Fall-related injuries in Amsterdam: Frail older women at risk

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ABSTRACT
Unintentional falls are a common cause of injury, especially among older persons. This study evaluates risk factors such as gender and age on morbidity and mortality after unintentional falls. Data were collected retrospectively for patients with an unintentional fall who were presented to the emergency department in 2013. A total of 3,217 patients were included; the majority were female. Patients over 65 years of age had a significant higher mortality and a longer length of hospital stay. Older women are at risk for sustaining a fall-related injury. Female gender is furthermore associated with increased length of stay in the hospital. Prevention should focus especially on these frail patients.

KEYWORDS
Accidental falls; older persons; risk factors

Introduction

In the geriatric population unintentional falls are a common occurrence, leading to an increased health-care utilization and even death. The older female population has a higher risk of falling, among others, due to a decrease of gait speed influencing their walking ability (Baker, O’Neil, & Karpf, 1987; Cumming, Nevitte, & Cummings, 1997). To allocate resources properly, it is important to examine epidemiological trends in trauma-related morbidity and mortality. In Europe alone, 14% of all disability-adjusted life years and 7% of all deaths are the result of trauma, and of these injuries the majority are unintentional injuries (Baker et al., 1987; WHO, 2011). In the United States falls cause 45% of unintentional trauma-related mortality; this is even higher for women (CDC, 2011; WHOE 2005). Falls in people above the age of 65 years are of special concern since only 50% of these seniors will live more than a year after sustaining a fall (Johnson et al., 2011).

Research in the Netherlands showed a 137% increase in the number of fall-related hospital admissions from 1989 through 2008 (Hartholt et al., 2010). Because of the aging population, the burden of disease for fall-related injuries is expected to have increased by 50% by 2025 (Burge et al., 2007). Fall-related injuries that result in hospital admissions are generally fractures. Approximately 10% of all falls result in fractures, most frequently hip fractures (50%), fractures of the extremities (13%), or head injuries (10%) (Bergeron et al., 2006; Nachreiner, Fidoroff, Wyman, & McCarthy, 2007). Hip fractures have a relatively high mortality, especially in women in the first 3 months after trauma (Gillespie et al., 2010). Furthermore, minor repercussions such as lacerations, strains, and sprains can have serious consequences, especially for older people, such as social isolation (Hartholt et al., 2011). This can even result in decreased functional status and a higher chance of placement in a nursing home (Gill, Murphy, Gahbauer, & Allore, 2013). Because of the continuous aging in the global...
population, it is likely that falls will remain a major public health problem in the future (Kannus, Niemi, Palvanen, & Parkkari, 2000). It is expected that the portion of the population that is aged over 65 years will make up to 25% of the general population in 2040 in the Netherlands (CBS, 2009).

Much has been written on the incidence of fall-related injuries among older persons; however, less is known on exact data for fall environments, risk factors, and related injuries. In Amsterdam, many houses are not equipped with elevators, so staircases are mostly used to travel up the frequently four-storey buildings. Therefore one could theorize this environment to be of influence on fall-related emergency department (ED) visits. In the Netherlands not much comparative data are available (van Hensbroek, Mulder, Luitse, van Ooijen, & Goslings, 2009). In order to create possible systemwide prevention programs, ED data might provide valuable information on fall environment and setting. The aim of this study is to describe the trends in fall-related morbidity and mortality and to assess fall settings and risk factors, with special focus on the geriatric patient and staircase-related falls in our region. To generate a fall risk assessment we conducted a retrospective observational study on all fall-related injuries and what patient characteristics are of influence on their outcome.

**Method**

**Data collection**

This is a retrospective observational cohort study. All patients who visited the ED of one of the following hospitals—VU University Medical Center (VUMC), Amstelland Hospital (AH), or Slotervaart Hospital (SH)—in Amsterdam with a fall-related injury in the year 2013 were included. These fall-related injuries include all nonintentional falls in and around the domestic or work area. This includes all falls, falls on stairs, or falls from ladders. Exclusion criteria were injuries sustained in traffic or while playing sports, falls from a height >5m, intentional injuries or jumps, or when an object fell on a patient. Data were obtained using the National Regional Trauma Database (NRTD) located at the VUMC. This is a registration system for all trauma patients in the Netherlands. NRTD data of the SH and AH are likewise stored at the VUMC. After approval for the use of data from the SH and AH, the NRTD was searched by using a query in the free-text field box of the description of the mechanism of trauma. The mechanism of trauma was manually confirmed (AMK and RME). Variables that were retrieved were patient demographics such as age and gender; details on the trauma mechanism such as date of the injury (time, day, month); involvement of stairs; patient data on intoxication status during injury; and in-hospital data on length of stay (LOS), number of days of Intensive Care Unit (ICU) admission, Injury Severity Score (ISS), Revised Trauma Score (RTS), Glasgow Coma Scale (EMV), and in-hospital mortality. Due to the retrospective and observational character of this study, this research does not apply to the WMO law (Onderzoek VCM, 2012) and therefore does not have to be reviewed by the institutional medical ethical review board.

