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Original Article

Survival after Hip Fracture: Short- and Long-Term Excess Mortality According to Age and Gender

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Abstract. The purpose of this study was to analyze the excess mortality after hip fracture and to reveal whether, and eventually when, the excess mortality vanished in different groups of age and gender. A population-based, prospective, matched-pair, cohort study among persons 50 years of age and older was conducted involving 1338 female and 487 male hip fracture patients with 11 086 and 8141 controls respectively. Occurrence of hip fracture and mortality were recorded from 1986 until 1995. We studied the excess mortality of the hip fracture patients versus controls by using Kaplan–Meier curves and extended Cox regression with hip fracture (yes/no) as time-dependent covariate. The male hip fracture patients had higher mortality than the women the first year after the injury, irrespective of age, both in absolute terms (31% and 17% respectively) and relative to their age-matched controls. The relative risk (RR) of dying within 1 year for hip fracture patients versus controls was 3.3 (95% confidence interval (CI) 2.1–5.2) for women and 4.2 (95% CI 2.8–6.4) for men below 75 years of age. The corresponding figures for persons 85 years and older were 1.6 (95% CI 1.2–2.0) for women and 3.1 (95% CI 2.2–4.2) for men. All groups of age and gender, except women 85 years and older, had a large and significant excess mortality lasting for many years after the hip fracture – at least 5–6 years for women below 75 years of age (RR = 3.2, 95% CI 1.9–5.6). The excess mortality after hip fracture for women 85 years and older had vanished after 3 months (RR = 1.0, 95% CI 0.8–1.1). When referring to the excess mortality after hip fracture it is therefore necessary to specify sex, age and time since injury.

Keywords: Age; Hip fractures; Mortality; Risk factors; Sex

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Introduction

Excess mortality following hip fracture has been shown in many studies. Mortality in hip fracture patients has been compared with mortality in sex- and age-matched controls [1–3], and with expected mortality in the general population [4–12]. Several studies have not stratified on age [1–3,8,12]. Two studies stratified on age and on sex, but not simultaneously [5,9]. Only one study [4] has estimated and significance-tested the excess mortality after hip fracture stratified by sex and age simultaneously for more than 1 year after the injury, but the estimates were not provided for all sex and age groups. That study reported a statistically significant excess mortality for up to 10 years after fracture. Two other studies found that the excess mortality ceased after 6–12 months [7,11]. This discrepancy between results may be due primarily to different sex and age distributions of the patient groups, indicated by the results from a 3-year follow-up study [6] dividing the patients into three age groups. In the oldest age group (85 years and older) the survival curves for male and female hip fracture patients paralleled the expected survival curves for the general population some months after fracture, whereas in the youngest age group (65–74 years) the survival curves continued to diverge from the

expected survival curves for 3 years. That study, however, could not tell whether the excess mortality continued for more than 3 years after the injury.

The present study analyzes 9-year excess mortality after hip fracture stratified by sex and age.

Materials and Methods

As a part of a continuing project in the Norwegian county of Nord-Trøndelag [13–16], we performed a population-based, prospective, matched-pair, cohort study. The study population consisted of all residents 50 years of age or more on January 1, 1984 and still alive and residing in the county on March 1, 1986. During the study period from March 1, 1986 to December 31, 1995 we recorded the occurrence of hip fracture and mortality in the study population.

The Matched-Pair Cohort

Of the 38 305 people initially in the cohort, 102 men and 92 women emigrated and were lost to follow-up after the date of emigration. Cases were defined as cohort members who sustained a hip fracture (exposure variable) in the study period. Outcome was defined as dead or alive. Death and emigration were identified by matching the cohort members to the Norwegian register of vital statistics by the 11-digit personal identification code. This register contains information on date of death and emigration covering the whole Norwegian population. Only the first hip fracture during the follow-up period was used to classify cases. The hip fracture patients were classified into three age groups (Table 1). Controls were randomly selected among the cohort members, matched by sex and age (in 1-year age intervals). Within the six different sex- and age-specific groups, all patients had the same number of controls (Table 1). In addition, the controls had to be without a new hip fracture since March 1, 1986 and alive at the date of the injury of the matched patient. Under these requirements each sex and age group contained as many controls as available in the population, varying from two controls per case in women 85 years and older to 34 controls per case in men 50–74 years of age (Table 1). The exposure time accounting started when the hip fracture occurred for the case, both for the case and for the matched controls.

