Societal consequences of falls in the older population: injuries, healthcare costs and long term reduced quality of life

Running head: Societal consequences of falls in older adults

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Abstract

Background: Fall incidents are a major cause of morbidity and mortality in older adults. The aim of this cohort study was to determine the incidence, costs, and quality of life for fall-related injuries in the older Dutch population presenting at the emergency department.

Methods: Data on fall-related injuries in persons 65 years or older were retrieved from the Dutch Injury Surveillance System, which records injuries treated at the emergency department, and a patient follow-up survey conducted between 2003 and 2007. Injury incidence, discharge rates, healthcare costs, and quality of life measures were calculated.

Results: Fall-related injuries were to the upper or lower limb in 70% of cases and consisted mainly of fractures (60%), superficial injuries (21%), and open wounds (8%). Falls led to a total healthcare cost of €474.4 million, which represents 21% of total healthcare expenses due to injuries. Both admitted and nonadmitted patients reported a reduced quality of life up to 9 months after the injury.

Conclusions: Fall-related injuries in older adults are age and gender related, leading to high healthcare consumption, costs, and long-term reduced quality of life. Further implementation of falls prevention strategies is needed to control the burden of fall-related injuries in the aging population.

Introduction

Fall incidents represent a major public health problem, because approximately one-third of all community-dwelling people aged 65 years or older fall once a year, and this goes up to 50% in persons aged 80years or older.[1] Older persons are at an increased risk of serious injuries, even after a relatively minor trauma such as a fall, because of to the number and severity of comorbidities, including osteoporosis.[2] In 22 to 60% of cases, medical treatment is required after a fall incident.[1] Therefore, falls are the leading cause of emergency department (ED) visits and hospitalisations due to an injury in those aged 65 years and older and result in a high healthcare demand worldwide.[3] Fall-related injuries are also accompanied by short- and long-term functional impairment and consequent reduction of quality of life among the elderly.[4] With the predicted aging of societies[5] and increasing trends in fall-related injuries in older adults,[6, 7] falls are expected to increase to one of the major public health problems for communities worldwide.[6, 8] Consequently, this will lead to expanding healthcare expenses.[9, 10] For prioritizing limited resources, for monitoring the impact of injury prevention strategies, and for optimal allocation of the restricted healthcare budget, the integrated measurement of fall-related morbidity and costs is essential.

Previous studies focused on injuries or costs alone.[9, 10] However, comprehensive studies on the societal impact of falls in older people focusing on both economic costs and quality of life are lacking. The aim of this study was to overview the societal consequences of falls among the older Dutch population in terms of injuries, healthcare costs and reduced quality of life.

Methods

Injury incidence and healthcare costs

In this study, we used the Dutch Burden of Injury model,[11] *i.e.*, a previously developed incidence-based model, to measure and describe healthcare use and costs resulting from injuries occurring during a specified period.[9, 12] Annual incidence rates of ED visits are extracted from the Dutch Injury Surveillance System (LIS). The LIS database is a continuous monitoring system in which injury diagnoses and injury mechanisms are registered by using the International Classification of Diseases of the World Health Organization (ICD 10th revision). LIS is based on 13 geographically distributed EDs in The Netherlands, resulting in a representative 12% sample of injury-related ED visits that can be extrapolated to national estimates. Per injury group, the number, healthcare consumption, and related costs are calculated based on the registered data in the LIS database, National Hospital Discharge Registry, and a patient survey. Healthcare consumption is split up in multiple categories, in which all healthcare consumptions are used; before, during, and after ED attendance. Costs and healthcare consumption are injury, gender, and age dependent. In this model, incidence rates, healthcare consumption, and costs can be selected for all injury mechanisms and age groups.

In this study, the model was applied to all unintended falls among persons aged 65 years or older between 2003 and 2007. An unintended fall was defined by using International Classification of Diseases, 10th revision, code for external causes of injuries (W00-W19).

Injury groups were based on a consensus of European expert groups (EUROCOST, APOLLO and INTEGRIS) and have been used in previous international publications.[3, 13] Based upon the 39 EUROCOST injury groups, an aggregation into 37 groups was used in this study.[13] Injuries by a fall were selected based upon the registered primary diagnosis. In case

of multiple injuries, the primary injury in LIS was determined by application of an algorithm giving priority to spinal cord injury, skull/brain injury, and lower extremity injury above injuries in other body parts, and fractures above other types of injury to determine the most serious injury. Incidence rates were expressed per 1,000 person-years.