**Analysis**

The statistical data analysis was performed using the SPSS 21.0. statistical analysis program (SPSS Inc., Chicago, IL). The main outcome measure was descriptive statistics: Continuous data are reported as medians (5–95 percentiles with Inter Quartile Rage [IQR]) for squid data and as means with standard deviations (SD) for normally distributed data. Proportions are given in numbers and percentages. Groups are compared using the χ² test for qualitative data or t-test and ANOVA test for quantitative data. All three hospitals are analyzed together for the length of stay (LOS), mortality, and correlation with age, gender, and staircase involvement. Logistic regression analysis was used to assess predictors of mortality or LOS reported as OR with 95% CI. The predictors that are assessed are gender, age, alcohol intoxication, ISS, RTS, EMV, and involvement.
of stairs. The variable age will be analyzed as a continuous variable as well as using two divisions: separating adults from children (age <18 or ≥18) and the geriatric population (age <65 or ≥65). P values were two-tailed and at a level of significance of .05; for the logistic regression analysis a level of significance of 0.15 was used.

**Results**

In 12 months, a total of 3,502 patients were presented at the EDs of the three participating hospitals with a fall-related injury; 285 patients were excluded (Figure 1). Reasons for exclusion were traffic accidents, sport-related injuries, fall from a height >5m, as well as intentional injuries or jumps or cases in which objects fell on a patient, leaving 3,217 presentations to be included for further analysis. Patient demographics are shown in Table 1. The median age was 54 years. The majority of patients visiting the ED were female (56.2%). The average age in the female group was higher than the average age of men, respectively 56.2 and 39.8 years old. The distribution of fall frequency across age is depicted in Figure 2. The Medical Mobile Team was involved in only 17 cases. In 723 fall accidents stairs were involved. Most patients were presented in the afternoon (40.6%), followed by the evening, morning, and night (respectively 28.9%, 21.4%, 9.0%, p = .000). In January, 312 patients visited the ED with a fall-related injury; this was significantly higher than other months analyzed (p = .014). In 3.6% (n = 116) of all presentations the patient was intoxicated, of which 113 cases were alcohol related. Of all patients, 36.18% were admitted to the hospital. Patients who were admitted to the hospital had an average length of stay of 6.73 days (± SD 9.65). The 95 patients who were admitted to the ICU had an average ICU admission of 3 days (IQR: 2–7). Eleven patients (0.3%) died as a result of their injuries, of whom seven were female. The differences in frequencies between older persons and the young as well as between the staircase-related and the non-staircase-related injuries are also depicted in Table 1.

We analyzed how alcohol and gender, age, and involvement of staircases were correlated at p level as shown in Table 2. A statically significant correlation (p < .05) between alcohol consumption and gender or the involvement of staircases was found. More men were intoxicated than women while falling, and alcohol was more frequently used in nonstaircase falls. We furthermore noticed

![Figure 1](Link_to_Figure) Flowchart: Number of included and excluded patients.
significant differences between alcohol consumption and age. Of the patients who were intoxicated while falling, 76.1% (n = 86) were in the age group of 18–65 years of age. When reviewing mortality, a significant correlation was found with age: Patients above the age of 65 years were more likely to die as a result of their injuries. Furthermore, there was a positive significant correlation between mortality and RTS of the patient; however, there was no significant correlation with EMV, ISS, or the involvement of staircases. When reviewing LOS, a significant positive correlation was found with age: Patients above the age of 65 years were more likely to have a longer LOS than the patients below the age of 65 years (5.38 versus 7.97 days, p < .05). The comparison of the ISS revealed similar