Because each patient within the specific sex and age group had to have the same number of controls, three patients in the oldest age group (one 103-year-old woman and two 98-year-old men) had to be excluded from the analysis as none or too few persons in the cohort could match these patients under the assumptions mentioned. A control who later suffered a hip fracture was also included as a case with the exposure time as a case starting at the date of hip fracture. The percentages of controls also becoming cases during follow-up are reported in Table 1. The hip fracture patient group thus consisted of 1338 women and 487 men (Table 1) and the control group consisted of 11 086 women and 8141 men.

Identification of the Hip Fracture Patients

In principle all residents of Nord-Trøndelag who suffer a hip fracture are admitted to one of two county hospitals. We used the patient discharge register in these two hospitals to identify patients with new hip fractures from our cohort by code 820, 9th revision of the International Classification of Diseases. For the period March 1, 1986

Table 1. Number of hip fracture patients and controls by age group, sex and outcome status in Nord-Trøndelag from March 1, 1986 to December 31, 1995

	Age at the time of the injury (years)		
	50–74	75–84	85+
Women			
No. of patients	367	581	390
No. (%) of deceased patients	88 (24)	268 (46)	248 (64)
No. of patient-years of follow-up	1461	1760	906
No. of controls	6239	4067	780
No. (%) of deceased among controls	686 (11)	1334 (33)	455 (58)
No. of person-years of follow-up	27627	14557	1992
Controls:patient ratio	17:1	7:1	2:1
No. (%) of controls who suffered a hip fracture	176 (3)	287 (7)	61 (8)
Men			
No. of patients	150	203	134
No. (%) of deceased patients	55 (37)	126 (62)	105 (78)
No. of patient-years of follow-up	586	494	196
No. of controls	5100	2639	402
No. (%) of deceased among controls	1003 (20)	1215 (46)	247 (61)
No. of person-years of follow-up	22898	8719	915
Controls:patient ratio	34:1	13:1	3:1
No. (%) of controls who suffered a hip fracture	59 (1)	97 (4)	17 (4)

to February 29, 1989, the fracture diagnosis was verified manually in the medical records of each patient. For the period March 1, 1989 to December 31, 1995 the hip fracture diagnosis was controlled by comparing the diagnosis codes with the codes of the surgical procedures. A validity study of the last period (1989–95) performed over 2 years (1992–93) at one of the hospitals revealed that 91.5% of all incident hip fractures had been captured. None of the hip fractures had been misclassified.

Statistical Methods

We analyzed the excess mortality in the hip fracture patients versus controls by Kaplan–Meier curves in the six different sex- and age-specific groups. To estimate the excess relative risk (RR) of dying for patients versus controls we used the extended Cox proportional hazard method. The exposure variable hip fracture (yes/no) generally does not meet the proportional hazard assumption because the relative risk of dying is higher during the first months after the injury than later. To deal with that we used the variable hip fracture (yes/no) as a time-dependent covariate in the extended Cox regression model to estimate RR of fatal outcome for hip fracture patients versus controls. We used the method described by Kleinbaum [17], but with several time intervals after the injury instead of only two. The model is described by one hazard ratio for each time interval, where the actual hazard ratio is constant over the actual interval. With, for example, four intervals the extended Cox regression model provides four hazard ratios (relative risks). We used the SAS statistical package as described by Kleinbaum [17] to compute the RR values in six separate models, one model for each of the six different sex- and age-specific groups (Table 2). The interval endpoints (Table 2) were chosen to show how long hip fracture patients in each of the six groups had statistically significant excess mortality. The precision of the RR values have been estimated with 95% confidence intervals (CI).

