End of the spectacular decrease in fall-related mortality rate: men are catching up

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Abstract

Objective: Determine time trends in numbers and rates of fall-related mortality in an aging population, for men and women.

Methods: Secular trend analysis of fall-related deaths in the older Dutch population (persons aged 65 years or older) from 1969 throughout 2008, using the national Official-Cause-of-Death-Statistics.

Results: Between 1969 and 2008, the age-adjusted fall-related mortality rate decreased from 202.1 to 66.7 per 100,000 older persons (decrease 67%). However, the annual percentage change (change per year) in mortality rates was not constant, and could be divided in three phases. First, a rapid decrease until the mid-eighties [men -4.1% (95%CI: -4.9; -3.2), women -6.5% (95%CI: -7.1; -5.9)]. Second, flattening of the decrease until the mid nineties [men -1.4% (95%CI: -2.4; -0.4), women -2.0% (95%CI: -3.4; -0.6)]. Third, stable mortality rates for women 0.0% (95%CI: -1.2; 1.3) and rising rates for men 1.9% (95%CI: 0.6; 3.2) over the last decade.

Conclusion: The spectacular decrease in fall-related mortality has ended, and is currently rising in older men to similar rates as seen in women. Due to the ageing society, absolute numbers in fall-related deaths are increasing rapidly.

Keywords: fall incidents, mortality rate, older adults, trend, the Netherlands

Introduction

Unintended falls present a major public health problem worldwide.(1-3) The World Health Organization has estimated that approximately 392,000 people worldwide died due to an unintended fall in 2004.(4) According to the Centers for Disease Control and Prevention in the United States, unintended falls are the leading cause of fatal injuries among older adults.(5)

Falls in older adults mainly occur in or around the home and their cause is often multifactorial.(6) Risk factors associated with fall incidents include a higher age, female gender, use of fall-risk-increasing medication, and co-morbidities.(7) Approximately a third of all community-dwelling persons aged ≥65 years fall annually (7, 8) which leads to a high healthcare demand, morbidity and mortality.(2, 9-13) The incidence rate of falls is age- and gender dependent. The majority of falls and related injuries occur in older females (≥75 year).(9, 14, 15) Furthermore, the incidence rates of fall-related injuries among older adults increased over the past 30 years.(3) New guidelines and preventive strategies have been developed in order to reduce falls among older adults. (16)

Absolute numbers of fall-related deaths are rising due to ageing societies worldwide.(17) In the Netherlands, the absolute number of persons aged ≥65 years is expected to double, up to 25% of the population in 2040 (15% in 2008).(18) The figures of aging societies are comparable to worldwide trends.(19) Due to the expanding older population, based on an increasing life expectancy, an increase in absolute numbers of fall-related deaths might be expected in the near future. In order to investigate how fall-related mortality in persons aged ≥65 years developed over time in the Netherlands, absolute numbers of fall-related deaths and adjusted mortality rates corrected for demographic changes were quantified from 1969 throughout 2008. In the older population, significant health differences between both genders have been demonstrated (20) and it is known that temporal

trends in disease mortality may show large gender differences as well.(21, 22) Therefore separate analyses for males and females were conducted, which were further specified by age-group.

Methods

Mortality data were obtained from the public accessible electronic database(23) of the Statistics Netherlands (CBS), including the Official-Cause-of-Death-Statistics (OCDS), in which the data is stored in 5-year age-groups for both genders during the study period. Data on unintended fall-related deaths of persons aged ≥65 years were collected between 1969 and 2008. An unintentional fall was defined using the International Classification of Diseases of the World Health Organization (8^{th} revision, code E880-E887; 9^{th} revision, code E880-E888; 10^{th} revision W00-W19, X59.0), *i.e.*, slipping, tripping and stumbling.

The Statistics Netherlands collects mortality data with a uniform classification system and has almost complete national coverage (99.7% in 2008). The OCDS is based upon the registration of the cause of death, by an official death certificate, which is required in all cases of death.(24) A death certificate may only be completed by the consulting physician who declares the patient dead or by a coroner. The death certificate includes data on age, gender, location, cause of death and co-morbidities that contributed to the death. Completeness and acceptability of the death certificates is verified with the national birth registry. In cases of uncertainty, the physician who completed the death certificate is contacted to provide additional information. In case of a non-natural death (*e.g.*, traffic accident, fall, or suicide) the coroner can perform an official autopsy to determine the official cause of death.

