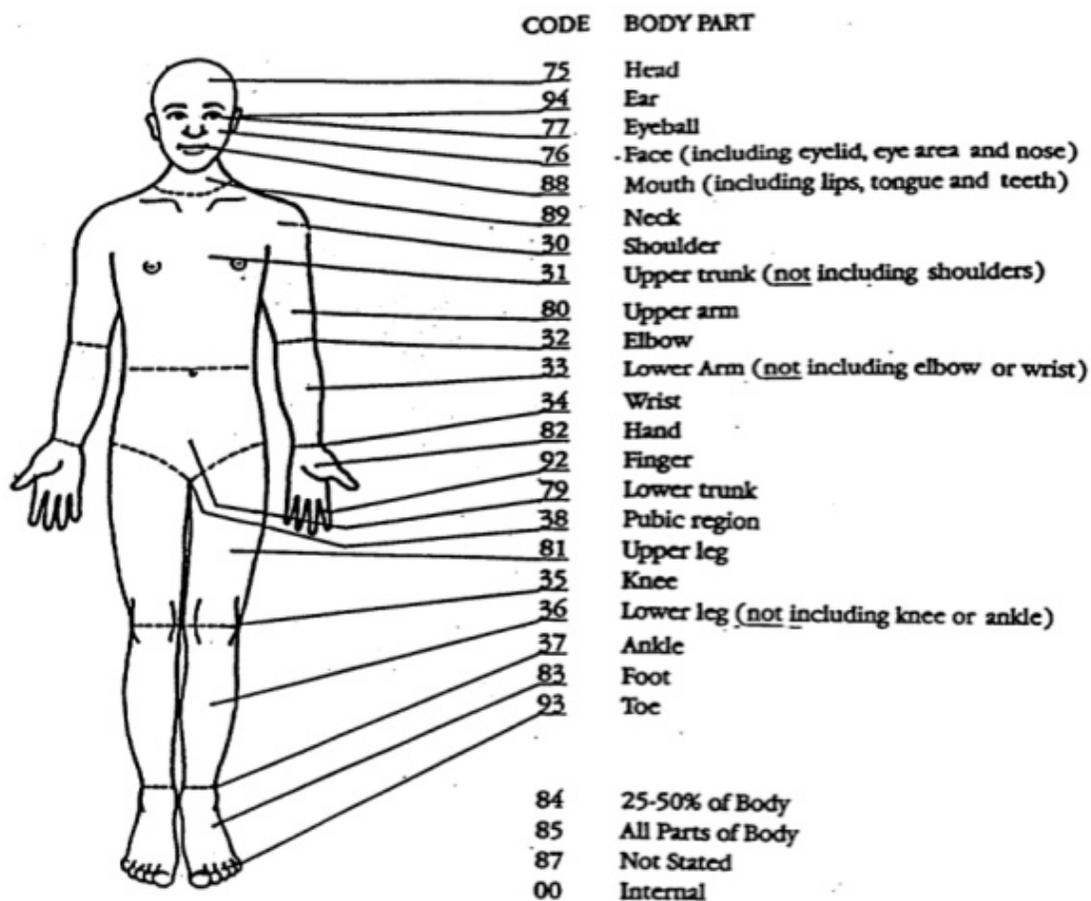


Figure 3. NEISS Body Part Diagram. From *NEISS Coding Manual*, by the CPSC, 2009a, p. 198. Reprinted with permission per CPSC website. Retrieved on March 21, 2014, from <http://www.cpsc.gov/library/library.html>

Once NEISS coordinators complete abstracting and coding of the variables the day's NEISS injury cases are entered into the CPSC client-system (CPSC, n.d.). As the

data are keyed into the CPSC client-system, the CPSC software with a complex algorithm checks the data entry automatically against the data format, completeness of the results in the data processing, and only acceptable entries are qualified for onward transmission. At the hospital, the NEISS coordinator then transmits the data via a secure, web-based data collection system (the CPSC Server-system; CPSC, n.d.). Upon reaching CPSC system, coders perform another editing and acceptable cases are automatically stored permanently into the NEISS database. The quality control officials review the data by checking the data fields and items as the data become available for further processing, analysis, and reporting. The CPSC provides both standards and instructions for entering data on the hospital ED visits, and also provides a toll free support number for the hospital staffs who may have challenges although entering the data in the system.

The NEISS-AIP legacy data are released by the CDC to the Interuniversity Consortium for Political and Social Research (ICPSR) where the data are made available to the general public for downloading. At the time of this report, the archived data up until 2011 are released to the general public. The raw data used in the analysis will be made available to anyone upon request.

Weighting Functions and National Estimates

The CPSC operates the NEISS-AIP data system which is a probability sample of hospital ED visits in the United States and its territories. The NEISS sample data collected are weighted based on the sample design to produce national estimates of the number of injuries treated on hospital ED visits. The sampling frame includes the hospitals with six or more beds and each hospital has an emergency department but

excluding institutions with psychiatric and penal affiliation. The sample design consist of five strata, four of which are based on size (the total number of ED visits reported by the hospital) and one stratum which is children's hospitals.

Sample weights were used for computing the national estimates. The owner of the data source applied weighting to the representative sample before making it available for public use. Each represented the inverse of the probability of selection of the case (CPSC, 2010). The sample weight are adjusted for the hospital non-response within each NEISS-AIP sample stratum and changes in the number of annual ED visits in the sampling frame of the hospitals. Two sample weights are provided. A WEIGHT as a sample weight is assigned to each case. A WEIGHTA is an annualized weight and it was calculated as $2 * \text{WEIGHT}$ of 2000 data I analyzed national estimates and temporal trend analysis based on data between 2009 and 2011 data files using the WEIGHTA (CPSC, 2010). The formal sample size estimation for the present study is provided below in the section labeled, "Sample Size Calculation".

Overall Annual National Estimates Based on Cases

The national estimates are based on weighted data obtained from patients treated in NEISS-AIP hospital ED visits from July 1st through December 2000 and from January 1st through December thereafter (CPSC, 2010). The overall annual estimates are based on approximate NEISS-AIP cases. There were 511,029 cases for 2008, 522,417 for 2009, 530,019 for 2010, and 540,010 cases for 2011 (CPSC, 2010). These time period were selected because it represents the newest dataset collected and very few inquiries were done. The annual national estimates are accurate and stable. However, the statistical

criteria recommended to determine unstable or unreliable national estimates included the following:

1. Computing estimates of NEISS cases fewer than 20 (based on un-weighted data).
2. National estimates less than 1,200 (based on weighted data).
3. The coefficient of variation (cv) of the estimate greater than 30%.

Weighting Functions

Weighting of the sample data were performed by the data source owner, CPSC and CDC. The weighting procedure provided includes algorithm which will be applied to the coding and programming of dataset for further analysis. As representative sample, data are involved the weighted sample data will be used to extrapolate and predict most severe types of falls at the national level. A logistic regression model is suitable for further analysis and the goodness-of-fit will be evaluated through the Hosmer Lemeshow goodness-of-fit statistic (Hosmer, et al., 1997; Hosmer & Lemeshow, (1980)). If the statistic indicates that there is evidence of lack of fit (i.e., $p < .05$), we carefully evaluated the model to try to identify the reason for lack of fit I systematically recategorized and/or inserted/removed the predictor variables to ensure adequate fit.

The basic hospital weights applied on NEISS-AIP sample are equal to the inverse of the probability of selection for the hospitals in each stratum (CPSC, 2012). This inverse probability of selection is the total number of hospitals on the sampling frame divided by the total number of hospitals in the NEISS-AIP sample calculated at the

stratum level. There are adjustments of basic weights made for non-response, hospital mergers, and when there is a change in the sampling frame.

A nonresponse adjustment factor is calculated every month. The basic weights are adjusted for a nonresponse from participating hospitals within certain time frame. If all hospitals responded in a particular month the nonresponse adjustment is one. The adjusted basic NEISS weight for a stratum like the children hospital in a particular year is calculated by the monthly nonresponse adjustment factor of the stratum multiple by the basic hospital weight. An example of the adjusted basic weight is expressed in Table 1 in Appendix A.

The adjustments for hospital merger occurred when one hospital in the NEISS-AIP sample merged with another hospital after the sampling frame was chosen (CPSC, 2012). The merged hospital is considered in the statistical sample as one hospital. When two hospitals merge and are in different strata classes, the probability of selection of the merged hospital is found by the union of two events:

$$P = P_1 + P_2 - P_1P_2$$

Where P_i = probability of selection of hospital i ; $i = 1, 2$

When two hospitals merge and they were in the same strata the situation was different because the sampling size was done without replacement (CPSC, 2012). The sample size in a particular strata class was a fixed number n , and the total number of hospitals in the size class was N for the original sample and frame. If S denotes the sample, H_1 and H_2 the hospitals, the three possibilities that lead to the retention of the merged hospital in the sample are:

- A. $H1 \in S, H2 \notin S$ Hospital 1 is in the original sample, hospital 2 is not
- B. $H1 \notin S, H2 \in S$ Hospital 2 is in the original sample, hospital 1 is not
- C. $H1 \in S, H2 \in S$ both hospitals are in the original sample

The probability of event A is:

$$\begin{aligned}
 P(A) &= P(H1 \text{ is selected on the first draw and } H2 \text{ is not selected on any draw}) \\
 &= n (1/N) ((N-2)/(N-1)) ((N-3)/(N-2)) \dots ((N-n+1)/(N-n+2)) ((N-n)/(N-n+1)) \\
 &= (n/N) ((N-n)(N-1))
 \end{aligned}$$

The leading multiplier n accounts for the possibility that H1 may be selected on any of the n draws. The probability of event B, $P(B)$, is the same as $P(A)$ from

Symmetry (CPSC, 2012). The probability of event C is expressed in the Appendix B.

A ratio adjustment to the basic NEISS-AIP weight to stabilize NEISS-AIP estimates overtime without taking a new sample is necessary. Hospital populations are dynamic over time. Hospitals can close, merge, or open to meet the changes in the number of ED visits (CPSC, 2012). The ratio adjustment applied to the basic NEISS-AIP weights is the ratio of the known total number of ED visits in the recent population over the estimate of the total ED visits based on the sample NEISS-AIP hospitals. To compute the ratio, the small and the media strata were combined although the large and very large strata were also combined (CPSC, 2012). The calculation of the ratio adjustment is stated in Appendix A and the result is shown in Appendix A: Table 2.

The final NEISS-AIP weight which is calculated each month and used for national estimates are stated in Appendix C. The bias in the ratio adjusted estimate was negligible and was considered unnecessary in the stratified sample that is additive

(CPSC, 2012). The national estimates of injuries from NEISS-AIP are also computed as expressed in the Appendix E.

Sampling errors associated with the NEISS-AIP estimates are expressed as coefficient of variation. The coefficient of variation is the standard errors divided by the estimates. The estimates of variances for the NEISS-AIP are calculated through the probabilities in selections, stratification, and weighting. The formula used to estimate variance is referenced in Appendix F, a section labeled as “NEISS-AIP Variances”.

Data Source and Data Collection

The archived data used for this study came from the NEISS database and the source of the dataset is from the medical records. The mode of data collection is through computer-assisted self-interview (CASI) and self-numerated questionnaire (ICPSR, n.d.). The institutional data collectors in a joint effort are U.S. Department of Health and Human Services, CDC, and National Center for Injury Prevention and Control. Currently, NEISS data are publicly available for downloading via the Internet through ICPSR initiatives and agreements to the terms of use specified in its website. In effect, ICPSR is the distributor of NEISS-AIP data to the general public for research and archival purposes.