Results

The probability of dying within 1 year after the hip fracture was 17% (95% CI 15–19%) for women and 31% (95% CI 27–35%) for men. Divided on age the corresponding figures were 7% (95% CI 4–9%) and 16% (95% CI 10–22%) for women and men aged 50–74 years, 18% (95% CI 15–21%) and 30% (95% CI 23–36%) for women and men aged 75–84 years and 27% (95% CI 22–31%) and 48% (95% CI 40–57%) for women and men 85 years and older.

Women younger than 75 years experienced a 5-fold increased risk of dying compared with their controls during the first 3 months after the injury (Table 2, Fig. 1). Men of the same age showed a 9-fold increased risk (Table 2, Fig. 2). Thereafter there was a 2- to 3-fold increased risk for at least 6.5 years for women and 5 years for men.

Female and male hip fracture patients 75–84 years of age had a 6- and 5-fold increased risk of dying in the first 3 months after the injury, respectively (Table 2; Figs 1, 2). Although the excess mortality was much reduced after 3 months, it remained statistically significant for at least 9 years for women and 5 years for men.

Among women 85 years or older the excess mortality was present during the first 3 months after the injury. During that period the risk of dying was increased 4-fold compared with controls (Table 2, Fig. 1). After 3 months the excess mortality in this group of patients vanished (RR = 1.0, 95% CI 0.8–1.1 when merging the intervals after 3 months in Table 2). Male patients 85 years or older had a 6-fold increased risk of dying in the first 3 months followed by a 2-fold risk until 1 year after the injury (Table 2, Fig. 2). Thereafter they did not have a

Table 2. Relative risk (RR) of fatal outcome for hip fracture patients versus controls by age, gender and time after hip fracture in Nord-Trøndelag from March 1, 1986 to December 31, 1995

Follow-up time	Age at the time of the injury (years)		
	50–74	75–84	85+
Women			
⩽1 year	3.3 (2.1–5.2)	2.5 (2.0–3.1)	1.6 (1.2–2.0)
⩽3 months	5.2 (2.4–10.9)	5.9 (4.1–8.3)	3.7 (2.5–5.4)
>3 months to 1 year	2.6 (1.5–4.6)	1.4 (1.0–2.0)	0.7 (0.5–1.1)
>1 year to 5 years	2.2 (1.6–3.0)	1.3 (1.1–1.6)	1.5 (0.8–2.9)
>5 years to 6.5 years	3.2 (1.9–5.6)	1.6 (1.0–2.4)	1.2 (1.0–1.4)
>6.5 years to 9 years	1.3 (0.5–3.5)	1.9 (1.2–3.0)	1.5 (0.8–2.9)
Men			
⩽1 year	4.2 (2.8–6.4)	2.9 (2.2–3.9)	3.1 (2.2–4.2)
⩽3 months	9.0 (4.9–16.5)	5.1 (3.5–7.5)	5.7 (3.4–9.6)
>3 months to 1 year	2.6 (1.4–4.8)	1.8 (1.2–2.8)	1.9 (1.2–3.0)
>1 year to 5 years	1.7 (1.1–2.6)	1.5 (1.2–2.0)	1.2 (0.9–1.8)
>5 years to 6.5 years	1.2 (0.4–3.3)	1.0 (0.5–2.2)	3.0 (0.8–11.8)
>6.5 years to 9 years	1.5 (0.6–3.8)	0.4 (0.1–3.2)	(0 patients left)

*Values are the relative risk with (in parentheses) 95% confidence intervals estimated by means of Cox regression with hip fracture (yes/no) as time-dependent covariate.