Direct medical costs were estimated using the Dutch Burden of Injury Model.[11] The age- and injury-specific costs are based on the estimated healthcare supplied to the individual injury patients. Healthcare costs of injuries were calculated by multiplication of incidence, healthcare volumes (*e.g.* length of stay in hospital or institution, number of outpatients visits, General Practitioner visits, home care hours, and physical therapy treatments), and unit costs (*e.g.* costs per day in hospital or institution, per visit, per hour, and per treatment). Healthcare volumes were estimated with national registration data and a patient follow-up survey. All unit costs were estimated according to national guidelines for healthcare costing.[14]

Reduced Quality of Life

A random sample of patients recorded in LIS (n=668 patients aged 65 years or older) had received an invitation to complete questionnaires on their quality of life at 2 months, 5 months, and 9 months after the fall incident.[15] Quality of life was measured with the EuroQuality of life-5D (EQ-5D). The EQ-5D classification system describes the respondents' health in three levels of severity on the health domains: "mobility", "self-care", "usual activities", "pain/discomfort", and "anxiety/depression". In our questionnaire "cognition" was added as a sixth dimension. In addition, a scoring algorithm based on empiric valuations from the Dutch general population and subsequent statistical modeling was used to express the separate five dimensions of the EQ-5D into a summary score.[16] This summary score is named the EQ-5D utility score. It ranges from 1 for full health to 0 for death, and can be interpreted as a judgment on the relative desirability of a health status compared with perfect health. The

EQ-5D utility score of the patients was compared with the general population norm of older persons (age 65 years or older) at 2 months, 5 months, and 9 months after a fall-related injury.

Results

Between 2003 and 2007, a national annual estimated number of 67,300 Dutch persons aged 65 years or older (*i.e.*, 2.9% of the older population) visited the ED because of a fall incident, which resulted in 22,170 (32.9%) hospital admissions annually. Patients had a mean age of 78.8 years, and three-quarters of the patients were women (Table 1). The overall incidence rate of fall-related ED attendance was 29.1 per 1,000 person-years in all patients aged 65 years or older. The incidence rate increased with age, from 17.7 for persons aged 65 to 74 years to 105.0 in persons aged 95 years or older. Admission rates and discharge destination were also age related. With a higher age, we found increasing proportions of patients who were admitted (22.4% in patients 65-74 years to 44.6% in patients aged $\geq$ 95 years), discharged to a long-term facility (3.8% in patients 65 years to 74 years to 8.4% in patients aged 95 years or older), or deceased during admission (2.6% in patients aged 65 years to 74 years to 13.3% in patients aged 95 years or older).

Four types of injury diagnosis groups represented 91.9% (61,790 injuries) of all fall-related injuries in older persons. Falls mainly caused fractures (59.6%), superficial injuries (20.9%), and head injuries (8.7% head wounds and skull-brain injuries). A more detailed analysis revealed that fractures of the hip (27.5%), wrist (19.8%), upper arm (7.2%), and clavicle (7.0%) represent the most frequently diagnosed fractures.

The five most frequently occurring injuries for men and women, and specified by age group, are shown in Table 2. In both men and women, the majority of falls resulted in superficial injuries and hip fractures in all age groups. However, after a fall, men presented

more often with open wounds and skull/brain injuries, whereas women presented more frequently with wrist and upper arm fractures. The proportion of hip fractures for fall-related injuries increased with age from 7% in persons aged 65 years to 74 years up to ~30% in patients aged 85 years or older. Approximately 40% of all hip fractures and upper arm fractures were due to slipping or stumbling. In only 3 to 6%, hip fractures or upper arm fractures were caused by a fall from steps or stairs. However, skull/brain injuries were frequent (21%) due to a fall from a stairs or steps, fall from height (9%), and only in 15% due to slipping or stumbling.

Numbers and incidences of the 15 most common fall-related injuries are shown in Table 3. Serious injuries, such as hip and femur fractures, were accompanied with a high admission rate. Table 3 shows that fall-related injuries among older persons put a high demand on healthcare services and lead to considerable cost amounts. Fall-related injuries among older adults in The Netherlands led to an estimated total annual cost of €474.4 million (€98.2 million for men and €376.2 million for women). This is 20.8% of the national healthcare budget spent on injuries and poisoning for all ages. The 15 most frequently occurring fall-related injuries among older persons account for 90.1% of the costs, with a major share for hip fractures (42.3%) because of a high incidence rate combined with high costs per case. Other costly injuries are skull-brain injury (7.7%), femur shaft fractures (6.8%; also because of high costs per case), and superficial injuries (6.5%; because to high incidence rates). Healthcare costs increased with age. Persons aged 75 years and older accounted for half of all older persons with fall-related injuries, but were responsible for three-quarters (€355 million) of the total fall-related healthcare costs in those aged 65 years or older. The mean costs per case were €7,058. The most expensive injuries per case were femur shaft fractures (€19,000) and hip fractures (€18,223), which were both characterized by a very high proportion of admitted patients and long admission duration.