| Table 1. Patient demographics: Young versus older persons and stairs versus no stairs involved. | N (%) | N (%) <65 | N (%) ≥ 65 | p | N (%) stairs | N (%) no stairs | p |
|---|---|---|---|---|---|---|---|
| Patients | 3217 (100.0) | 1946 (60.5) | 1271 (39.5) | | 723 (22.5) | 2494 (77.5) | |
| Male | 1409 (43.8) | 1036 (53.2) | 373 (29.3) | p < 0.05 | 340 (47) | 1069 (42.9) | 0.047 |
| Age median (IQR) | 54 (20–77) | 26 (7–48) | 82 (74–88) | p < 0.05 | 40 (19–61) | 59 (21–81) | p < 0.05 |
| Transportation | 1861 (57.8) | 1387 (71.3) | 474 (37.3) | p < 0.05 | 449 (62.1) | 1412 (56.6) | 0.004 |
| Own transport | 1180 (36.7) | 457 (23.5) | 723 (56.9) | | 249 (34.4) | 931 (37.3) | |
| Ambulance | 17 (0.5) | 10 (0.5) | 7 (0.6) | 0.888 | 9 (1.2) | 8 (0.3) | 0.003 |
| Not involved | 3200 (99.5) | 1936 (99.5) | 1264 (99.4) | | 714 (98.8) | 2486 (99.7) | |
| Intoxication | 113 (3.5) | 89 (4.6) | 24 (1.9) | p < 0.05 | 43 (5.9) | 70 (2.8) | p < 0.05 |
| Yes | 1642 (51.0) | 955 (49.1) | 687 (54.1) | | 350 (48.4) | 1292 (51.8) | |
| No | 723 (22.5) | 560 (28.8) | 163 (12.8) | p < 0.05 | 1412 (56.6) | 2494 (77.5) | |
| Mean ISS ± SD | 7.85 (± 6.122) | 7.22 (±7.04) | 8.22 (±5.484) | 0.010 | 8.57 (±8.03) | 7.65 (±5.47) | 0.081 |
| Mean RTS ± SD | 11.16 (±1.61) | 11.11 (±1.67) | 11.19 (±1.59) | 0.582 | 11.34 (±1.42) | 11.11 (±1.66) | 0.110 |
| Mean EMV ± SD | 14.56 (±1.80) | 14.27 (±2.31) | 14.79 (±1.22) | p < 0.05 | 14.4 (±2.04) | 14.6 (±1.73) | 0.222 |
| Mean LOS ± SD | 6.73 (±9.65) | 5.38 (±11.70) | 7.97 (±8.43) | p < 0.05 | 5.48 (±8.13) | 7.49 (±10.12) | 0.005 |
| ICU days median (IQR) | 3 (2–7) | 3 (2–6) | 3 (2–10.7) | 0.417 | 3 (2–7.75) | 3 (2–7) | 0.676 |
| Mortality | 11 (0.3) | 2 (0.1) | 9 (0.7) | 0.004 | 1 (0.1) | 10 (0.4) | 0.287 |