After the NEISS-AIP hospital coordinator events of abstracting, coding, transcribing, and transmitting the data into NEISS-AIP systems, the NEISS-AIP coders complete the reliability, validity, and interpretation of the data. Once the consistency and accuracy of the data were successful the dataset were updated into the NEISS-AIP database. The hospital coders are trained to transcribe the information recorded by the

medical providers about the ED visits and not to interpret the cause of an injury although the NEISS-AIP coders translate the ED records into the cause and the intent of the injury. The CDC updates affiliated research institutions with these datasets. Currently, CDC has updated ICPSR database with archive data up to 2011.

Once ICPSR database was updated, the data undergo a confidential review and were altered when necessary to limit the risk of disclosure (ICPSR, n.d.). In addition, ICPSR routinely create metadata records on the NEISS data. In the process the ready-to-go data files were created to accompany setups in the major statistical software formats as well as standard codebooks to be used with the data (ICPSR, n.d.). The data collection procedures were also performed to create variable labels for users' easy access of data and to check for out-of-bound codes or undocumented codes (ICPSR, n.d.). The data from 2009 to 2011 were downloaded from the ICPSR website for this study (ICPSR, n.d.).

Data Collection

The sample data were collected from national sample of 66 out of 100 NEISS-AIP hospitals between 2009 and 2011 by CPSC in conjunction with CDC. Clinical coordinators at various NEISS-AIP hospitals extract data from patient medical records on fall-related cases and are transmitted to CPSC systems. The hospital coders do not interpret the information in the ED records but transcribe exactly what the medical provider recorded in the medical chart. The CPSC coders translate and interpret the datasets using standard procedure and guidelines. The national sample data are released

by the CPSC to the ICPSR to be used by the general public for research purposes.

Currently, the NEISS-AIP datasets are available up until 2011.

The datasets were downloaded from ICPSR secured website. The relevant SPSS data files were extracted onto the local drive of my personal computer. The data files for 2009, 2010, and 2011 were merged into one data file in SPSS system for further analysis.

The frequency distributions and descriptive statistics were computed to reflect the demography of the subjects and the other characteristics of interest in the study sample.

Though not shown, the sample distributions were slightly different than the weighted data. For example, the sample data suggested that female patients who reported at the hospital EDs for treatment were at greater odds of hospitalization than the males. Other examples were the location of falls and the body part affected. It is expected that there may be some differences between the unweighted and weighted data given sample size/power and that some groups have more influence/weight on the findings. As noted, the calculation of the weights was to permit unbiased estimates and extrapolate the data up to the dimensions of the entire population nationally. It is worth noting also that, there should not be any issue with selection bias as the sites are specifically selected to ensure that these are representative of the US population. Thus, assuming that the original sampling scheme for the NEISS-AIP participating sites is scientifically appropriate (which all evidence seems to suggest), we can have confidence that the weighted data are truly reflective of the underlying target population and that these findings are appropriate in describing the epidemiology of falls necessitating an emergency department visit in the United States.

Data Elements Collected

The NEISS-AIP collects data on age, gender, race, primary body part affected, incident locale, severity of disposition at discharge from the ED, cause/mechanism of injury, and the intent of the injury. In every incident there was a brief narrative description associated with it (Quinlan, et al 1999; Schroeder, & Ault, 2001). These data elements from the ED records and codes are associated with the elements and the narratives of cause/mechanism and intent of injury. The data elements coded were consistent with the coding guideline specified in the International Classification of Disease (ICD; ICPSR, n.d.).

Fall is one of the major categories of cause/mechanism of injury defined as data element in NEISS-AIP. The severity and cause or mechanism of injury are coded from the derivative of the way a person sustained fall injury and the process the injury occurred. The NEISS-AIP coders at CPSC code for both precipitating and direct cause of injury although precipitating cause will define what started the chain of events leading to injury, the direct cause was what produced the actual physical harm to the faller (CPSC, 2012). If a middle-aged adult falls from skiing and hit his head on a tree, the fall is categorized as precipitating and the tree he came into contact is interpreted as a direct caused. Without the precipitating cause there will be no direct cause for categorizing the mechanism.

Variables and Coding

The data source owner provided weighting on the representative sample data and we used it to compute and extrapolate the national estimates. The independent and dependent variables in this study will be used to compute the logistic regression. The goodness-of-fit will be evaluated through the Hosmer Lemeshow goodness-of-fit statistic (Hosmer & Lemeshow, 1980). If the statistic indicates that there is evidence of lack of fit (i.e., $p < .05$), we carefully evaluated the model to try to identify the reason for lack of fit. I systematically re-categorized and/or insert/remove the predictor variables to ensure adequate fit.

Outcome Measures

The sample population will include patients with falls who visit the ED during the study period. Of those visits some patients were admitted and hospitalized although others were discharged and not hospitalized I used hospitalization as a proxy for severity. Therefore outcome variable for this study is hospitalization as a proxy for severity of falls for persons presenting to hospital EDs who will be compared to those persons with falls who present to the same EDs, but are not hospitalized.

The hospital coders transcribe information provided by the clinicians in ED records on hospitalization. Referencing from NEISS coding manual the hospitalization is measured and categorized into two scales. Two different variables are coded depending on the disposition of cases recorded. If the disposition of case is either treated and transferred to another hospital facility or treated and admitted in the same hospital the patient will be classified as hospitalized. In the same token, if the disposition of case is

treated and released or subject examined and released without treatment, the patient will be classified as not hospitalized. Certain disposition of patients will be excluded as they are not informative/not applicable in classifying whether a patient was hospitalized, held for observation, left without being seen due to the level of fatality or died in hospital ED, and no existence of records. Variables for the NEISS data associated with hospitalization are derived from precipitating cause of injury and immediate cause of injury.

Independent Variables

The predictor variables in this study are age, gender, race, primary body part affected, and incident locale. The age of the subjects recorded is the age at the time of the year the FRIs occurred and will be measured on a continuous scale in the multivariable modeling. For the first aim (rates of falls presenting to EDs in the US), age will be categorized into the following groups: children (under 19 years), young (between 20 and 34 years), middle-aged (between 35 and 64 years), and older adults (greater than 65 years). The categorization of the other independent variables are shown in Appendix A: Table 4.

The race is grouped and categorized as either White, Black or other; with White being the referent group. The other group defined will include all patients who are neither from White nor Black race. To incorporate this information into regression modeling, we used $k-1$ dummy variables where k is the number of levels; in this case, three levels, thus two dummy variables.

The locations where injury occurred are grouped and categorized as home, not home or other; with home being the referent group. The not home group included

incidents that occurred at school or sport events although the other group included all incidents that neither occurred at home nor at school or sport event. To incorporate this information into regression modeling we used $k-1$ dummy variables where k is the number of levels; in this case, three levels, thus two dummy variables.

The primary body part affected are grouped and categorized as head, trunk, extremities or other; with head being the referent group. The defined other group will refer to all unknown affected body part not recorded by the clinicians. To incorporate this information into regression modeling we used $k-1$ dummy variables where k is the number of levels; in this case, four levels, thus three dummy variables.

Sample Size Calculation

The sample population included patients with falls who visit the EDs during the study period. Of those visits, some patients were admitted and hospitalized although others were discharged and not hospitalized. The outcome variable for this study is hospitalization as a proxy for severity of falls for persons presenting to hospital EDs who were compared to those persons with falls who presenting to the same EDs but were not hospitalized.

We computed the sample size calculation using the G*Power (<http://wise.cgu.edu/downloads/Power%20Analysis%20with%20GPower%20120409.pdf>) to illustrate the statistical power for the multiple logistic regression that was used for the analysis. To use this software, it was downloaded from the Internet. In order to run the application the central and non-central distributions tab is selected I made other selections to include test family, statistical test, and type of power analysis to be used I input

parameters of effect size, odds ratio, and the probability at alpha and beta errors to run and return total sample size and actual power. These same parameters can be used to plot graphs or calculate power analyses I assumed that there should be at least 1000 persons in the multiple logistic regression model. With 1000 persons, two-sided test, $\alpha=0.05$, we have at least 80% power to detect an odds ratio of 1.3 (or greater).

Research Questions and Hypotheses

There are two research questions associated with the main purpose within the methodology of the research study and five statistical hypotheses were tested where H_0 represented the null hypothesis and H_a represented the alternate hypothesis:

Question 1. What is the rate of falls presenting to a representative sample of hospital EDs in the United States., overall and by age groups (< or = 19, 20–34, 35–64, and 65+) between 2009 and 2011 time period?

Question 2. What factors (age, gender, race, incident locale, and primary body part affected) are independently associated with hospitalization among persons presenting to a representative sample of hospital EDs in the United States?

Hypothesis Question 2a: H_0 : There is no association between age (categorized groups) and the hospitalization among persons presenting to a representative sample of hospital EDs in the United States *H_A :* There is an association between age (categorized groups) and the hospitalization among persons presenting to a representative sample of hospital EDs in the United States

Hypothesis Question 2b: H_0 : There is no association between gender and the hospitalization among persons presenting to the representative sample of hospital EDs in

the United States H_A : There is an association between gender and the hospitalization among persons presenting to a representative sample of hospital EDs in the United States

Hypothesis Question 2c: H_0 : There is no association between race and the hospitalization among persons presenting to a representative sample of hospital EDs in the United States H_A : There is an association between race and the hospitalization among persons presenting to representative sample of hospital EDs in the United States

Hypothesis Question 2d: H_0 : There is no association between incident locale and the hospitalization among persons presenting to a representative sample of hospital EDs in the United States H_A : There is an association between incident locale and the hospitalization among persons presenting to representative sample of hospital EDs in the United States

Hypothesis Question 2e: H_0 : There is no association between primary body part affected and the hospitalization among persons presenting to a representative sample of hospital EDs in the United States H_A : There is an association between primary body part affected and the hospitalization among persons presenting to a representative sample of hospital EDs in the United States.

Data Analysis and Threats of Data Validity

The statistical package for the social science (SPSS) and Statistical Analysis System (SAS) are the software packages used for all statistical analysis of this study. To start with a descriptive analysis was done for the following variables: age, gender, race, incident locale, disposition, hospitalization, and the body site injured. The frequency distribution of the location where injury occurred and the diagnosis at the hospital was

included for inferential statistical analysis. Simple and multiple logistic regression analyses was both employed to examine the unadjusted and adjusted relationship between the independent variables (age, gender, race, primary body part affected, and incident locale) and dependent variable (hospitalization) I used the dependent variable, hospitalization in a form of yes or no, as a proxy for severity of falls, that is, those who are hospitalized will be classified and considered as having more severe falls than those not hospitalized. The sample population included patients with falls who visit the EDs during the study period. Of those visits, some patients were admitted and hospitalized although others were discharged and not hospitalized. Those hospitalized have severe falls than those not hospitalized.

The fit of the models was assessed with the Hosmer-Lemeshow goodness-of-fit statistic (Archer et al., 2007; Roger & Alder, 2001). If the statistic indicates that there is evidence of lack of fit (i.e., $p < .05$), we carefully evaluated the model to try to identify the reason for lack of fit I systematically re-categorized and/or inserted/removed the predictor variables to ensure adequate fit. The logistic regression models yielded odds ratio, corresponding to odds increase in hospitalization for one group compared to the other/referent category (e.g., males vs. females). Ninety-five percent confidence intervals (95% CIs) were calculated around all odds ratios, along with the corresponding p -values. The significance level for all analyses will be .05; thus a p value less than the significance level will indicate statistical significance and rejection of the corresponding null hypothesis. A p value greater than or equal to the significance level will indicate a failure to reject the given null hypothesis.