All fall-related injuries together had a substantial impact on the quality of life. Compared to norms of the general older population, both admitted and nonadmitted patients reported a reduced quality of life score, even at 9 months after the incident (a reduced utility score of 0.19 and 0.03, respectively). For all older fallers treated at the ED, the overall utility score was reduced by 0.09 at long term (Figure 1). Admitted patients overall reported more problems on the five dimensions of the EQ-5D, compared with the Dutch population norm of persons aged 65 years or older. Although there is a slight improvement in the quality of life over time, problems at 9 months after the fall incident were still reported for "mobility" (70%), "self-care" (41%), "usual activities" (64%), and "anxiety/depression" (28%) in admitted patients. Nonadmitted patients reported problems at 9 months after the fall mainly on "self-care" (22%) and "usual activities" (41%).

Table 4 shows the prevalence of limitations at 9 months follow-up on the five health dimensions of EQ-5D and cognition for hip fractures, arm fractures, and skull-brain injuries. Compared to the general older population, all three injury types are accompanied by large increases in reported problems with self-care and usual activities. In addition, specific increases in functional problems by type of injury were found, such as long-term mobility problems occurring in 90% of the hip fracture cases.

Discussion

For this study a representative sample of ED visits between 2003 and 2007 was used to estimate national incidence rates, quality of life measures, and healthcare costs because of fall incidents among older adults in The Netherlands. Fall incidents led to high numbers of injuries and resulted in a major public health problem in older adults with large financial consequences. Injury patterns due to falls were gender and age related and resulted mainly in

fractures, superficial injuries, and open wounds. A substantial loss in the quality of life was found after a fall-related injury in admitted and nonadmitted patients. Injuries resulting in a long-term reduction of the quality of life were accompanied by high healthcare costs (*e.g.*, hip fractures) and by large increases in problems with self-care and usual activities compared with the general older population.

Of the Dutch population aged 65 years or older, women compromise 60% of the population. Especially, women and the oldest old are at risk for fall-related injuries.[10, 17] This is not surprising because age, female gender, and medication use are well-known risk factors for fall incidents. Also, the type of injuries is changing with an increasing age to a higher severity level, because the oldest old presented with a higher incidence rate of hip and pelvic fractures.[18] There is most likely an association with fall techniques and comorbidity.[19] "Younger" adults are trying to reduce the impact of a fall in a moment of time by stretching their arms, which endures high pressure on impact. This mechanism leads to fractures of the upper extremity. As the oldest old fail to do so, because of less muscle mass, muscle strength, and reflexes reaction time, they cannot reduce the impact of their fall as younger adults can do. Also, underlying diseases as osteoporosis is more pronounced in females and the oldest old and could potentially explain the higher numbers of hip and wrist fractures in these groups compared with males and younger persons.[2, 20]

Fall-related injuries are leading to a reduced quality of life even at 9 months after a fall incident, suggesting that patients are still suffering from the consequences of their injuries. Problems with "self-care" and "usual activities" were most frequently reported in both patients with major and minor injuries. At population level, not only "major" but also "minor" injuries have a serious impact on the quality of life, because of the very high frequency of fall incidents leading to minor injuries. Apparently, there is room for treatment improvement for the full severity spectrum of older fallers presented at the ED. Observed differences in quality

of life for admitted and nonadmitted patients can possible be explained by the severity of injuries. Admitted patients often required surgery and rehabilitation. The proportion of admitted patients increased with age, and besides the high proportion of hip fractures, also frailty could influence the risk of falling and severity of injuries. Older adults who sustained an injurious fall often complain of loss of independence, confidence, and functional activity, and of fear to fall again.[21, 22] Disabilities resulting from injuries are reflected in the increased number of older adults reporting problems of "self-care" and "usual activities". This could be the difference between independent living and the need for social care. Therefore, the social impact exceeds the medical and economical consequences of falls as described in our study. Further research is needed to determine the cause for the observed reduced quality of life in the fall-related injuries and to suggest injury-specific treatment adaptations to optimize the quality of life.