Note. N = number, % in the total study population (unless noted otherwise); SD = standard deviation; MMT = mobile medical team; ISS = injury severity score; RTS = revised trauma score; EMV = Glasgow Coma Scale; ICU = intensive care unit; LOS = length of stay.
| Table 2. Correlations.                                                                 |
|---------------------------------------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| Alcohol +                                 | p              | CI             | Mortality      | p              | CI             | LOS mean ± SD  | p              | CI             |
| Total                                      | N = 113        |                |                |                |                |                |                |                |
| Gender                                     | Male           | 0.000          | (1.666, 3.536) | 4              | 0.619          | (0.215, 2.500) | 6.77 (± 10.95) | 0.439          | (−1.727, 0.750) |
|                                            | Female         | 7              |                |                |                |                |                |                |
| Stairs                                     | Yes            | 0.000          | (0.327, 0.675) | 1              | 0.287          | (0.372, 22.608) | 5.48 (± 8.12)  | 0.005          | (0.607, 3.424)  |
|                                            | No             | 10             |                |                |                |                |                |                |
| Age                                         | < 18           | 0.000          | (0.031, 0.303) | 1              | 0.271          | (0.043, 2.606) | 1.24 (± 1.14)  | 0.000          | (−7.469, −6.121) |
|                                            | ≥ 18           | 10             |                |                |                |                |                |                |
|                                            | < 65           | 0.000          | (1.626, 3.924) | 2              | 0.004          | (0.031, 0.671) | 5.38 (± 11.70) | 0.000          | (−3.788, −1.390) |
|                                            | ≥ 65           | 9              |                |                |                |                |                |                |
| Alcohol                                    | Positive       | 0              | 0.457          | 5.24 (± 14.32) | 0.112          | (−0.502, 4.798) |                |                |
|                                            | Negative       | 8              |                | 7.39 (± 9.96)  |                |                |                |                |
| Arrival day                                 | Monday         | 0.027          | 1              | 6.26 (± 7.47)  | 0.325          |                |                |                |
|                                            | Tuesday        | 0              | 0.015          | 6.86 (± 10.08) |                |                |                |                |
|                                            | Wednesday      | 0              |                | 7.58 (± 10.83) |                |                |                |                |
|                                            | Thursday       | 4              |                | 8.64 (± 10.89) |                |                |                |                |
|                                            | Friday         | 0              |                | 6.78 (± 11.60) |                |                |                |                |
|                                            | Saturday       | 5              |                | 7.33 (± 9.68)  |                |                |                |                |
|                                            | Sunday         | 1              |                | 6.15 (± 6.64)  |                |                |                |                |
| LOS mean (±SD)                             | 5.24 (± 14.32) | 0.112          | (−0.502, 4.798)| 8 (±8.22)      | 0.762          | (−7.030, 5.150) |                |                |
results: Older persons showed higher ISS than those younger than 65 years (7.22 versus 8.22, \( p = .01 \)). We found no statistically significant correlation between LOS or mortality and alcohol intoxication.

Logistic regression analysis was used to assess the influence of alcohol consumption, involvement of stairs, EMV, RTS, ISS, age, and gender as risk factors for mortality or LOS. Linear regression analysis showed that there was no statistical significant effect on mortality (\( R^2 = 0.022, p = .836 \)). However, there was a significant influence seen on LOS (\( R^2 = 0.229, p < .05 \)) (Table 3).

**Discussion**

This study shows age to be a significant risk factor for fall-related injuries, as previously reported in other studies (WHO, 2012). In our cohort, older women are at much greater risk of falling, as can be observed in the bimodal distribution of the sample (Figure 2). The increased risk in the female population could be due to an increased mean age; women still have a higher life expectancy than men do. Women tend to outlive men, which may explain the disproportionate effect in the female population. Furthermore, women are more prone to develop impairments in their mobility due to the loss of muscle mass because their baseline muscle mass is lower than that of men, and loss of muscle mass reduces muscle strength. Moreover, women tend to develop arthritis of the hip more frequently and have a lower bone mineral density, which decreases neuromuscular functions and reduces mobility (CBO 2004, Lanting, Stam, Hertog, & Brugmans, 2005; Laecken, 2003, Stel, 2003). As women age, there might be an accumulation of risk factors that are associated with the increased risk of falling. Therefore, the increased risk of falling is probably not only intrinsic to aging itself. The difference in fall frequency between men and women could also be attributed to older adults’ gender role expectations for household chores: Women continue to engage in their household activities whereas elderly men do not (Stahl & Albert, 2014). When reviewing the influence of age on mortality, a higher overall mortality rate is seen among the geriatric population presenting with trauma than among the adult population (Hashmi et al., 2014). However, we were not able to find this correlation using regression analysis. This could be due to the low number of mortalities in this cohort and the difference in included trauma patients; whereas, we review relatively low-impact trauma mechanisms compared to a combined mechanism of trauma that also includes high-energy traumas. Nevertheless, we did see a correlation with an increased mortality for the overall older population when a divide was made between young and older persons.