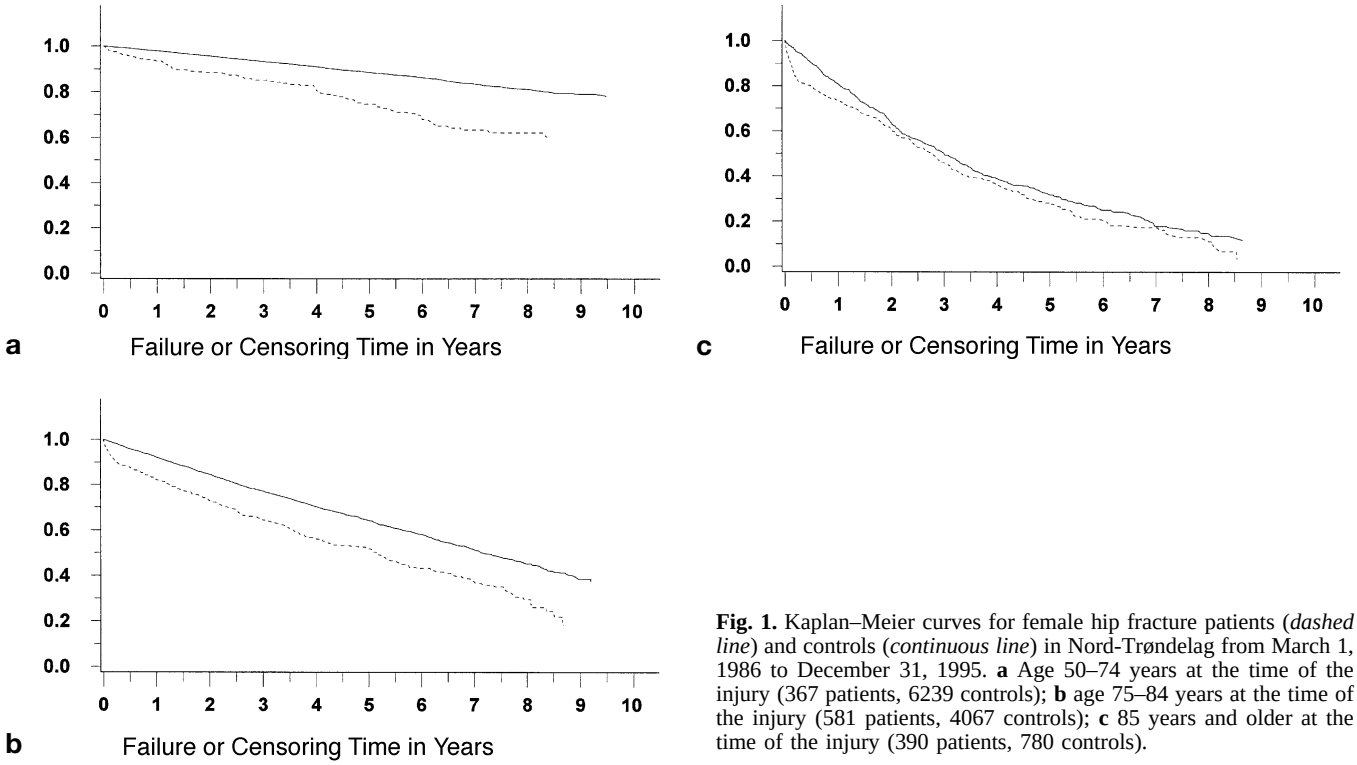

Fig. 1. Kaplan–Meier curves for female hip fracture patients (*dashed line*) and controls (*continuous line*) in Nord-Trøndelag from March 1, 1986 to December 31, 1995. **a** Age 50–74 years at the time of the injury (367 patients, 6239 controls); **b** age 75–84 years at the time of the injury (581 patients, 4067 controls); **c** 85 years and older at the time of the injury (390 patients, 780 controls).