Ethical Procedures

Prior to conducting this research, we sought an approval from the Walden University Institutional Review Board to use a secondary source of data I use archival data and did not have any direct interaction with any participants. The archival database from NEISS-AIP is a national database available to the general public for research purpose and does not require approval from the NEISS. It does not contain any protected health information on individuals which can make patient's identity traceable. Each NEISS hospital ED incident was associated with a unique case number assigned by a NEISS coordinator (CPSC, 2009a).

The datasets made available for public use did not contain any variables that could link individuals to geographical locations, date, and place of births (CPSC, 2009a) I signed a confidential agreement and accessed data that contained information which may be used to identify respondents (CDC, 2006). Although this study did not involve any direct interaction with patients or participants or data that include information that may be used to identify the respondents, it is important to express that NEISS-AIP data collection, handling, and transmission procedures include mechanism that ascertain confidentiality and protection of participants (CDC, 2006).

Summary

The essence of this chapter was to describe the research design and the methodology used to address the problem statement, discuss data sampling and collection methods, and to explain how the datasets will be analyzed using regression analysis. The method of inquiry is a quantitative cross-sectional study through the use of archival data

between 2009 and 2011 from NEISS-AIP database. The FRIs are recorded in participating NEISS-AIP hospitals at patients ED visits and clinicians report fall events into patient medical records. The qualified NEISS-AIP hospital coders then extract, transform, and load the clinician's records into the NEISS-AIP database. The data become available to the CPSC coordinators who check the validity, reliability, and complete the coding as handled by the previous hospital coders. The datasets were made available to the public for research purposes after the data were cleansed (Gotsch, et al 2002a; Gotsch, et al 200b; McLoughlin et al., 2002).

Sample data was used for this study. The weighting of the sample data are applied by the data source owner and the procedure provide an algorithm which we applied to compute the national estimates I discussed how the variables are coded based on certain established NEISS-AIP procedures and mechanisms. The variables of interest include the severity of falls (dependent) with hospitalization as a surrogate and age, gender, race, body part affected, and incident locale (independent). By using these variables logistic regression will be computed to test the hypothesis and address the research questions. The goodness-of-fit was evaluated through the Hosmer-Lemeshow goodness-of-fit statistic If the statistic indicates that there is an evidence of lack of fit (i.e., $p < .05$), we carefully evaluated the model to try to identify the reason for lack of fit I systematically re-categorized and/or insert/remove the predictor variables to ensure adequate fit I also discussed the threats of data validity, subject protections, and rights for data confidentiality.

In the next chapter, the study and the results of the study was reported. The

results of the test was analyzed to find whether there was any association between age and the severity of falls with hospitalization as a surrogate due to FRIs as reported in the NEISS-AIP hospital ED. In Chapter 4, we focused in determining if there is a relationship between incident locale and the severity of falls with hospitalization as a surrogate to predict the most severe types of falls I also addressed if there is any association between age, race, gender, body part affected and hospitalization (as noted, a surrogate for severity of falls). The in-depth analysis and the findings as illustrated in this chapter will be discussed also in Chapter 4.

Chapter 4: Results

Introduction

The current chapter presents the study results based on two primary research questions. The research questions involved evaluating the rate of falls, overall and by age-defined subgroups, and examining the association of patient-related factors (age, gender, race, incident locale, and body part affected) with hospitalization (a measure of severity) among persons who presented to a participating hospital's ED for a FRIs during the study period. The participating sample was from the NEISS-AIP, a random sample of 66 hospitals with 24-hour EDs in the United States. The data from NEISS-AIP were extrapolated to the entire United States; thus, the results presented here were based on the weighted data, that is, the inverse probability of selection explained as part of the methodology in the previous chapter. The current chapter is divided into two sections: The first presents the rate of falls using univariable analyses, and the second describes the bivariable and multivariable analyses to examine factors associated with hospitalization.

Univariable (Descriptive) Analyses

The total number of FRIs presenting to hospital emergency departments in the NEISS-AIP surveillance system between 2009 and 2011 (i.e., the weighted data) was 464,062. Applying the weights to these $N = 464,062$ cases reported in NEISS-AIP, approximately 9,074,371 patients were treated annually for falls in hospital EDs between the study period of 2009 and 2011 in the United States.

Demographic Variables (Age, Gender, and Race)

The ages of persons experiencing falls ranged from 1 and 98 years. The children

(≤ 19 years) group constituted the largest population and accounted for 40.6 % ($n = 188,234$) of the study sample. The next group in line is adults between the ages of 35 and 64 years who accounted for 25.6% ($n = 118,861$) of the study sample. Older adults (65 years +) accounted for 21.3% ($n = 98,814$), more than half the percentage of children group, although the young adults are the least among the study population groups amounting to only 12.5% ($n = 58,122$). The majority of the subjects in the study population were female ($n = 244,524$, 52.7 %) versus 219,517 males (47.3%). Of those with known race, 50.4% ($n = 233,867$) were White and 15.4% ($n = 71,401$) were Black as shown in Table 1.

Table 1

Patient Characteristics and Frequency Distribution of the Weighted Study Sample

Patient characteristics	N=464,062* average No. (%)	Annual estimates** No. (%)
<i>Age category</i>		
Children (0–19)	188,234 (40.6)	2,862,137 (31.5)
Young adults (20–34)	58,122 (12.5)	1,273,959 (14.0)
Middle-aged adults (35–64)	118,861 (25.6)	2,618,500 (28.9)
Older adults (65+)	98,814 (21.3)	2,318,933 (25.6)
<i>Gender</i>		
Male	219,517 (47.3)	4,098,909 (45.2)
Female	244,524 (52.7)	4,974,462 (54.8)
<i>Race</i>		
White (Caucasian)	233,867 (50.4)	5,539,936 (61.1)
Black (African American)	71,401 (15.4)	898,387 (9.9)
<i>Incident locale</i>		
Home (Apt., Mobile, & Farm)	190,167 (41.0)	3,923,235 (43.2)
Not Home (School, Sport, St., Public)	131,387 (28.3)	2,498,330 (27.3)
<i>Body part affected</i>		
Head area (head & neck)	104,330 (22.5)	1,872,577 (20.6)
Trunk area (lower & upper)	69,717 (15.0)	1,598,440 (17.6)
Extremities (legs & hands)	114,566 (24.7)	2,225,470 (24.5)
<i>Hospitalization status</i>		
Hospitalized (treated & hospitalized)	44,095 (9.5)	860,315 (9.5)
Not Hospitalized (treated & released)	419,967 (90.5)	8,213,597 (90.5)

* Sums may not equal N because some values were missing and were excluded in the analysis.

** Weighted annual estimates and weighted percentages.

** Population - unweighted (X^2 (N = 464,063, $df = 8$) = 642.354, $p < .001$) and weighted (X^2 (n = 45,777,207, $df = 8$) = 1628.856, $p < .001$). Difference exist in the two populations.

Body Part Affected

From the analysis shown on Table 1, 62.2% ($n = 288,613$) had known affected body part injuries. Of these, 24.7% ($n = 114,566$) were injuries to the extremities, 22.5% ($n = 104,330$) were injuries to the head area where as 15.0% ($n = 69,717$) were injuries to the trunk area. The cases with injuries to the bodily extremities included hands, legs, wrists, lower and upper arms, and feet regions. The head region also included injuries to head, face, neck, ears, eyes, and mouth. On the other hand cases with injuries to the trunk area were on the shoulders, upper and lower trunks region.

Incident Locale

About 69% of the fall-related injuries in NEISS-AIP had known incident locale. Of those with non-missing information, 41.0% ($n = 190,167$) occurred at home versus 28.3% ($n = 131,387$) outside home (including schools, sports, streets, workplaces, backyards, and farm locations).

Hospitalization

The vast majority, 90.5% ($n = 419,967$), of patients were outpatients with falls, were treated, and were sent home without been hospitalized or discharged without receiving any treatment at a hospital ED; the remaining 9.5 % ($n = 44,095$) of cases involved patients who were hospitalized due to their falls.

Research Question 1: Rate of Falls Estimated by Age Group

Research Question 1 estimates the rate of falls by age group based on the surveillance data presented to the hospital EDs within the study period. The number of cases reported due to falls during the study period was 464,062. Each of these cases were weighted. The weights for the study period were summed ($n = 27,221,737$). The amount was divided by 3 (number of years) to determine the average annual national estimates of falls between the study period of 2009 and 2011. The annual population estimate was computed using 2011 U.S. population estimates from the Census Bureau at 311,582,564 and were considered to be from free sampling error (as these are population estimates). The annual rate of falls of children (0–19 years) population, as indicated in Table 2 was 3,494 falls per 100,000 population/year ($n = 2,862,137$ (31.5), 95% *C.I.* = 3380 to 3608). The annual rate of falls in the young adults on the other hand was 2,031 per 100,000 ($n = 1,273,959$ (14.0%), 95% *C.I.* = 1944 to 2118). The rate of annual falls in the middle-aged adults was 2,097 per 100,000 ($n = 2,618,500$ (28.9%), 95% *C.I.* = 2008 to 2186). In the older adults (65+ years), the rate of falls annually was measured as 5,610 falls per 100,000 population ($n = 2,318,933$ (25.6), 95% *C.I.* = 5,467 to 5,753).

Table 2

The Rate of Falls: Number of Cases per Annual Population Estimates of Patients Treated in Hospital EDs by age in United States, 2009–2011

Patient characteristics	Average annual estimates of fall (weights / year) for 2009-2011 and in percent (%)	2011 - Census annual population estimates in U.S (million)	Average annual fall estimates per 100,000 for 2009-2011	95% C.I. for the rate of falls x 1000 per 100,000
Age group				
0–19	2,862,137 (31.5)	82,814,893	3494 / 100,000	3.3803.608
20–34	1,273,959 (14.0)	63,949,598	2031 / 100,000	1.9442.118
35–64	2,618,500 (28.9)	123,448,560	2097 / 100,000	2.0082.186
65+	2,318,933 (25.6)	41,369,513	5610 / 100,000	5.4675.753

Research Question 2: Factors Associated With Hospitalization

Bivariable Analyses. Research Question 2 was designed to explore the association of factors (gender, race, age, incident locale, and primary body part affected) with hospitalization among persons visiting ED due to falls. The analyses were performed unadjusted (i.e., bivariable analyses, present section) and adjusted for potential confounding factors (i.e., multivariable analyses, next section). Simple logistic regression models were fit to examine the unadjusted relationship between each of the aforementioned factors and hospitalization.

The result of the simple logistic regression models, as shown in Table 3, indicated statistically a significant association in the relationship between each of the predictor variables and hospitalization. Among the gender group the odds of hospitalization for the males were 1.31 times (95% CI: 1.30–1.32, $p < .001$) higher compared with females. Among those with known race, the odds of hospitalization in the Black (African

American) group were 1.26 times (95% *CI*: 1.24–1.27, $p < .001$) higher than the White group.

Among those with known age, the odds of hospitalization of the young adult group was 0.60 times (95% *CI*: 0.59–0.62, $p < .001$) less than the children group (the referent group). The odds of hospitalization for the middle-aged and older adult group were respectively 0.20 (95% *CI*: 0.19–0.22, $p < .001$) and 1.05 (95% *CI*: 1.0–41.06, $p < .001$) than for children.