Reduced quality of life may lead to more healthcare consumption and related healthcare expenses. For example, patients with a hip fracture often require hospitalization, surgical treatment, and long-term rehabilitation. This explains the higher costs of injuries with an intensive treatment and a reduced quality of life compared with patients with minor injuries who are not admitted. Costs of falls in older adults have been analyzed in a small number of previous studies. It have estimated that falls lead to high healthcare costs in other countries,[3, 10] comparable to in The Netherlands. Because the population worldwide is ageing,[5] the population at risk for falls is increasing. To control for healthcare cost, prevention of falls and more healthcare efficiency are needed.

Although a representative sample of the Dutch population was used, numbers of fall-related injuries observed could be an underestimation of the real situation. A possible underestimation might have occurred because not all fall-related injuries were recognized as fall related in the discharge letters and coded accordingly. In addition, fall incidents resulting

in direct death before reaching the hospital and patients with minor injuries who presented only to their General Practitioner were not recorded in this database and consequently not analyzed in this study. Therefore, this study represents the incidence rate, costs, and functional consequences of mild and serious fall-related injuries resulting in ED attendance. In case of multiple injuries, the primary injury in LIS was determined by application of an algorithm giving priority to spinal cord injury, skull/brain injury, lower extremity injury above injuries in other body parts, and to fractures above other types of injury to determine the most serious injury. Injuries to specific body parts (*e.g.*, internal injuries) or injuries noted at a tertiary survey (*e.g.*, spinal cord injuries) could be underestimated. In this study, functional problems were estimated with a generic quality of life measure and compared to norm scores of the general older population. For this aim, we used the EQ-5D, which is internationally recommended to assess quality of life in older fallers. However, a problem in making comparisons with general population norms is the potential difference in the "pre-injury health status" between this general population and a population of older fallers. On one hand, falling could be the result of a more active lifestyle reflecting a better than average pre-injury health status but on the other hand, it could be associated with frailty.

Valid data on pre-injury health status are difficult to obtain and were not available for our study. Therefore, we may have overestimated or underestimated the impact of fall-related injuries on quality of life. Only a few studies have measured a pre-injury health state so far in quality of life after injury studies, showing a better than average health status among injured populations in Australia[23] and the United Kingdom.[24] These studies support our conclusion of a reduced quality of life after fall-related injuries, because they indicate an underestimation of this effect in our study.

Multiple effective falls programs have been developed in the past years with promising results.[25] These programs should be further implemented and focused on the high-

risk groups, such as in women and the oldest old. Also, the use of proven effective bone quality improving drugs can be used to reduce the number of serious injuries due to falls according to the guidelines for osteoporosis treatment. Furthermore, optimization of medical treatment and social support to maintain independence living in older adults should be further developed.

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Table 1. Patient characteristics, annual numbers, and incidence rates of fall-related Emergency Department visits of older persons (aged 65 years or older) with admission characteristics and discharge locations (The Netherlands, 2003-2007)

Characteristic	**Overall ≥65 yr**	**65-74 yr**	**75-84 yr**	**85-94 yr**	**≥95 yr**
Population (X 1,000 persons)	2,273	1,247	787	224	18
Annual number of ED visits (n)	67,300	22,100	27,850	15,770	1,470
Incidence (per 1,000 persons)	29.1	17.7	35.4	70.4	105.0
Female gender (%)	76	71	76	81	86
Hospital admissions (n)	22,170	4,940	9,540	6,970	720
Admitted (%)	32.9	22.4	34.2	44.0	44.6
Median length of stay (d)*	10 (4-17)	7 (3-12)	10 (5-18)	11 (6-20)	11 (5-19)
Discharge after hospitalisation (%)					
Home	68.5	83.1	68.3	59.5	60.2
Transfer	19.0	10.6	19.8	23.8	18.1
Long-term care	6.6	3.8	6.6	8.6	8.4
Deceased	5.9	2.6	5.3	8.1	13.3

Transfer, transferred to another hospital; Long term care, nursing facility and rehabilitation facility; Deceased, died during hospital admission. * 25^{th} to 75^{th} percentile; total numbers are different from the total count in the table because the counts have been rounded.