Numbers of fall-related deaths were specified for age and gender. The age-specific mortality rates were calculated in 5-year age groups using the number of the fall-related deaths in that specific age group, divided by the population size within that specific age-group for male and female patients, and was expressed per 100,000 persons in that age-group. Age-adjusted incidence rates allowed us to compare the incidence rate for a standardized population during the study period, and were performed by 'Direct Standardization' to correct for demographic changes throughout the study. The age-adjusted incidence rate is therefore

the outcome of interest. The mid-year population was used for each year of the study. Data on demographics were obtained from the Statistics Netherlands. Mortality data were absolute numbers covering the whole Dutch population.

Statistical analysis

In order to model the trend in fall-related mortality, a regression model with Poisson error and log link was built with log mid-year population size of each year of the study as offset factor. This model gives evidence of increasing linear trends, stable trends over time, or decreasing trends. To assess whether the trend was stable, or changed during the study period, a Joint-Point regression analysis was used. This analysis identifies points where a statistically significant change over time occurred in the linear slope of the trends in fall-related mortality rates (Join-Point Regression Program, Version 3.4.3. Statistical Research and Applications Branch, National Cancer Institute, USA). The Joint-Point function accommodates piecewise linear fits, connected with one another at the best Joint-Point (25), and showed the necessity for assuming a spline instead of a simple linear model. In Joint-Point analysis, the best-fitting points correspond to where the rate changes significantly (*i.e.*, increases or decreases). The analysis starts with the minimum number of joint points and tests whether one or more joint points are statistically significant in the model and should be added. In the final model, each joint point indicates a statistically significant change in trend, and an annual percentage change is computed for each of those segments by means of generalized linear models assuming a Poisson distribution. The best joint points were used for the analysis, and divided the study in three periods (1969-1983; 1984-1996; 1997-2008). The parameter for calendar year, corrected for gender and age-group was transformed into Percentage Annual Change (PAC). Interactions of the spline for gender were added and tested in order to investigate differences in trends for genders. Statistical analyses were performed using SPSS software (version 16.1.1). A p-value <0.05 was considered as statistically significant.

Results

General information

The population aged ≥65 years increased from 1.3 million in 1969 to 2.4 million in 2008, representing 10.0% and 14.7% of the Dutch population, respectively. Approximately 90% (63,463) of all fall-related deaths in the Netherlands during that time-span occurred in the population aged ≥65 years (Table 1).

Absolute numbers

The absolute number of fall-related deaths in persons aged ≥65 years annually decreased from 1,927 in 1969 to 1,312 deaths in 1985, but since the mid 1980's the number of deaths has shown a persistent increase to 1,892 in 2008 for men and women together (Figure 1). The majority of fall-related deaths occurred in the population aged ≥85 years, which represented an increasing share in the proportion of fall-related mortality among older persons, from 37% in 1969 to over 50% since 1985 (Table 1).

Gender and age-specific mortality rates

Gender and age-specific fall-related mortality rates in persons aged ≥65 years decreased in all age-groups, both for men and women throughout the study period. However, age-specific rates of fall-related mortality increased with age, and continued to be highest among adults over 95 years for both men and women (Table 2).

Trends in age-adjusted mortality rates for males and females

During the whole study period (1969-2008) the PAC for the age-adjusted fall-related mortality rate decreased with -1.54% (95% CI: -1.66; -1.43, $p<0.001$) per year in older men and by -3.61% (95% CI: -3.69; -3.53, $p<0.001$) per year in older women. The Joint-Point

regression analysis revealed that the PAC in mortality rate was not stable over time and can be divided in three phases (see Figure): Until the mid-eighties the PAC in mortality rates due to a fall decreased strongly in both men (-4.1%, 95% CI: -4.9; -3.2, $p<0.001$) and women (-6.5%, 95% CI: -7.1; -5.9, $p<0.001$). Subsequently, after that period until the mid-nineties the decrease leveled off in both men (-1.4%, 95% CI: -2.4; -0.4, $p<0.001$) and women (-2.0%, 95% CI: -3.4; -0.6, $p<0.001$). Finally, over the last decade, the age-adjusted mortality rate remained stable among older women (0.0%, 95% CI: -1.2; 1.3, $p=0.97$) and started to rise again in older men (1.9%, 95% CI 0.6; 3.2, $p=0.005$).