Among those with known incidents, the odds of hospitalization for incident locale outside the home was 1.14 times (95% *CI*: 1.13–1.16, $p < .001$) higher than inside the home, referent group. Among the groups with known affected body part, the odds of hospitalization for the trunk area was 1.30 times (95% *CI*: 1.28–1.32, $p < .001$) compared to the head area, the referent group. Similarly, the odds of hospitalization for the extremities area was 2.25 times (95% *CI*: 2.24–2.26, $p < .001$) higher than the head area as shown on Table 3 below.

Table 3

Simple Logistic Regression - Unadjusted Analysis of Patient Characteristics and their Association with Hospitalization

*Patient characteristics	Unadjusted odds ratio (95% CI)	<i>p</i> values
Gender		
Female	1.0	
Male	1.31 (1.30–1.32)	<.001
Race		
White (Caucasian)	1.0	
Black (African American)	1.26 (1.24–1.27)	<.001
Age category		
Children (0–19)	1.0	
Young adults (20–34)	0.60 (0.59–0.62)	<.001
Middle-aged adults (35–64)	0.20 (0.19–0.22)	<.001
Older adults (65+)	1.05 (1.04–1.06)	<.001
Incident locale		
Home (Apt., Mobile, & Farm)	1.0	
Not Home (School, Sport, St., Public)	1.14 (1.13–1.16)	<.001
Body part affected		
Head area (head & neck)	1.0	
Trunk area (lower & upper)	1.30 (1.28–1.32)	<.001
Extremities (legs & hands)	2.25 (2.24–2.26)	<.001

*All the variables in the unadjusted analysis were used in the model

Multivariable Analyses. The independent relationship between the covariates (gender, race, age, primary body part affected, and incident locale) and the outcome, hospitalization, were assessed through the analyses using the multiple logistic regression. The multiple logistic model was fit to examine the adjusted relationship between the predictors and the hospitalization. The Hosmer and Lemeshow goodness of fit test was also employed to assess whether there was any evidence of lack of fit with the multivariable model.

The result of the multiple logistic regression models, as shown in the Table 4 below, indicated a statistically a significant association in the relationship between the predictors and the outcome, hospitalization. Among the gender group the odds of males versus the females were 1.23 (95% *CI*: 1.21–1.26, $p < .001$). On the race group the odds for the Blacks versus Whites were 2.12 (95% *CI*: 2.11–2.13, $p < .001$). Among the age group the odds for the young adult versus the children were 0.77 (95% *CI*: 0.72–0.81, $p < .001$). For the middle-aged adults the odds versus the children were 0.28 (95% *CI*: 0.27–0.29, $p < .001$). The older adult the odds versus the children were 1.07 (95% *CI*: 1.05–1.08, $p < .001$).

Table 4

Multiple Logistic Regression - Adjusted Analysis of Patient Characteristics and their Association with Hospitalization

Patient characteristics	Adjusted odds ratio (95% CI)	<i>p</i> values
<i>Gender</i>		
Female	1.00	
Male	1.23 (1.21–1.26)	<.001
<i>Race</i>		
White (Caucasian)	1.00	
Black (African American)	2.12 (2.11–2.13)	<.001
<i>Age category</i>		
Children (0–19)	1.00	
Young Adults (20–34)	0.77 (0.72–0.81)	<.001
Middle-aged Adults (35–64)	0.28 (0.27–0.29)	<.001
Older Adults (65+)	1.07 (1.05–1.08)	<.001
<i>Incident locale</i>		
Home (Apt., Mobile, & Farm)	1.00	
Not Home (School, Sport, St., Public)	1.14 (1.13–1.15)	<.001
<i>Body part affected</i>		
Head area (head & neck)	1.0	
Trunk area (lower & upper)	0.27 (0.25–0.28)	<.001
Extremities (legs & hands)	0.98 (0.97–0.99)	<.001

*All the variables in the adjusted analysis were used in the model

Among the incident locale group, the odds for the group with injuries outside homes were 1.14 (95% CI: 1.13–1.15, $p < .001$) versus the group with injuries inside homes. On the body part affected, the odds of the group with injuries on the trunk area were 0.27 (95% CI: 0.25–0.28, $p < .001$) versus the group with injuries on the head area.

The odds of the group with injuries on the extremities were 0.98 (95% *CI*: 0.97–0.99, $p < .001$) versus the group with injuries on the head area.

The Hosmer-Lemeshow goodness of fit statistic X^2 was 45,300.55 with a p value of .002. As the p value is significant at the 0.005 level, the test suggests that there may be evidence of lack of fit for the multivariable model. However, it is recognized that this test is influenced by the very large sample size and it commensurate the statistical power. Thus, we also examined the c-statistic (measures how well the model used can discriminate between the observations at different levels of the outcome) and the c-statistic obtained the values of 0.74 in the adjusted model, both of which suggested accepted discrimination I concluded that the multivariable model is appropriate for identifying predictors related to hospitalization among those presenting to hospital EDs for fall-related injuries.

Summary

This chapter presented the results of the study based on two research questions. The first research question was to evaluate the rate of falls, overall and based on age-defined subgroups. The second research question was to examine the association between patient-related factors (age, gender, race, incident locale, and primary body part affected) and the hospitalization (a measure of severity). Unadjusted and adjusted analyses were both utilized for the second research question.

The total number of fall-related injuries presenting to hospital emergency departments in the NEISS-AIP surveillance system between 2009 and 2011 (i.e., the weighted data) was 464,062. The annual rate of falls of children (0–19 years) population,

was 3,494 falls per 100,000 population/year ($n = 2,862,137$ (31.5), 95% *C.I.* = 3380 to 3608). The rate of falls in the young adults was 2,031 per 100,000 ($n = 1,273,959$ (14.0%), 95% *C.I.* = 1944 to 2118). The rate of annual falls in the middle-aged adults was 2,097 per 100,000 ($n = 2,618,500$ (28.9%), 95% *C.I.* = 2,008 to 2,186). In the older adults (65+ years), the rate of falls annually was measured as 5,610 falls per 100,000 population ($n = 2,318,933$ (25.6), 95% *C.I.* = 5,467 to 5,753). The annual rate of falls resulting in hospitalization for the older adults were almost as twice as those of children. There were no significant difference in the rate of annual falls between the young and middle-aged adults resulting in hospitalization.

Age, gender, race, primary body part affected, and incident locale were all independently associated with hospitalization assessed through multiple logistic regression analyses. Among the gender group the males have a higher odds of hospitalization versus the females. In the race groups the blacks have twice the odds versus the whites. Among the age groups children have highest odds of hospitalization in the analysis. The group with fall-related injuries outside homes were higher in the odds versus inside homes. Among the body part affected, the group with injuries on the head area constitute higher odds of hospitalization versus the trunk or extremity areas.

The next chapter will include the interpretation of the study results, presented in the current chapter. Chapter 5 will also include a discussion regarding implications for social change due to this study, and provide recommendations for future research.

Chapter 5: Discussion, Conclusions, and Recommendations

Introduction

The purpose of this study was to determine the epidemiology of falls and FRIs based on surveillance data from hospital EDs in the United States. Understanding the nature and epidemiology of falls and related injuries is critical for developing targeted interventions to reduce the occurrence and sequelae of falls (e.g., hospitalization). Although researchers well understood that FRIs were a significant source of morbidity and mortality, few studies examine the rates of falls across age groups. The present study is unique in that I explored factors (patient- and fall-related) associated with hospitalization, a surrogate for severity.

Researchers in the past focused on fall injuries among older adults with few studies carried out on other age groups. The current study sample involved a wide range of age-defined subgroups and included persons aged between 1 and 98 years I were, therefore, able to determine the rate of falls in the United States for children, young adults, middle-age adults, as well as older persons. The chapter provides an interpretation of the results expressed in the previous chapter, along with my attempt to answer the research questions in light of the limitations of the study I also discussed the implication of these findings for social change and provide recommendations for further studies.

The sample used was from the NEISS-AIP, a random sample of 66 hospitals with 24-hour EDs in the United States. The study sample included persons who were treated at participating EDs for FRI during the study period of 2009 and 2011 I examined the association between the patient-related factors (age, gender, race, incident locale, and

primary body part affected) for FRI and hospitalization (a proxy for fall severity) I found in the current study the annual rate of falls between 2009 and 2011 in children (0–19 years) was 3,494 falls per 100,000 persons. The rate of falls in young adults was 2,031 per 100,000 persons. The rate of annual falls in the middle-aged adults was 2,097 per 100,000 persons. In the older adults (65+ years), the rate of falls annually was measured as 5,610 falls per 100,000 persons. The annual rate of falls resulting in hospitalization for the older adults was almost as twice as that of children.

Age, gender, race, primary body part affected, and incident locale were all independently associated with hospitalization in this study. Children were found to have the highest odds of hospitalization relative to other age groups, including older persons, even after adjusting for other factors. Males and Black participants had higher rates of falls than females and White participants, respectively. FRI were more frequent outside the home than inside the home, and FRI involving the head area resulted in more hospitalizations than those involving the trunk or extremity areas.

Interpretation of the Findings

The finding on the first objective shows that children and older adults have the highest rates of falls across the age groups. For children, falls may be due primarily to their vigorous lifestyles and intensive daily activities, especially relative to other age groups (De Roo et al., 2013). The estimated rate of falls in the older persons 65 years and older were found to be the highest among the aged groups, and it was as twice that of children. For older adults, the reasons behind falls are multifold and include such factors as body structure, coordination, balance, medication usage, psychology, physiology, and

emotional needs (Boye, et al., 2012). Similar contributing factors were found in the Boye et al (2014) study on the circumstances leading to injurious falls in older men and women in the Netherlands.

In a national study to determine the rate of falls and ED visits for injurious falls among the older adults, Owens et al., (2009) found that one in every three Americans of age 65 years and older falls every year. They looked at different factors on the rate of falls including: age, gender and types of common injuries associated with fall-related ED visits. However, they did not consider the severity of falls. The findings in the current study is consistent with the Owens et al., study, i.e., a similar rate of falls in the older population was observed, despite differences in the sampling strategies applied. Owens et al found that in 2006, one in 10 ED visits for injurious falls were patients aged 65 years and older. In addition to determining the rate of injurious falls by gender and age, Owens et al., also found hip fracture accounted for about one in eight injurious fall-related ED visits among older persons.

Another national research study examining public health approaches for preventing falls in older persons provided data suggesting that unintentional falls among person aged 65 and older increases with age (Noonan, et al., 2011). That is, for example, the rate of falls for persons of 85 years is higher than those of 65 years. In the current study, the annual rate of falls in children was 3,494 falls per 100,000 persons. This rate of falls in children was higher, almost as the rates of the young and middle-aged adults combined. Children have a strong desire to explore their environments and may not be aware of potential hazards that could lead to falls, compared with other age groups (De

Roo et al., 2013). In addition, participation in sports, recreational activities at school and outside homes may lead to FRIs in children. In a national study on stair-related injuries among young children aged < 5 years, Zielinski, Rochette, and Smith (2012) investigated the epidemiologic characteristics, trends in the injuries and found the rate of falls to be on the decline during the study period. They attributed the decline to an increase in prevention efforts, including parental education, and improved in stairway design. The decline may also be due to policies implemented at the governmental level to reduce unintentional injuries resulting from genetic abnormalities in children at the residential homes (Mack, et al., 2015). On the other hand, Harris et al., (2011) using the national representative sample investigated unintentional injuries and found an increase in the falls rate on pediatric injuries attributable to falls from windows in the U.S between 1990 and 2008. It is consistent with the finding in the current study confirming the children curiosity of the ability to explore their environment and the effect on injuries. Overall, the current findings on the rate of falls for both older adults and children are consistent with each of the findings discussed on the earlier research studies.