Table 2. Top 5 injuries due to falls in older persons (aged 65 years or older) presented at the Emergency Department, specified for gender and age group (The Netherlands, 2003-2007)

	Description	**%**	**Description**	**%**	**Description**	**%**
Males	65-74 yr (N=5,970)		75-84 yr (N=6,120)		≥85 yr (N=3,019)	
	Superficial wounds	26.8	Superficial wounds	26.1	Hip fracture	28.5
	Wound head/face	9.0	Hip fracture	18.0	Superficial wounds	24.8
	Skull/brain injury	7.5	Wound head/face	8.5	Wound head/face	8.5
	Hip fracture	7.0	Skull/brain injury	7.2	Skull/brain injury	5.4
	Wrist fracture	5.9	Wrist fracture	4.9	Wrist fracture	4.0
Females	65-74 yr (N=15,650)		75-84 yr (N=21,280)		≥85 yr (N=14,060)	
	Superficial wounds	19.8	Superficial wounds	19.3	Hip fracture	25.5
	Wrist fracture	16.6	Hip fracture	16.4	Superficial wounds	21.3
	Hip fracture	7.0	Wrist fracture	15.0	Wrist fracture	9.2
	Ankle fracture	5.3	Upper arm fracture	5.2	Upper arm fracture	4.1
	Elbow fracture	5.0	Clavicula/Scapula fracture	4.7	Femur shaft fracture	4.0

Table 3. Annual numbers, incidence rates, admission characteristics optimization, and healthcare costs of fall-related injuries in older persons (aged 65 and older; The Netherlands, 2003-2007)

	ED visits		Admissions		Healthcare costs		
Diagnostic group	**Number**	**Incidence†**	**Percent**	**LOS**	**Total (1,000)***	**Per case**	**Costs (%)**
Superficial injury, including contusions	14,000	6.1	10.9	6 (2-11)	€31,064	€2,219	6.5
Hip fracture	11,000	4.6	94.6	12 (8-20)	€200,450	€18,223	42.3
Wrist fracture	7,900	3.4	6.1	2 (2-4)	€21,303	€2,697	4.5
Wound head/face	3,300	1.4	23.5	2 (1-4)	€13,448	€4,075	2.8
Upper arm fracture	2,900	1.3	17.4	6 (3-12)	€16,128	€5,561	3.4
Clavicle/scapula fracture	2,800	1.2	13.7	4 (2-9)	€14,924	€5,330	3.1
Skull/brain injury	2,550	1.1	64.5	3 (2-10)	€36,418	€14,281	7.7
Hand/fingers fracture	2,200	0.9	1.7	1 (1-2)	€4,991	€2,269	1.1
Elbow/forearm fracture	2,100	0.9	19.0	3 (2-7)	€9,890	€4,710	2.1
Ankle fracture	2,000	0.9	29.8	8 (4-15)	€11,110	€5,555	2.3
Open wounds	1,800	0.8	7.7	8 (3-17)	€3,128	€1,738	0.7
Femur shaft fracture	1,700	0.7	93.4	14 (9-23)	€32,300	€19,000	6.8
Pelvis fracture	1,500	0.6	56.1	11 (6-18)	€16,170	€10,780	3.4
Foot/toes fracture	1,500	0.6	4.4	5 (2-10)	€2,960	€1,973	0.6
Fracture knee/lower leg	1,400	0.6	47.7	12 (6-20)	€13,013	€9,295	2.7
Subtotal	58,650	25.3	33.9	10 (3-17)	€427,297	€7,180	90.1
Other	8,650	3.9	27.5	8 (4-16)	€47,064	€6,154	9.9
Total overall	67,300	29.1	32.9	10 (4-17)	€474,361	€7,048	100.0

LOS: Length of hospital stay in days, median length of stay (25^{th} -75^{th} percentile).

†Incidence rate per 1,000 person years.

Injuries to internal organs, complex soft tissue injuries, eye injuries, and injuries to the spinal cord were rare and therefore not shown in the table.

Table 4. Prevalence of functional problems on the five dimensions of the EQ-5D and cognition at 9 months after a fall-related injury in patients aged 65 year or older in The Netherlands

Injury-group	Mobility (%)	Self-care (%)	Usual activities (%)	Pain/ Discomfort (%)	Anxiety/ Depression (%)	Cognition (%)
Population norm	37.9	8.3	21.9	41.4	12.1	11.4
Hip fracture	90.0	54.4	73.3	69.1	26.9	37.7
Upper arm fracture	32.2	30.3	52.7	61.0	13.7	9.5
Skull/brain injury	44.8	21.7	31.0	40.8	24.8	32.2

Figure 1. Quality of Life up to 9 months after presentation at the Emergency Department in persons aged 65 years or older due to a fall incident in The Netherlands between 2003 and 2007