In 1969, the age-adjusted mortality rate for women (260.4 per 100,000 persons) was twice as high as for men (119.4 per 100,000 persons). However, the rates for men are catching up with those of women. In 2008 the age-adjusted mortality rates were 69.8 per 100,000 older women and 62.8 per 100,000 older men (Figure 1).

Discussion

This observational study was based upon the OCDS of the Statistics Netherlands. The aim was to determine secular trends in fall-related mortality in persons ≥65 years. The spectacular reduction in the age-specific and age-adjusted fall-related mortality rate in the seventies and eighties of the previous century has ended in the mid-nineties. Moreover, since then, mortality rates due to falls are rising among older men to similar rates as seen for women.

A strength of this study is the accurate OCDS monitoring of nearly all deaths in the Netherlands (99.7% in 2008), which allowed us to assess long-term trends over an extensive period of 40 years, covering the whole Dutch population. Since the database is verified with the national birth registry,(24) the mortality rates and numbers presented are real figures rather than estimates of the entire older Dutch population.

Petridou *et al* found decreasing trends in unintended fall related mortality rates in persons aged 65 years and older for most European countries, but this study did not go beyond 2002 and may have been conducted too early to pick up unfavorable trends within the first decade of the 21st century.(26). Similar trends in fall-related mortality as observed in our study were seen in Finland, with a recent increasing trend for men and a stable rate for women.(27) The observed change in the trend in fall-related mortality rates in the final period of our study might be explained by an increasing life expectancy, which is accompanied by a prolonged period of co-morbidities and disabilities.(28) Our hypothesis is that the fall-related mortality mainly occurs among older adults who are frail, resulting in an increased fall-risk and less functional reserve to cope with the consequences of falls. It is not likely that migration has significantly affected the observed mortality trends to a large extent, since the proportion of migrants is only 4% of the older Dutch population and no significant differences in fall-related mortality by ethnic background exist in the Netherlands.(29)

Although the age-specific mortality rates remained highest among women, the mortality rates of men are catching up to the mortality rate of women. A possible explanation for this finding could be that the life expectancy in men increased more rapidly than in women over the last decades, resulting in a smaller gap in the life expectancy between men and women.(28) Consequently, men become more vulnerable for age-related (co)morbidities over a prolonged period of life. This assumption is supported by our previous report on a more rapid increase in fall-related hospitalizations in older men than in older women in the Netherlands.(3, 30) Since age itself is an independent risk factor for falls,(31) the number of falls will grow with an increasing life expectancy.

The shift in mortality rates could also be based upon gender-specific injury patterns that have been demonstrated for men and women.(9) Fractures are the main fall-related injuries in women. Fracture treatment, especially for hip fractures, has improved rapidly over the last decades, and might have contributed to the decreasing fall-related mortality rates. Men however, present more often with severe skull-brain injuries,(1) with fewer therapeutic options. These gender-specific injury patterns, together with the differential increase in life expectancy, may have contributed to the (near) closure of the gap between the fall-related mortality rates between men and women.

A limitation of the current study is that the numbers and incidence rates of fall-related mortality among older Dutch adults might not be directly generalizable to other populations. However, absolute numbers and rates of fall-related mortality also increased in the USA(32) and Finland(2) over recent years, which shows that our findings are not unique and could possibly indicate a universal phenomenon for western countries. Further studies are required to show similar trends for other countries.

In addition, during the study period, new versions (9^{th} and 10^{th} revision) of the ICD classification system were published and implemented in the OCDS, which may have led to changes in the coding of subgroups of falls. The code for ‘falls’ in the ICD 8^{th} and 9^{th} revision

included a category 'Fractures unspecified'. In the ICD 10th revision, this code has been replaced by code X59.0 (*i.e.*, fracture, cause unspecified). Analysis of coroner reports by Statistics Netherlands has shown that nearly all fractures contributing to the mortality cases in older adults are caused by a fall. Because of these findings, after introduction of ICD10, Statistics Netherlands decided to include all cases with the code X59.0 within the category of falls. In our study we followed this decision and included all codes X59.0 in the analysis to avoid artificial trend interruptions in our time series analyses due to changes in registration practice and/or coding. However, the WHO and Euroipn analytical databases do not include X59.0 in the category of falls, which must be considered and comparing our findings with studies using these databases.

For comparative purposes, a sensitivity analysis of trends in fall-related deaths was conducted from the introduction year of ICD10 (1996) onwards under different assumptions concerning the cause of fractures, cause not specified (X59.0). The sensitivity analysis showed that the addition of the code X59.0 did not inflate our time trend figures, but has instead produced a conservative estimate of unfavorable developments in the most recent period of our study (1997 – 2008).