Limitations of the Study

One major limitation of this study was the use of secondary data through the NEISS-AIP dataset. All information we derived from NEISS_AIP is from medical charts. Information from these charts may contain inaccurate or missing data which may lead to a wrong inferences and conclusions. Furthermore, as the study relied solely on NEISS-AIP, many other variables or useful data that might have been considered in a study with

primary data collection was not available. For example, preexisting medical conditions, evidence of those factors that influence the need for hospitalization, and injury severity were not available and therefore not included in the statistical analysis. NEISS-AIP database provides dataset for this study and one additional limitation is that long-term morbidities of injuries are not captured by the database.

The required variable codes are dependent upon the information entered by clinicians in the patient discharge dispositions. Transcriptions of these codes into the NEISS database by the hospital coders and the NEISS coordinators may not adequately reflect the conditions of the patients at the time of the admissions. This may, in turn, produce inaccurate information in the database.

There were some differences between parameters of sample and weighted estimates from the chi-square analysis in the previous chapter. This suggested that the weighted and the population from which it was drawn have differences in the distribution. This could be source of some selection bias to our study. I however, used auxiliary or archival data with the known population characteristics to reduce sampling error, and we therefore believe that the bias is minimal and should not affect interpretations of our findings with regards to falls in this population.

Another limitation is that less severe falls were not captured in the present study, that is, those falls that did not involve visits to the hospital EDs given that NEISS-AIP does not capture injuries treated or reported at physicians' office or any outpatient settings, and those that did not require any medical attention. Additionally, falls presenting to urgent care clinics may not be captured, nor would falls in nursing homes

be fully captured. Arguably, these falls are not as clinically meaningful as they did not, by definition, necessitate a trip to an ED; however, these non-ED treated falls are probably the most common types of falls.

Recommendations

Awareness about falls across all age groups is as important as any other cause of fatal and nonfatal injuries. Education to reduce the occurrence of falls is also essential however, caution must be exercised to reduce and avoid stereotypic dispositions. To clarify, children warrant a different approach of education than older adults. And similarly, middle-aged person require different strategies for fall prevention than other age groups.

In terms of children who have one of the highest rates of falls across the age groups, targeted intervention is needed for the children and their parents. Education may be provided to parents of preschoolers, elementary and middle school students to reduce the incidence of falls. Children may be educated on the essence of wearing helmets, playground manners, recreational and sports etiquettes to help reducing incidents of fall injuries (Zielinski et al., 2012). In older adults, targeted public health programs can be developed and instituted for fall prevention. Older adults, and their caregivers, may be provided education regarding triggers for falls and how to prevent falls (e.g., care in bathing Murphy, et al., 2006). Researchers know that bathing disability is associated with many adverse circumstances: increase hospital utilization, incidence of bone fracture, and mortality (Reuben, et al., 2002; Carey, et al., 2004). In addition, encouraging older adults to participate in physical fitness activities should not only prevent falls, but should

minimize the impact of falls should they occur (e.g., increasing bone density, Hall, et al., 2014). Finally, clinicians, especially those in ED and urgent care settings should be prepared to deal with FRI, recognizing that it is a significant public health issue.

Analyses revealed that certain data were not available in this study due to limitations in the data acquisition within the NEISS_AIP database or missing data among variables collected. Future studies designed with the specific goal of capturing relevant information on falls should be conducted.

Implications

The results of this study have implications for positive social change by adding key information to the existing body of knowledge which may further increase awareness of falls. I understand that awareness of falls among parents, educators, and public health officials will help to minimize the cost of treatments and hospitalizations of children and older adults. Age-specific programs to encourage older adults and children involvement in events outside homes with organized supervision we may be attempting to reduce any long term disabilities due to falls.

Everyone is at risk of falling and there is no exception to age limit; however, statistical reports and the reviews of the literature discussed in this paper indicated that the population most at risk for disability, mortality, loss of autonomy and independence, and financial costs to both individual and society is the older adults and children. The study provides evidence that children and older adults have higher risk of falling and hospitalization for fall related injuries. Interventions must focus on these age groups.

The implications for social change based on this study are grounded in several sections of Chapter 1 and the results reported in Chapter 4. The review of the literature supports age-specific interventions to promote positive advocacy of wellness and self-efficacy which are ingredients to sustaining change in unworthy behavior. Public health officials will understand the epidemiology of falls in various ED settings. As a result, we will better develop and implement interventions for targeted populations of a specific age to improve the quality of life and enhance life expectancy (United States Department of Health and Human Services, 2000).

The finding of this study will be valuable to public health practitioners, health care providers, and other stakeholders in recognizing the relationship between patient-related factors and hospitalization, and the increased vulnerability among the older adults and children. Researchers understood that multiple factors contribute to fall, however, these causation are different between children and older adults. For example an active participation in sports activities outside home (outdoor) settings by children may not be suitable for older adults. In the same token, we can say that household gardening as part of inside home activities (indoor) may be good for the older adults but may not be appropriate for children for fear of misusing of the garden tools or spaces to increase the risk of falls. Educating children on the essence of safe outdoor events and the risk of body-part fall-related injuries through their parents, stakeholders, and caretakers, there is a higher chance of maintaining safety events in their future. Recognizing the relationship between these factors and the stakeholders we may be helping to identify and remediate the vulnerabilities in children and older adults on falls.

FRIIs are sometimes debilitating to individuals as those experiencing falls may not be able to return to their normal lifestyle and may suffer significant morbidity and even death (Adams et al., 2005; CDC, 2006b). Fall injuries impose substantial financial burden and increased medical cost on individuals and institutions. Intervention for the targeted population, understanding of the epidemiology and the predictors of falls for different groups through programs, services, and policies we will be ensuring that people are taking safety measures to reduce disabilities due to FRIIs and to engage in a healthy lifestyle.

Conclusion

Older adults and children are at greatest risk for hospitalization than any other age group. The results of this study reaffirmed that FRIIs constitute a significant public health problem in the United States. Although the annual rate of falls in older adults are significantly higher than children, implementing age-specific programs against events outside homes (outdoor) may help reduce the long-term disability, and financial burden due to FRIIs on the affected head or extremity body-part areas. The results of the study based on the national database reinforced that the males are more at risk of falls than the females. Suggesting the education and the intervention through gender-specific programs may help to reduce the disparity due to FRIIs and prevent the incidences of falls in the United States.

References

- Abrahamsen, B., van Staa, T., Ariely, R., Olson, M., & Cooper, C. (2009). Excess mortality following hip fracture: A systematic epidemiological review. *Osteoporosis International, 20*, 1633–1650.
- Adams, P. F., Dey, A. N., & Vickerie, J. L. (2005). Summary health statistics for the U.S. population: National Health Interview Survey. *Vital Health Statistics, 10*(233), 1–104.
- Aleman, K. B., & Meyers, C. M. (2010). Mountain biking injuries in children and adolescents. *Sports Medicine, 40*(1), 77–90.
- Archer, K. J., Lemeshow, S., & Hosmer, D. W. (2007). Goodness-of-fit tests for logistic regression models when data are collected using a complex sampling design. *Computational Statistics & Data Analysis, 51*, 4450–4464.
- Band, C., & Sundarajan, V. A. (2010). A 10-year cohort study of the burden and risk of in-hospital falls and fractures using routinely collected hospital data. *Quality and Safety in Health Care, 19*, 1–7.
- Banthin, J. S., Cunningham, P., & Bernard, D. M. (2008). Financial burden of health care, 2001–2004. *Health Affairs, 27*(1), 188–195. doi:10.1377/hlthaff.27.1.188
- Bergland, A., & Wyller, T. B. (2004). Risk factors for serious fall related injury in the elderly women living at home. *Injury Prevention, 10*, 308–313.
doi:10.1136/ip.2003.004721
- Blum R. W., McNeely, C., & Nonnemaker, J. (2002). Vulnerability, risk, and protection. *Journal of Adolescent Health, 31*(1 Suppl), 28–39.

- Boye, D. A. N., Van Lieshout, M.M.E., Van Beeck, F.E., Hartholt, A. K., Van der Cammen, J. M. T., & Patka, P. (2012). The impact of falls in the elderly. *Trauma, 15*(1), 29–35. doi: 10.1177/1460408612463145
- Boye, D. A. N., Mattace-Raso, F. U. S., Van der Velde, N., Van Lieshout, M. M. E., De Vries, J. O., Hartholt, . . . Van Beeck, F. E. (2014). Circumstances leading to injurious falls in older men and women in the Netherlands. *International journal of the care of the injured, 45*(8), 1224–1230.
- Calder, L. A., Forster, A. J., Stiell, I. G., Carr, L. K., Perry, J. J., Vaillancourt, C., & Brehaut, J. (2012). Mapping out the emergency department disposition decision for high-acuity patients. *Annals of Emergency Medicine, 60*(5), 567–576.
- Callista, R. (2011). Research based on the Roy Adaptation: Last 25 years. *Nursing Science, 24*, 312 doi: 10.1177/0894318411419218
- Carey, E. C., Walter, L. C., Lindquist, K., Covinsky, K. E. (2004). Development and validation of a functional morbidity index to predict mortality in community-dwelling elders. *Journal of General Internal Medicine, 19*, 1027–1033.
- Centers for Disease Control and Prevention. (2008). Self-reported falls and fall-related injuries among persons aged >65 years—United States, 2006. *Morbidity and Mortality Weekly Report*. Retrieved from <http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5709a1.htm>
- Centers for Disease Control and Prevention (CDC). (2006a). Web-based Injury Statistics Query and Reporting System (WISQARS) [online]. *NCIPC, CDC (producer)*. Retrieved from www.cdc.gov/ncipc/wisqars

- Centers for Disease Control and Prevention (CDC), (2006b). Fatalities and injuries from falls among older adults - United States, 1993–2003 and 2001-2005, *MMWR*, 55(45), 1221–1224.
- CDC. (2007). Web-based Injury Statistics Query and Reporting System (WISQARS) [database online]. National Center for Injury Prevention and Control [NCIPC], CDC (producer). Retrieved from www.cdc.gov/ncipc/wisqars
- CDC. (2010). National Electronic Injury Surveillance System—All Injury Program (NEISS-AIP). Retrieved from <http://www.cdc.gov/ncipc/wisqars/nonfatal/datasources.htm#5.3>
- CDC. (2001). National estimates of nonfatal injuries treated in hospital emergency departments – U.S., 2000. *Morbidity and Mortality Weekly Report*, 50(17), 3406.
- CDC. (2009). Home and recreational safety: Feasibility of expanding NEISS to monitor nonfatal injuries treated in US emergency departments. Retrieved September 5, 2013 from <http://www.cdc.gov/HomeandRecreationalSafety/Research/neiss.html>
- CDC-NCHS. (2013). Health, United States, 2012: with special features on Emergency care. Retrieved from <http://www.cdc.gov/nchs/data/hus/hus12.pdf#087>
- CDC. (2013a). Colorectal cancer control program (CRCCP). Retrieved from <http://www.cdc.gov/cancer/crccp/sem.htm>
- CDC. (2013b). Colorectal cancer control program. Retrieved from http://www.cdc.gov/cancer/crccp/pdf/CRCCP_FactSheet.pdf
- CDC. (2009). Home and recreational safety: Feasibility of expanding NEISS to monitor nonfatal injuries treated in US emergency departments. Retrieved from

<http://www.cdc.gov/HomeandRecreationalSafety/Research/neiss.html>

Consumer Product Safety Commission. (2000). National electronic injury surveillance system all injury program sample design and implementation. Washington, DC.