When reviewing the consumption of alcohol as a risk factor for fall-related injuries, this was not shown to be a risk factor for the older population. In the younger group it is associated with a higher risk of falling; this group also tends to fall more frequently on weekend days than weekdays. This can be explained due to the fact that it is likely that young people drink more on the weekend, which is in concordance with the literature (WHOE, 2005); whereas the older group has a distributed fall

| Model | Unstandardized coefficients | Standardized coefficients | 95.0% confidence interval for B |
|-------|-----------------------------|--------------------------|-----------------------------|
|       | \( B \) | Std. error | Beta | Sig. | Lower bound | Upper bound |
| 1 (Constant) | \(-7.794\) | 15.582 | .618 | \(-38.575\) | 22.986 |
| Alcohol | \(-4.844\) | 2.185 | \(-.168\) | .028 | \(-9.161\) | .527 |
| Stairs | \(-.122\) | 2.044 | \(-.005\) | .952 | \(-4.161\) | 3.916 |
| EMV | .757 | .993 | .056 | .447 | \(-1.204\) | 2.718 |
| RTS | \(-.120\) | .404 | \(-.022\) | .766 | \(-.918\) | .677 |
| ISS | .540 | .147 | .271 | .000 | .250 | .831 |
| Age | .099 | .028 | .278 | .001 | .043 | .155 |
| Gender | \(-2.666\) | 1.516 | \(-.133\) | .081 | \(-5.661\) | .328 |

*Dependent variable: LOS.

Table 3. Regression analysis.
frequency throughout the week. Additionally, more than one in three presentations resulted in hospitalization. The actual ratio, however, could be lower because we only had access to the data of the admitted patients of the AH and SH, excluding those who were discharged immediately or were treated in our out-patient clinic. The average LOS of 7 days is long in comparison with the study of van Hensbroek et al., who reports on a median LOS of 3 days (van Hensbroek, 2011), though comparison is difficult since they analyzed only 61 who were admitted to the hospital. The small number of patients who required hospitalization could explain the difference in length of hospital stay. When reviewing risk factors for increased LOS, we found a significant relationship with the regression analysis for alcohol, involvement of stairs, EMV, RTS, ISS, age, and gender. Older persons were hospitalized nearly 2 days longer than patients below the age of 65 years; these results are compatible with Ghodsi et al. (2003), whose study showed that the duration of hospitalization in older patients (≥65 years) was 8.3 and in younger patients (<65 years) 6 days.

We were unable to find a correlation between the involvement of stairs and mortality, though this was expected at inception. The risk of death increases with increasing height of the fall on stairs, as described by Wyatt et al. (1999). In our study we excluded patients with falls from heights greater than 5 meters. This would explain why we found no correlation between falls on stairs and mortality. Furthermore, we present a relatively low number of casualties. In our data set only 11 people died, and 723 patients fell down stairs, of which one died. Our results are in agreement with van Hensbroek et al.: Out of a total of 464 falls on stairs, only two patients died; likewise there was no correlation. In order for the perceived increase in the number of patients presented to the ED because of a fall-related injury to be measured, we hereby present baseline data.

Due to the retrospective and observational character of this study, this research had some limitations. For one, we were limited to the data that were available through the databases. Second, though this is a relatively frequently occurring phenomenon, there are low numbers of outcome measurements reported, making it difficult to correlate. In our study we had a total of 11 dead patients, which could explain why we were unable to find a significant relation between age and fall from stairs on mortality with our regression analysis. Another limitation in our study was the missing data for some variables: Alcohol intoxication, EMV, RTS, and ISS register. Therefore, we were unable to find a correlation with these variables. To further study the influence of gender on mortality and morbidity, it is necessary to perform a prospective study. Considering the scope of the problem of fall-related morbidity, it is of interest to focus on injury prevention to create a safer environment and stimulate safe behavior for those at risk. One could think of physical exercise for older women to improve muscle strength, balance, and mobility, or nationwide awareness programs.

**Conclusion**

This study analyzes all accidental falls suffered by a specific population during 2013. In the literature there are several studies on falls in the population but few in which they discuss what factors were present prior to falling and what factors influence morbidity or mortality. We have reviewed the influence of pre-hospital-stay risk factors such as age; gender; use of alcohol; the involvement of stairs; and time of day, week, and month in which the fall occurred on the outcome for the patient. In our population frail older women are at a higher risk of falling. Of the 11 people who died as a consequence of their injuries, nine were above the age of 65 years. Furthermore, we found a higher percentage of alcohol-related falls in the younger cohort of our population, especially during the weekend. Several risk factors for an increased length of hospital stay after fall-related injuries are shown, namely, alcohol intoxication, involvement of stairs, EMV score, RTS, ISS, age, and gender. There was no relationship between the risk factors and mortality; this could be due to the low number of casualties in our cohort. Therefore, further research into the
environment of fall-related injuries and risk factors needs to be done in order to create prevention programs, with special emphasis on the female and older population.

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