Mortality rates are a combination of injury incidence and case-fatality rates.(33) In a recent study we have shown that the incidence of severe fall-related injuries requiring hospitalization increased with 61% to over 30,000 annually in the Netherlands between 1981 and 2008.(3) The decreasing rate of fall-related mortality makes it therefore likely that the case-fatality rate of fall incidents has dropped. The decrease might be explained by several factors. During the study period new diagnostic tools like Computed Tomography and Magnetic Resonance Imaging have been introduced. Also standardized protocols for treatment of trauma patients at the Emergency Department have been introduced, such as the Advanced Trauma and Life Support.(34) Furthermore, new and better treatment possibilities were developed during the study period, *e.g.*, osteosynthesis material and Intensive Care

Units. The possible effects of all these factors cannot be specified, but it is unlikely that the introduction of falls prevention guidelines had a strong effect on fall-related mortality, since the guidelines were only introduced in the Netherlands after the year 2000.(35) Fall-risk and hence fall-related mortality in general, may be rising because of increased mobility of frail elderly, due to the use of walking aids and other equipment (*i.e.* electric mobility scooters), which is seen in among others the Netherlands and the United States.(36, 37) As a result of sustained walking abilities, these older persons remain at risk for fall incidents. Another potential cause that has been shown to contribute to an increased fall-risk in older adults, is a more active lifestyle (*e.g.*, sports participation).(38)

In conclusion, the spectacular decrease in fall-related mortality since 1969 has ended around the mid-nineties. Currently the mortality rates in women are stable and they are increasing in older men. Falls are expected to become an even more serious cause of death in the near future due to aging societies worldwide. In recent years, the health care system has not been able to compensate fully for the ageing society and for rising numbers of fall-related injuries. These findings indicate the need for further research identifying factors which can be used to reduce fall-related mortality among older adults and to control for the recent unfavorable trend.

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Human Participant Protection

The institutional review board of the Erasmus MC, University Medical Center Rotterdam, approved the study protocol (ref. MEC-2010-402).

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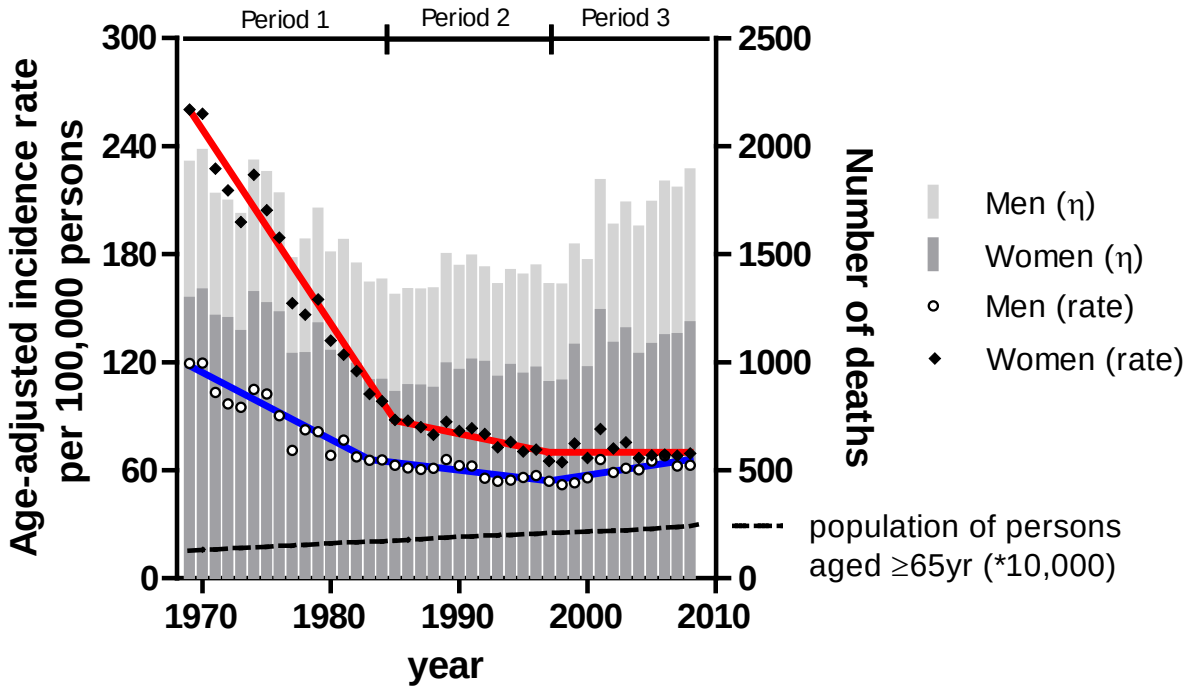
Table 1. Absolute number of fall-related mortality in the Dutch population, 1969-2008