Consumer Product Safety Commission, (2002). National electronic injury surveillance system all injury program sample design and implementation. Washington, DC.

Consumer Product Safety Commission. (2009a). NEISS coding manual. Retrieved March from

<http://search.cpsc.gov/query.html?qt=NEISS+coding+manual+and+Report+Legend&charset=iso-8859-1&col=pubweb>

Consumer Product Safety Commission. (2009b). U.S. Consumer Product Safety Commission information quality guidelines. Retrieved from

<http://www.cpsc.gov/library/library.html>

CPSC, (n.d.). National Electronic Injury Surveillance System. Retrieved from

<http://www.cpsc.gov/en/safety-education/safety-guides/general-information/national-electronic-injury-surveillance-system-neiss/>

CPSC, (2012). National Electronic Injury Surveillance System - All Trauma. Retrieved from <http://www.icpsr.umich.edu/icpsrweb/ICPSR/studies/34640/>

Centers for Disease Control and Prevention (2006). Behavioral risk factor surveillance system operational and user's guide. Retrieved November 20, 2013 from

<ftp://ftp.cdc.gov/pub/Data/Brfss/userguide.pdf>

Close, J. C., Lord, S. L., Menz, H. B. & Sherrington, C. (2005). What is the role of falls? *Best Practice and Research Clinical Rheumatology*. 19(6):913935

- Coussement, J., De Paepe, L., Schwendimann, R., Denhaerynck, K., Dejaeger, E., & Milisen, K. (2008). Interventions for preventing falls in acute- and chronic-care hospitals: a systematic review and meta-analysis. *Journal of the American Geriatrics Society*, *56*(1):29-36.
- Cummings, S. R., & Nevitt, M. C. (1994). Falls. *The New England Journal of Medicine*, *331*, 872-873.
- Cunningham, P. J., & May, J. H. (2003). Insured Americans drive surge in emergency department visits. Washington, DC: Center for Studying Health System Change; 2003. Issue Brief no. 70. Retrieved on September 2, 2013, from:
<http://www.hschange.com/CONTENT/613/>
- Deits, J., Yard, E. E., Collins, L. C., Fields, S. K., & Comstock, D. R. (2010). Patients with Ice Hockey injuries presenting to US Emergency departments, 1990-2006. *Journal of athletic training*, *45*(5), 467-474.
- De Roo, C. A., Chounthirath, T., & Smith, A. G. (2013). Television-related injuries to children in the United States, 1990-2011. *Pediatrics*, *132*, 267-274.
doi:10.1542/peds.20131086.
- Ellis, A. A., & Trent, R. B. (2001). Do the risks and consequences of hospitalized fall injuries among older adults in California vary by type of fall? *Journal of Gerontology Medical Sciences*; *56A*, M686-M692.
- Garcia, T. C., Bernstein, A. B., & Bush, M. A. (2010). Emergency department visitors and visits: Who used the emergency room in 2007? NCHS Data Brief no. 38. Hyattsville, MD: NCHS; 2010. Retrieved from

<http://www.cdc.gov/nchs/data/databriefs/db38>

- Gardner, J. W., & Sanborn, J. S. (1990). Years of potential life lost (YPLL) -- what does it measure? *Epidemiology*, *1*(4): 3229. Retrieved from <http://neuron.mefst.hr/docs/CMJ/issues/2002/43/4/12187522.pdf>
- Gotsch, K., Annest, J. L., Holmgreen, P., & Gilchrist, J. (2002a). Sports- and recreation-related injuries treated in emergency departments- United States, July 2000-June 2001. *Morbidity and Mortality Weekly Report*, *51*(33), 736740.
- Gotsch, K., Annest, J. L., Holmgreen, P., & Gilchrist, J. (2002b). Choking-related injuries in children. *Morbidity and Mortality Weekly Report*, *51*(42), 945948.
- Government Accountability Office, (2009). Hospital emergency departments: Crowding continues to occur, and some patients wait longer than recommended time frames. Washington, DC: GAO; 2009. Pubno. GAO-09-347. Retrieved from: <http://www.gao.gov/new.items/d09347.pdf>
- Hall, P. A., Zehr, C., Paulitzki, J. & Rhodes, R. (2014). Implementation intentions for physical activity behavior in older adult women: An examination of executive function as a moderator of treatment effects. *Ann. behavioral medicine*. 48: 130136
- Harris, V. A., Rochette, L.M., & Smith, G.A (2011). Pediatric injuries attributable to falls from windows in the United States in 1990-2008. *American Academy of Pediatrics*, vol. *128* (3), 455462. doi: 10.1542/peds.20102687.
- Hartholt, K. A., Stevens, J. A., Polinder, S. T. J. M. & Patka, P. (2011). Increase in fall-related hospitalization in the United States, 2001-2008. *Journal of Trauma: Injury, Infection and Critical Care*, *7*(1), 255258.

- Hausdorff, J. M., Rios, D. A., & Edelberg, H. K. (2001). Gait variability and fall risk in community-living older adults: a 1-year prospective study. *Archives of Physical Medicine and Rehabilitation, 82*, 1050-1056.
- Healthy People 2010. (2005). *Leading health indicators*. Retrieved from <http://www.healthypeople.gov/LHI/Priorities.htm>
- Helmkamp, J., Bixler, D., Kaplan, J., & Hall, A. (2008). All-terrain vehicle fatalities: West Virginia, 1999-2006. *Morbidity and Mortality Weekly Report, 57*(12), 312-315.
- Helmkamp, J. C., & Carter, M. W. (2009). ATV deaths among older adults in West Virginia: Evidence suggesting that "60 is the new 40!". *Southern Medical Journal, 102*(5), 465-469.
- Hosmer, W. D., Hosmer, T. S., & Lemeshow (1997). A comparison of goodness-of-fit tests for the logistic regression model. *Statistics in Medicine, 16*, 965-980.
- Hosmer, D. W., & Lemeshow, S. (1980). A goodness-of-fit test for the multiple logistic regression model. *Communications in Statistics, A10*, 1043-1069.
- Hedstrom, M. E., Svensson, O., Bergstrom, U., & Michno, P. (2010). Epidemiology of fractures in children and adolescents. Increased incidence over the past decade: a population-based study from northern Sweden. *Acta orthopaedica. 81*(1), 148-153.
- Hochman, S., & Kernan, W. (2011). *A social-ecological model for addressing stress on the college campus*. Retrieved from http://health.columbia.edu/files/healthservices/alice_SocEcoStress_ACHA_2010.pdf

ICPSR, (n.d.). National Electronic Injury Surveillance System All Program, 2010.

Retrieved from <http://www.icpsr.umich.edu/icpsrweb/ICPSR/studies/34640>

Ikeda, R., Mahendra, R., Saltzman, L., Crosby, A., Willis, L., Mercy, J., Holmgren, P., & Anest, J. L. (2002). Nonfatal self-inflicted injuries treated in hospital emergency departments--United States, 2000. *Morbidity and Mortality Weekly Report, 51*(20), 436438.

Inouye, S. K., Brown, C., & Tinetti, M. (2009). Medicare nonpayment, hospital falls, and unintended consequences. *New England journal of Medicine, 360*(23), 23902393.

Institute of Medicine, National Academy of Sciences, (1988). *The future of public health*. Washington, DC: National Academy Press.

Institute of Medicine, (2007). *Hospital-based emergency care: At the breaking point*. Washington, DC: National Academies Press. Retrieved from http://www.nap.edu/openbook.php?record_id=11621&page=1

Kellogg International Work Group, (1987). The prevention of falls in later life. *Danish Medical Bulletin, 34*(4), 124.

Kellerman, A. L., & Martinez, R. (2011). Perspective: The ER, 50 years on. *New England Journal of Medicine, 364*(24), 22789.

Killingsworth, J. B., Tilford, J. M., Parker, J. G., Graham, J. J., Dick, R. M., & Aitken, M. E. (2005). National hospitalization impact of pediatric all-terrain vehicle injuries. *Pediatrics, 115*(3) e316e321. doi:/10.1542/peds.2004-1585.

Kramarow, E., Chen, L., Hedegaard, H., & Warner, (2015). Deaths From Unintentional Injury Among Adults Aged 65 and Over: United States, 2000-2013. Retrieved

from <http://198.246.124.22/nchs/data/databriefs/db199.pdf>

- Levin, A. K. (2006). Study design III: Cross-sectional studies. *Evidence-Based Dentistry*, 7, 24-25, doi:10.1038/sj.ebd.6400375
- Li, c., Ekwueme, D. U., Rim, S. H., & Tangka, F. K. (2010). Year of potential life lost and productivity losses from male urogenital cancer deaths -- United States, 2004. *Urology*, 76(3), 52835. doi: 10.1016/j.urology.2010.04.030.
- Lord, S. R., Sherrington, C., Hylton, M. B., & Close, J. T. (Eds.). (2007). *Falls in older people* (2nd ed.). West Nyack, NY: Cambridge University Press.
- Luo, X., Liu, G., Frush, K., & Hey, L. A. (2003). Children's health insurance status and emergency department utilization in the United States. *Center for clinical effectiveness, Pediatrics*, 112(2), 314319.
- Lucas, D., Woodward, C., & Lincoln, J. (2013). Fatal and nonfatal injuries involving fishing vessel winches – Southern shrimp fleet, United States, 2000-2011. *Morbidity, Mortality Weekly Report*, 62.9.
- Mao, S. J., McKenzie, L. B., Xiang, H., & Smith, G. A. (2009). Injuries associated with bathtubs and showers among children in the United States. *Pediatrics*, 124, 541-547. doi:10.1542/peds.2008-2489
- Mack, K. A., Liller, K. D., Baldwin, G. & Sleet, D. (2015). Preventing unintentional injuries in the home using the health impact pyramid. Health education and behavior. vol. 42 (1S) 115S122S doi: 10.1177/1090198114568306
- Mack, A. K., Rudd, A. R., Mickalide, D. A., & Ballesteros, F. M. (2013). Fatal unintentional injuries in the home in the U.S, 2000-2008. *American Journal of*

Preventive Medicine; vol. 44(3), 23946.

- Mack, M. G., Sacks, J. J., & Thompson, D. (2000). Testing the impact attenuation of loose fill playground surfaces. *Injury Prevention, 6*, 1414.
- Marks, R., & Allegrante, J. P. (2004). Falls-prevention programs for older ambulatory community dwellers: From public health research to health promotion policy [Electronic version]. *Sozial und Praventivmedizin, 49*, 171178.
- McCarter-Bayer, A., Bayer, F., & Hall, K. (2005). Preventing falls in acute care. *Journal of Gerontological Nursing, 31(3)*, 2533.
- McDonald, E, Girasek, D, & Gielen, A. (2012). Home injuries. In K. Liller (Ed.), *Injury prevention for children and adolescents: Research, practice, and advocacy*. Washington, DC: American Public Health Association.
- McLean, F. S., & Tyroch, A. H. (2012). Injuries sustained after falls from bridges across the United States-Mexico border at EL Paso. *Rev Panam Salud Publica, 31(5)*, 42734.
- McLeroy, K. R., Bibeau, D., Steckler, A., & Glanz, K. (1988). An ecological perspective on health promotion programs. *Health Education Quarterly, 15(4)*, 351377.
- McLoughlin, E., Middlebrooks, J. A., Annet, J. L., Holmgreen, P., & Dellinger, A. (2002). Injuries and deaths among children left unattended in and around motor vehicles. *Morbidity and Mortality Weekly Report, 51(26)*, 570572.
- Merks, A., Verberk, F., De Kuiper, M., & Lowry, L. W. (2012). Neuman systems model in holland: an update. *Nursing Science Quarterly, 25(4)*, 3648. doi: 10.1177/0894318412457056.