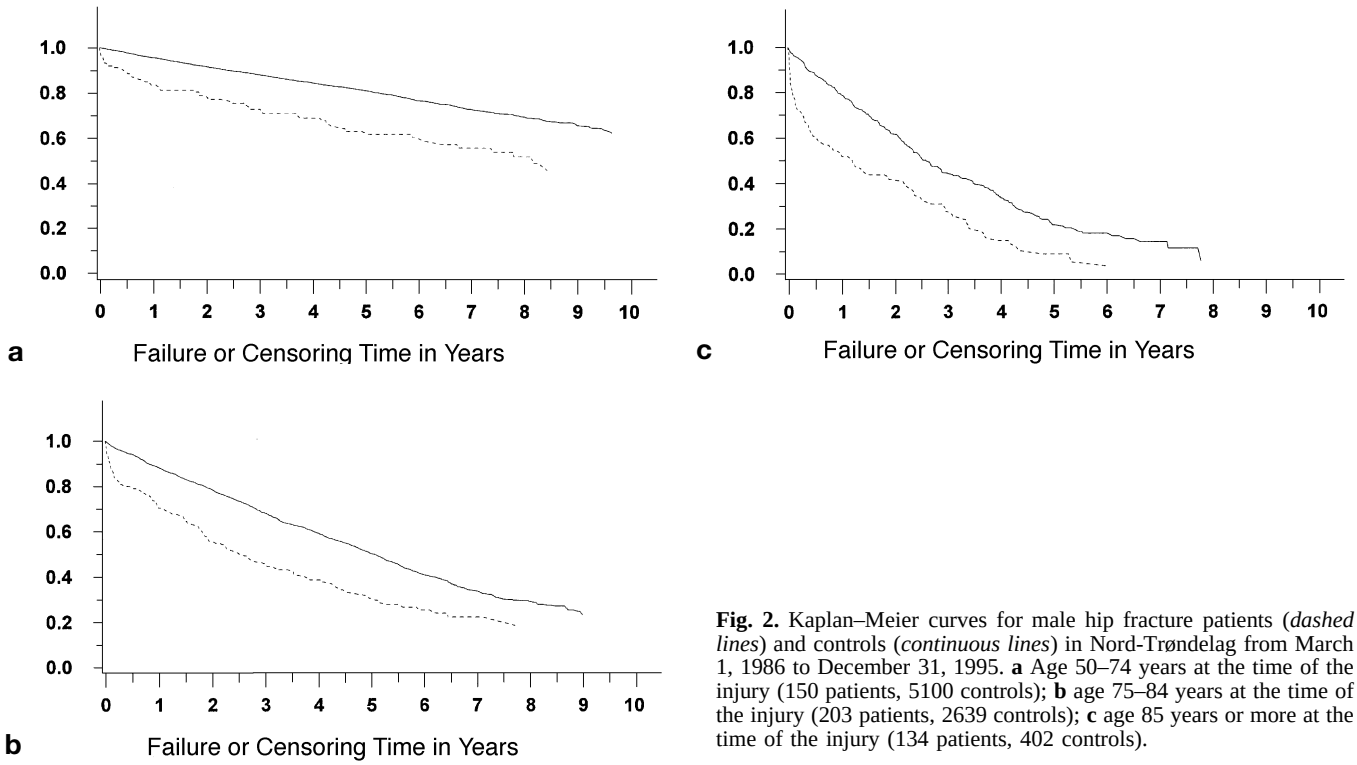

Fig. 2. Kaplan–Meier curves for male hip fracture patients (*dashed lines*) and controls (*continuous lines*) in Nord-Trøndelag from March 1, 1986 to December 31, 1995. **a** Age 50–74 years at the time of the injury (150 patients, 5100 controls); **b** age 75–84 years at the time of the injury (203 patients, 2639 controls); **c** age 85 years or more at the time of the injury (134 patients, 402 controls).

statistically significant increased mortality (RR = 1.3, 95% CI 0.9–1.8, when merging the intervals after 1 year in Table 2).

All groups, except women below 75 years of age, had a statistically significant decrease in excess mortality after 3 months.

Discussion

Our study showed that men had higher mortality following hip fracture than women in the first 1-year period after the injury. This finding was present, irrespective of age, both in absolute terms and relative to the age-matched controls. For older women the excess mortality after hip fracture occurred during the first 3 months after the injury. In other sex and age groups, especially among younger women, the excess mortality was large and significant for at least 5–6 years.

Our findings corroborate those of other studies on the excess mortality after hip fracture that have controlled for sex, age and time since injury [4–6]. A study from New England found that both for women and men 85 years of age and older the survival curves eventually paralleled the population curves [6]. Our study showed this clearly for women already 3 months after the injury. Men in our study had statistically significant excess mortality for at least 1 year. Further, for patients younger than 85 years of age, the New England study showed that the survival curves continued to diverge from the population curve during the whole follow-up period (3 years), whereas this excess mortality continued for at least 5 years in our study. For women aged 75–84 years the excess mortality was nearly 2-fold and statistically significant even at the end of the 9-year follow-up period.