	<65 year		65-69 year		70-74 year		75-79 year		80-84 year		≥85 year		Total
Period	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**
1969-1974	1,322	10.7%	525	4.2%	960	7.8%	1,906	15.4%	3,087	24.9%	4,577	37.0%	12,377
1975-1979	831	9.0%	355	3.8%	632	6.8%	1,267	13.7%	2,178	23.5%	3,989	43.1%	9,252
1980-1984	774	9.6%	257	3.2%	490	6.1%	1,027	12.8%	1,700	21.1%	3,804	47.2%	8,052
1985-1989	729	9.6%	207	2.7%	375	5.0%	864	11.4%	1,505	19.9%	3,879	51.3%	7,559
1990-1994	704	8.9%	189	2.4%	369	4.7%	807	10.3%	1,480	18.8%	4,320	54.9%	7,869
1995-1999	846	10.6%	231	2.9%	417	5.2%	844	10.6%	1,451	18.2%	4,176	52.4%	7,965
2000-2004	1,068	11.4%	269	2.9%	476	5.1%	1,052	11.2%	1,726	18.4%	4,794	51.1%	9,385
2005-2008	813	10.0%	257	3.2%	430	5.3%	846	10.5%	1,583	19.6%	4,162	51.4%	8,091
Total	7,087	10.0%	2,290	3.2%	4,149	5.9%	8,613	12.2%	14,710	20.9%	33,701	47.8%	70,550

Table 2. Age-specific incidence rates of fall-related mortality in the older Dutch population per 100,000 persons, 1969-2008

	≥65 year	65-69 year		70-74 year		75-79 year		80-84 year		85-89 year		90-94 year		≥95 year	
Period	**Overall**	**Men**	**Women**	**Men**	**Women**	**Men**	**Women**	**Men**	**Women**	**Men**	**Women**	**Men**	**Women**	**Men**	**Women**
1969-1974	129.5	18.3	17.5	38.9	45.2	94.6	140.7	242.7	414.8	504.7	867.4	1062.7	1617.0	1727.9	2713.3
1975-1979	110.0	15.5	11.9	30.3	29.2	73.0	93.8	193.0	279.6	409.0	681.2	862.5	1268.5	1565.9	2223.0
1980-1984	87.0	11.3	8.0	23.7	20.0	59.5	62.0	149.9	174.9	338.1	449.9	721.9	915.4	1311.1	1702.7
1985-1989	75.0	9.2	5.4	18.3	14.1	53.7	43.3	129.5	126.1	311.4	327.1	733.7	753.1	1457.0	1319.2
1990-1994	72.7	7.7	4.7	16.7	12.7	47.7	38.4	123.6	109.2	298.3	305.1	670.4	717.5	1323.9	1330.3
1995-1999	67.9	9.4	5.4	17.6	13.3	46.5	36.2	108.8	103.6	274.2	251.8	596.1	580.3	1294.5	1202.4
2000-2004	75.2	10.4	6.2	20.4	13.8	51.1	42.8	124.5	106.5	294.7	264.7	659.1	603.4	1405.0	1162.6
2005-2008	76.7	11.2	7.0	24.0	13.5	54.0	37.5	132.4	107.7	292.8	248.7	784.6	548.7	1357.8	1048.4

Figure 1. Absolute number of fall-related deaths and age-adjusted fall-related mortality rates in persons ≥65 years in the Netherlands 1969-2008



The Percentual Annual Change (95% CI) was:

Period 1: rapid decrease, men [1969-1983] -4.1% (-4.9; -3.2), and women [1969-1985] -6.5% (-7.1; -5.9);

Period 2: flattening decrease, men [1984-1996] -1.4% (-2.4; -0.4), and women [1986-1996] -2.0% (-3.4; -0.6);

Period 3: slight increase men [1997-2008] 1.9% (0.6-3.2), stabilized rate women [1997-2008] 0.0% (-1.2; 1.3)