- Morse, J. (2002). Enhancing the safety of hospitalization by reducing patient falls. *American Journal of Infection Control*, 30(6), 376380.
- Mish, F. C. (Eds.). (1994). *Merriam Webster's collegiate dictionary* (10th ed.). Springfield, MA: Merriam-Webster.
- Murphy, L. S., Gretebeck, K. A., & Alexander, B. N. (2006). The bath environment, the bathing task, and the older adult: A review and future directions for bathing disability research. *Disability and rehabilitation*; 29 (14): 10671075
- Naaldenberg, J., Vaandrager, L., Koelen, M., Wagemakers, A. M., Saan, H., & de Hoog, K. (2009). Elaborating on systems thinking in health promotion practice. *Global health promotion*, 16(1), 3947. doi: 10.1177/1757975908100749
- National Electronic Injury Surveillance System-All Injury Program (2010). Resources. Retrieved from http://www.healthindicators.gov/Resources/DataSources/NEISS-WORK_88/Profile
- NEISS - Safety Policy, (n.d.). NEISS. Retrieved from www.safetypolicy.org/hp2010/neiss.htm
- Nnodim, J. O., & Alexander, N. B. (2005). A comprehensive fall evaluation to reduce fall risk in older adults. *Geriatrics*, 60(10), 2428.
- Noonan, K. R., Stevens, J. A., & Baldwin, G. (2011). The public health approach to older adult fall prevention: comments from the U.S. Centers for Disease Control and Prevention. *Open Longevity Science*, 5, 26-31.
- Office of Technology Assessment, U.S. Congress, (1995). *Risks to students in school*. Washington (DC): U.S. Government Printing Office

- Oliver, D., Healey, F., & Haines, T. (2010). Preventing falls and fall-related injuries in hospitals. *Clinic of Geriatric medicine*, 26(4), 645-692.
doi:10.1016/j.cger.2010.06.005
- Ordin, Y. S., Karayurt, O., & Wellard, S. (2013). Investigation of adaptation after liver transplantation using Roy's Adaptation model. *Nursing Health Science*, 15(1), 31-8. doi: 10.1111/j.1442-2018.2012.00715.x.
- Owens, L. P., Russo, A.C., Spector, W., & Mutter, R. (2009). Emergency department visits for injurious falls among the elderly, 2006.HCUP Statistical Brief #80. Agency for Healthcare Research and Quality, Rockville, MD. Retrieved from www.hcup-us.ahrq.gov/reports/statbriefs/sb80.pdf
- Peppe, E. M., Mays, J. W., Chang, H. C., Becker, E., & DiJulio, B. (2007). Characteristics of frequent emergency department users. Menlo Park, CA: Kaiser Family Foundation. Retrieved from <http://www.kff.org/insurance/upload/7696.pdf>
- Phelan, K. J., Khoury, J., Kalkwarf, H. J., & Lanphear, B. P. (2001). Trends and patterns of playground injuries in United States children and adolescents. *Ambulatory Pediatrics*, 1(4), 227-33.
- Quigley, P.A, Campbell, R.R., Bulat, T., Olney, R.L., Buerhaus, P., & Needleman, J. (2012). Incidence and cost of serious fall-related injuries in nursing homes. *Clinical nursing research*, 21 (1), 1023; doi: 10.1177/1054773811414180
- Quinlan, K. P., Thompson, M. P., Annest, J. L., Peddicord, J., Ryan, G., Kessler, E. P., & McDonald, A. K. (1999). Expanding the National Electronic Injury Surveillance System to monitor all nonfatal injuries treated in US hospital emergency

- departments. *Annals of Emergency Medicine*, 34, 637645.
- Reuben, D. B., Keeler, E., Seeman, T., et al., (2002). Development of a method to identify seniors at high risk for high hospital utilization. *Med Care*; 40: 782793.
- Rider-Ellis, L., & Love-Hartley, J. (2004). *Nursing in today's world: Trends, issues and management* (8th ed.). Baltimore, MD: Lippincott Williams & Wilkins.
- Rosen, T., Mack, K. A., & Noonan, R. K. (2013). Slipping and tripping: fall injuries in adults associated with rugs and carpets. *Journal of injury and violence research*. 5(1), 6169
- Rothman, K. J., & Greenland, S. (1998). *Modern epidemiology* (2nd ed.). Philadelphia, PA: Lippincott-Raven Publishers.
- Roudsari, B. S., Ebel, B. E., Corso, P. S., Molinari, N. A., & Koepsell, T. D. (2005). The acute medical care costs of fall-related injuries among the U.S. older adults. *Injury*, 36(11), 131622.
- Rubenstein, L. Z., Robbins, A. S., Josephson, K. R., Schulman, B. L., & Osterweil, D. (1990). The value of assessing falls in an elderly population. A randomized clinical trial. *Annals of Internal Medicine*, 113(4), 30816.
- Rubenstein, Z. L., & Josephson, R. K. (2006). Falls and their prevention in elderly people: What does the evidence show? *Medical Clinics of North America*, 90, 807824. doi:10.1016/j.mcna.2006.05.013
- Sattin, R. W., Lambert-Huber, D. A., DeVito, C. A., Rodriguez, J. G., Ros, A., Bacchelli, S., Stevens, J. A., & Waxweiler, R. J. (1990). The incidence of fall injury events

- among the elderly in a defined population. *American Journal of Epidemiology*, *131*(6), 10281037.
- Schaffer, P. L., Daraiseh, N. M., Daum, L., Mendez, E., Lin, L., & Huth, M. M. (2011). Pediatric inpatient falls and injuries: A descriptive analysis of risk factors. *Journal for specialists in pediatric nursing*, *17*, 1018. doi: 10.1111/j.1744-6155.2011.00315.x
- Schroeder, T., & Ault, K. (2001). *The NEISS Sample (Design and Implementation) from 1997 to present*. Washington, DC: U.S. Consumer Product Safety Commission.
- Scuffham, P., Chaplin, S., & Legood, R. (2003). Incidence and costs of unintentional falls in older people in the United Kingdom. *Journal of Epidemiology Community Health*, *57*, 7404.
- Shields, B. J., Burkett, E., & Smith, G. A. (2011). Epidemiology of balcony fall-related injuries, US, 1990-2006. *The American Journal of Emergency Medicine*, *29*(2), 174780.
- Schiller, J. S., Kramarow, A. E., & Dey, A. N. (2007). Fall injury episodes among noninstitutionalized older adults: United States, 2001-2003. *Advance Data from Vital & Health Statistics*, *392*.
- Shults, Ruth A., West, Bethany A., Rudd, Rose A., Helmkamp, & James C. (2013). All-terrain vehicle-related nonfatal injuries among young riders in the United States, 2001-2010. *Pediatrics*, *132*(2), 282289.
- Simon, T. R., Annet, J. L., Holmgren, P., Saltzman, L., Swahn, M. H., Mercy, J. A., &

- Ingram, E. (2002). Nonfatal physical assault-related injuries treated in hospital emergency departments--United States, 2000. *Morbidity and Mortality and Weekly Report*, 51(21), 460463.
- Simon, M. K., & Goes, J. (2013). *Dissertation and scholarly research: Recipes for success (2013 Edition)*. Seattle, WA: Dissertation Success, LLC.
- Smith, L. O. (2006). Alpine climbing: Injuries and illness. *Physical medicine and rehabilitation clinics of North America*, 17, 633644.
- Sleet, A. D., Ballesteros, F. M., & Borse, N. N. (2009). A review of unintentional injuries in adolescents. *Annual Review of Public Health*, 3, 195212, doi:10.1146/annurev.publhealth.012809.103616
- Sleet, D. A., Moffett, D. B., & Stevens, J. (2008). CDC's research portfolio in older adult fall prevention: A review of progress, 1985-2005, and future research directions [Electronic version]. *Journal of Safety Research*, 39, 259267.
- Sterling, D., O'Conner, J. A., & Bonadies, J. (2001). Geriatric falls: Injury severity is high and disproportionate to mechanism. *Journal of Trauma-Injury Infection and Critical Care*, 50(1), 116119.
- Stevens, J. A. (2006). Fatalities and injuries from falls among older adults – United States, 1993-2003 and 2001-2005. *MMWR*, 55(45).
- Stevens, J. A., Corso, P. A., Finkelstein, E. A., & Miller, T.R. (2006). The costs of fatal and non-fatal falls among older adults. *Injury Prevention*, 12(5), 290295. doi:10.1136/ip.2005.011015.

- Stevens, & Sogolow (2005). Gender differences for non-fatal unintentional fall related injuries among older adults. *Injury Prevention, 11*, 115119
doi:10.1136/ip.2004.005835
- Stevens, J. A., Mack, K. A., Paulozzi, L. J., & Ballesteros, M. F. (2008). Self-reported falls and fall-related injuries among persons aged > 65 years. United States, 2006. *MMWR, 57*(9), 225229
- Stevens, J. A., Haas, E. N., & Haileyesus, T. (2011). Nonfatal bathroom injuries among persons aged greater or equal to 15 years – United States, 2008. *Journal of Safety Resource, 42*(4), 3115. doi: 10.1016/j.jsr.2011.07.001
- Stokols, D. (1996). Translating social ecological theory into guidelines for community health promotion. *American Journal of Health Promotion, 10*(4), 28298.
- Stokols, D. (2000). Social ecology and behavioral medicine: implications for training, practice, and policy. *Behavioral Medicine, 26*(3), 129129.
- Strobl, R., Muller, M., Thorand, B., Linkohr, B., Autenrieth, C. S., Peters, A. & Grill, E. (2014). Men benefit more from midlife leisure-time physical activity than women regarding the development of late-life disability - Results of the KORA-Age study. *Preventive Medicine. vol. 62: 8-13* doi:10.1016/j.ypmed.2014.01.017
- Talbot, L. A., Musiol, R. J., Witham, E. K., & Metter, J. E. (2005). Falls in young, middle-aged and older community dwelling adults: Perceived cause, environmental factors and injury. *BMC Public Health, 5*, 86.
- Tang, N., Stein, J., Hsia, R. Y., Maselli, J. H., & Gonzales, R. (2010). Trends and characteristics of US emergency department visits, 1997-2007. *JAMA, 304*(6),

66470.