A study from Baltimore found that the death rates for women approached the expected rates approximately 6 months after fracture. In our study, the excess mortality for the female hip fracture patients, overall, was still statistically significant in the interval 5–9 years after the injury (data not shown). A possible explanation for this difference is different age range of the patients. The Baltimore study included patients 65 years and older while our study included patients aged 50 years and older. Another possible explanation is the difference in follow-up time, which was only 1 year in the Baltimore study.

The strength of our study is that the patients were unselected and the controls had the same year of birth and resided in the same area as the patients. Many previous studies [4,5,8,9,11] have used expected survival curves from a larger area, including the study population, which might have given biased results because of possible regional differences in hip fracture incidence and mortality. Due to the large patient sample in our study, we were able to segregate our analysis by sex and age, which was of importance since both sex and age were risk modifiers. Age was in addition a confounder within each sex- and age-specific group. Therefore we controlled for age by using age-matched control groups within each of these groups. Our study is the only one using hip fracture (yes/no) as a time-dependent covariate (Table 2). The advantage of this method is that we could estimate the relative risk of fatal outcome for hip fracture patients versus controls for several time intervals after the injury and not give only the overall relative risk for the whole follow-up period. An overall relative risk is dependent on the length of follow-up, which makes the comparison between studies difficult.

Limitations of our study ought to be mentioned. A validation study suggested that about 8.5% of the hospitalized hip fractures were underreported in our study. Since we analyzed risk and not prevalence or incidence of hip fracture and death, the few hip fracture patients missed by the study do not influence the results, assuming that they were missed at random. Inhabitants of Nord-Trøndelag moving from the county were followed up on mortality, but not on hip fracture after the date of moving. These dates were not registered. Because of this we have possibly not recorded some more hip fracture cases. However, the inhabitants of Nord-Trøndelag seldom move out of the county, especially not the oldest. In 1997, 40 persons aged 67 years and older moved out, while the corresponding number for ages 50–66 years was 158 [19].

We could not use the information about second hip fractures because we did not have that information for the first 3-year period of follow-up. The exposure variable was dichotomous and the exposure counting started at the occurrence of the first hip fracture and could not be updated when a second hip fracture occurred. Among women and men 75 years and older, 10% and 8%, respectively, sustained a second hip fracture in the period 1989–95. The corresponding figures for those aged 50–74 years were 6% and 5%. One impact of a second hip fracture is that a part of the effect of the first hip fracture on mortality worked through a second hip fracture.

The control groups in our study were randomly selected from the general population of Nord-Trøndelag, matched for sex and age of the cases. Therefore members of the control groups could sustain hip fractures and become cases (Table 1). In additional analyses we selected alternative control groups where cohort members who sustained a hip fracture during follow-up were not included. These analyses with alternative control groups did not alter the results (data not shown), probably because the number of persons in the original control groups who later suffered a hip fracture was few (Table 1).

Reduced health status is frequent in hip fracture patients [5]. The excess mortality after hip fracture can be attributed to comorbid conditions, the acute effect of the trauma or a combination of these [2,3]. It is also possible that long-term health and lifestyle consequences of the fracture itself may lead to increased mortality, but we do not know of any study exploring this. The present study included only gender, age (and fracture) as covariates; a measure of comorbid conditions was not included and can thus not be evaluated. However, the excess mortality was most prominent during the first 3 months after the fracture, and this short-term very high mortality might best be explained by a combination of comorbid conditions and the acute effects of the injury [18]. The long-term excess mortality after hip fracture

for younger women and men, on the other hand, may in larger extent be due to comorbid conditions [3].

When referring to the excess mortality after hip fracture it is necessary to specify sex, age and time since injury. Older women have almost no excess mortality after 3 months, while men and younger women have an excess mortality for many years.

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