- Thomas, K. E., Stevens, J.A., Sarmiento, K., & Wald, M.M. (2008). Fall-related traumatic brain injury deaths and hospitalizations among older adults – US, 2005. *Journal of Safety Research*, 39(3), 26972; doi: 10.1016/j.jsr.2008.05.001
- Tinetti, M. E. (2003). Preventing falls in elderly persons. *New England Journal of Medicine*, 348, 4249.
- Tinetti, E. M., Baker, D. I., King, M., Gottschalk, M., Murphy, T. E., Acampora, D., & Allore, G. H. (2008). Effect of dissemination of evidence in reducing injuries from falls. *New England Journal of Medicine*, 359, 25226. doi: 10.1056/NEJMoa0801748
- Tinetti, M. E., Gordon, C., Sogolow, E., Lapin, P., & Bradley, E. H. (2006). Fall-risk evaluation and management: Challenges in adopting geriatric care practices. *Gerontologist*, 46, 717725.
- Tinetti, M. E., Speechley, M., & Ginter, S. F. (1988). Risk factors for falls among elderly persons living in the community. *New England Journal of Medicine* 319(26), 17017.
- Tinsworth, D., & McDonald, J. (2001). *Special study: Injuries and deaths associated with children's playground equipment*. Washington DC: U.S. Consumer Product Safety Commission
- Thacker, S. B., & Berkelman, R. L. (1988). Public health surveillance in the United States. *Epidemiology Review*, 10, 164190.
- United States Department of Health and Human Services (2000). *Healthy People 2010:*

- Understanding and improving health. 2nd ed.* Retrieved from <http://www.healthypeople.gov/document/pdf/uih/2010uih.pdf>
- Watson, S. D., Shields, J. B., & Smith, A. G. (2011). Snow shovel-related injuries and medical emergencies treated in US EDs, 1990 to 2006. *American Journal of Emergency Medicine, 29*, 1117.
- Willgoss, G. T., Yohannes, M. A., & Mitchell, D. (2010). Review of risk factors and preventative strategies for fall-related injuries in people with intellectual disabilities. *Journal of Clinical Nursing, 19*, 21002109. doi: 10.1111/j.1365-2702.2009.03174.x
- Wong, Recktenwald, A. ML, J., Waterman, B., Bollini, M., & Dunagan, W. C. (2011). The cost of serious fall-related injuries at three Midwestern hospitals. *Joint Commission Journal on Quality and Patient Safety, 37*(2), 8187.
- Yeoh, T. H., Lockhart, E. T., & Wu, X. (2013). Nonfatal occupational falls among U.S. health care workers, 2008-2010. *Workplace Health & Safety, 61*(1), 38. doi:10.3928/21650799-20121221-55.
- Zaccagni, L., Masotti, S., Donati, R., Mazzoni, G., & Gualdi-Russo, E. (2014). Body image and weight perceptions in relation to actual measurements by means of a new index and level of physical activity in Italian university students. *Journal of Translational medicine, 12*:42
- Zielinski, A. E., Rochette, L.M., & Smith, G. A (2012). Stair-related injuries to young children treated in US emergency department, 1999-2008. *American Academy of Pediatrics, 129*(4), 721727.

Appendix A: Data

Table 1
NEISS All Injury Program Sample Characteristics
July to December 2000

Stratum	Range of Total ERVs	Number of Hospitals in Universe	Total Sample	Basic Weight
1	1 - 16,830	3,179	31	102.55
2	16,831 - 28,150	1,059	9	117.67
3	28,151 - 41,130	674	6	112.33
4	41,131 +	426	15	28.40
Children's	Various	50	5	10.00
Total		5,388	66	

Source: SMG Health Facility File, SMG Marketing Group Inc., 1995.

Note: The basic weight is based on the 1995 SMG data when the NEISS was redesigned in 1997.

Ratio Adjustments to NEISS All Injury Program Weights
July 1, 2000 through December 31, 2000

Stratum	1999 ERVs from Emergency Rooms on Original Frame	1999 ERVs from Emergency Rooms New to 1999 Frame	Total ERVs	Estimated ERVs from NEISS-AIP Sample	Ratio Adjustment
1	24,895,553	177,975	25,073,528	25,784,670	
2	23,759,376	269,898	24,029,274	18,988,883	1.096692
3	23,253,312	38,516	23,291,828	26,235,338	
4	23,441,652	77,000	23,518,652	23,879,032	0.934073
Children's	1,984,668	269,222	2,253,890	2,388,930	0.943473
Total	97,334,561	832,611	98,167,172	97,276,853	

Source: SMG Health Facility File, SMG Marketing Group Inc., 1999.

TABLE. National Estimates of the Number and Percentage* of Persons with Nonfatal Injuries Treated in Hospital Emergency Departments, by Selected Characteristics, National Electronic Injury Surveillance System All Injury Program, United States, 2010

Characteristic	2010	
	No.	%
Total	31,575,978	100.0
Age in Years		
0-4	2,494,357	7.9
5-9	1,783,707	5.6
10-14	2,366,110	7.5
15-19	3,063,235	9.7
20-24	2,978,596	9.4
25-29	2,599,956	8.2
30-34	2,238,017	7.1
35-39	1,990,635	6.3
40-44	1,999,550	6.3
45-49	2,087,357	6.6
50-54	1,847,972	5.9
55-59	1,414,089	4.5
60-64	1,035,837	3.3
65-69	786,119	2.5
70-74	648,320	2.1
75-79	610,488	1.9
80-84	668,820	2.1
85+	960,522	3.0
Unknown	2,290	0.0

Classifications of Variables Used in the Current Study

Variables	Type of Variable	Classification
Hospitalization (Dependent Variable)	Categorical	Hospitalized: <ul style="list-style-type: none"> ● Admitted to same facility ● Transferred and admitted to another inpatient facility Not hospitalized
Age (Independent variable)	Continuous (for multivariable modeling) Categorical (for calculation of rates)	For categorical age: <ul style="list-style-type: none"> ● Child (<19 years) ● Young (20-34 years) ● Middle-aged adults (35-64 years) ● Older adults (+ 65 years)
Gender (Independent Variable)	Categorical	Categorical gender: <ul style="list-style-type: none"> ● Male ● Female
Race (Independent variable)	Categorical	<ul style="list-style-type: none"> ● White/Caucasian (referent group) ● Black/African-American ● Other (incl. non-White, non-Black and unknown race)
Locale Where Injured (Independent variable)	Categorical	Categorical Incident Locale: <ul style="list-style-type: none"> ● Home ● Not Home (School/Sport) ● Other (non-Home, non-School/Sport, and unknown locale)
Body Part Affected (Independent variable)	Categorical	Categorical Body part Affected: <ul style="list-style-type: none"> ● Head ● Trunk ● Extremities ● Other (not head, not trunk, not extremities, & unknown body part)

Appendix B: Probability

The probability of event C is:

$$\begin{aligned} P(C) &= 2 \binom{n}{2} P(H_1 \text{ is selected in the first draw and } H_2 \text{ is selected on the 2nd}) \\ &= 2 \binom{n}{2} \frac{1}{N} \frac{1}{N-1} \end{aligned}$$

The probability of inclusion of the merged hospital is then:

$$\begin{aligned} P(A) + P(B) + P(C) &= \frac{n(2N - n - 1)}{N(N - 1)} = \frac{2n}{N} - \frac{n(n - 1)}{N(N - 1)} \\ Wgt_{hi} &= \frac{1}{\frac{2n_h}{N_h} - \frac{n_h(n_h - 1)}{N_h(N_h - 1)}} \left(\frac{n'_h}{r_h} \right) \end{aligned}$$

Taking into account any non-response adjustment, the basic merged weight of hospital i is computed as:

Where:

- N_h = Number of hospitals in the NEISS-AIP sampling frame for stratum h
- n_h = Number of hospitals selected from the NEISS-AIP sample for stratum h
- r_h = Number of hospitals participating in the NEISS-AIP sample for stratum h for the time period
- n'_h = Number of in-scope hospitals in the NEISS-AIP sample for stratum h

Appendix C: Equation 1

Within each combined stratum, the ratio-adjusted weights, w_{hi}^* , are computed as:

$$w_{hi}^* = w_{hi}' \left(\frac{ERV_{up,h^*}}{\sum_{h \in h^*} \sum_i w_{hi}' ERV_{up,i}} \right) = w_{hi}' * R_{h^*} \quad (\text{Equation 1})$$

where

- w_{hi} = NEISS-AIP basic weight (adjusted for hospital mergers if necessary)
- w_{hi}' = NEISS-AIP basic weight (adjusted for hospital mergers if necessary: see discussion below)
- ERV_{up,h^*} = Total ERVs on updated SMG file for combined stratum h^*
- $ERV_{up,i}$ = Number of ERVs from the updated SMG file for NEISS-AIP hospital i
- R_{h^*} = Ratio adjustment for combined stratum h^*

Appendix D: Equation 2

$$NEISS_{wt} = \left(\frac{N_h \cdot n^*_h \cdot n'_h}{n_h \cdot n'_h \cdot r_h} \right) * R_h \quad (\text{Equation 2})$$

where:

- N_h = Number of hospitals in the original sampling frame for stratum h
- n_h = Number of hospitals selected for the NEISS-AIP sample for stratum h
- n^*_h = Number of in-scope hospitals in the NEISS sample for stratum h
- n'_h = Number of in-scope hospitals in the NEISS-AIP sample for stratum h
- r_h = Number of NEISS-AIP hospitals participating in stratum h for the given month
- R_h = Ratio adjustment for combined stratum h

Appendix E: National Estimate of Injuries from the NEISS-AIP

National estimates for a given month of NEISS-AIP are calculated using the following formula

$$Estimate = \sum_i wgt_i x_i \quad (Equation 3)$$

where:

wgt_i = Weight of hospital i for the month

x_i = Number of cases for a type of injury reported by hospital i for the given month

Except for the unique weights of merged hospitals, the weights of the hospitals are the same within a stratum and *equation 3* can be written as:

$$Estimate = \sum_{h=1}^m \sum_{i=1}^{r_h} \left(\frac{N_h}{n_h} \frac{n^*_h}{n'_h} \frac{n'_h}{r_h} \right) R_{h^*} x_{hi} \quad (Equation 4)$$

where:

m = Number of strata in the NEISS-AIP sample during the given time period

N_h = Number of hospitals in the NEISS-AIP sampling frame for stratum h

n_h = Number of hospitals selected for the NEISS-AIP sample for stratum h

n^*_h = Number of in-scope hospitals in the NEISS sample for stratum h

n'_h = Number of in-scope hospitals in the NEISS-AIP sample for stratum h

r_h = Number of NEISS-AIP hospitals participating for stratum h for the given

Appendix F: NEISS-AIP VARIANCE

$$\sigma_x^2 = \sum_{h=1}^m \frac{r_h}{r_h - 1} \sum_{i=1}^{r_h} \left(\frac{N_h n'_h}{n_h r_h} \right)^2 (x_{hi} - \bar{x}_h)^2 = \sum_{h=1}^m \frac{r_h}{r_h - 1} \sum_{i=1}^{r_h} (\text{wgt}_{hi} x_{hi} - \text{wgt} \bar{x}_h)^2$$

where:

- m = Number of strata in the sample for the time period
- r_h = the number of hospitals participating in stratum h for the time period
- N_h = Number of hospitals in the NEISS sampling frame for stratum h
- n_h = Number of hospitals selected for the (current) sample for stratum h
- n'_h = Number of in-scope hospitals in the (current) sample or stratum h
- x_{hi} = the number of injuries reported for the time period in the i-th hospital in stratum h
- wgt_{hi} = The weight of hospital i in stratum h for the time period

$$\bar{x}_h = \sum_{i=1}^{r_h} \frac{x_{hi}}{r_h} \quad \text{and} \quad \text{wgt} \bar{x}_h = \sum_{i=1}^{r_h} \frac{\text{wgt}_{hi} x_{hi}}{r_h}$$