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Declining incidence trends for hip fractures have not been accompanied by improvements in lifetime risk or post-fracture survival – A nationwide study of the Swedish population 60 years and older

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ABSTRACT

Background: Hip fracture is a common cause of disability and mortality among the elderly. Declining incidence trends have been observed in Sweden. Still, this condition remains a significant public health problem since Sweden has one of the highest incidences worldwide. Yet, no Swedish lifetime risk or survival trends have been presented. By examining how hip fracture incidence, post-fracture survival, as well as lifetime risk have developed between 1995 and 2010 in Sweden, this study aims to establish how the burden hip fractures pose on the elderly changed over time, in order to inform initiatives for improvements of their health.
Material and Methods: The entire Swedish population 60 years-old and above was followed between 1987 and 2010 in the National Patient Register and the Cause of Death Register. Annual age-specific hip fracture cumulative incidence was estimated using hospital admissions for hip fractures. Three-month and one-year survival after the first hip fracture were also estimated. Period life table was used to assess lifetime risk of hip fractures occurring from age 60 and above, and the expected mean age of the first hip fracture.
Results: The age-specific hip fracture incidence decreased between 1995 and 2010 in all ages up to 94 years, on average by 1% per year. The lifetime risk remained almost stable, between 9% and 11% for men, and between 18% and 20% for women. The expected mean age of a first hip fracture increased by 2.5 years for men and by 2.2 years for women. No improvements over time were observed for the 3-month survival for men, while for women a 1% decrease per year was observed. The 1-year survival slightly increased over time for men (0.4% per year) while no improvement was observed for women.
Conclusions: The age-specific hip fracture incidence has decreased over time. Yet the lifetime risk of a hip fracture has not decreased because life expectancy in the population has increased in parallel. Overall, survival after hip fracture has not improved.

Introduction

Proximal femoral fracture, or hip fracture [1], is a common cause of disability and death among the older population, resulting in high healthcare and societal costs, as well as impaired quality of life for individuals [2,3]. Sweden has one of the highest incidences of hip fractures worldwide [4] with about 22 (men) and 34 (women) annual cases per 1000 for individuals 80 years old and above, as measured for the year 2013 [5]. Incidence has increased from the 1950s to mid-1990s, but it has since remained stable or even decreased [5–19], despite the predicted increase in the incidence for Sweden [20] and worldwide [21]. Considering the health of the ageing population in Sweden in an era of widespread use of preventive medicine and interventions, the postponement over time of the first hip fracture to higher ages could be expected.

In order to understand how morbidity and mortality from hip fractures has changed over time, incidence, case fatality, and life time risk need to be interpreted in conjunction. If mortality from hip fractures decreased over time it could be the result from either declining incidence or improved survival. Stable incidence and improved survival implies

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increasing disability among the elderly, while decreasing incidence clearly indicates improvements in health. It is also of importance to present age-specific morbidity and mortality information since they may have improved up to a certain age but remained unchanged or even increased among the very oldest, for example.

The lifetime risk of hip fracture in Sweden has been estimated to be as high as 23% for women above the age of 50 [22], while an even higher estimation, lifetime risk around 30% for the age of 50, is reported for the neighboring Norway [23]. Despite the high hip fracture incidence and lifetime risk in Sweden, it is unclear how lifetime risk has changed over time since no such trends have been presented in the literature. Lifetime risk is affected by incidence but also by overall survival in the population. Previous studies may have overestimated the incidence of hip fractures in the population, and as a consequence overestimated the lifetime risk, by including all fractures occurring at/near the hip (also subsequent fractures), available from the National Patient Register. However, lifetime risk increases also if life expectancy increases. This is because individuals will be more years at risk of experiencing a hip fracture. Even with stable incidence of hip fracture, lifetime risk will increase in an ageing population, which is why incidence has to decrease at older ages in order to observe decreasing lifetime risk of hip fracture in an ageing population.

Regarding survival after an incident hip fracture, previous studies in Sweden have estimated a reduction compared to the hip fracture free population, particularly in men [24–29]. However, no studies have looked into survival trends after the first hip fracture in Sweden. A small improvement in survival after the first hip fracture in men has been observed in neighboring Norway, while no changes have been observed for women [30]. Similar changes in survival over time may be expected for Sweden as well, given the fact that the old population in the two countries has similar demographic and socioeconomic characteristics. On the other hand, treatment patterns after a hip fracture may differ, causing differences in survival trends between Sweden and Norway.

By examining how hip fracture incidence, post-fracture survival, as well as lifetime risk have developed between 1995 and 2010 in Sweden, this study aims to establish how the burden hip fractures pose on the elderly changed over time, in order to inform initiatives for improvements of their health.

Material and methods

Study Material

The Total Population Register [31] covers everyone living in Sweden since the year 1968 and was used to collect information regarding the date of birth and migration status of individuals in the study cohort. In order to double-check whether individuals in the Total Population Register were indeed alive and resident in Sweden, we linked the register with the Longitudinal Integration Database for Health Insurance and Labor Market Studies (LISA) [31]. This register includes yearly information regarding individuals' wages, pensions, and social transfers. Everybody resident in Sweden should be in this register.

Hip fracture incidence was estimated using hospital admissions for hip fractures, both as main or secondary cause, from the National Patient Register (NPR) [32] (International Classification of Diseases (ICD) codes: ICD-9 820. ICD-10 S72 excluding codes S72.3, S72.4, and S72.9). The NPR has nationwide coverage since 1987 and includes information for all hospital admissions in Sweden [32]. An admission to the hospital due to a hip fracture event that had a minimum duration of one night was chosen for the analysis. Hip fracture cases without an overnight stay were not included (n = 4 426); due to the severity of this condition, such cases were likely to be incomplete fracture cases, trochanteric avulsions or deemed untrustworthy (suspected hip fractures, not clinically proven).

Information about deaths were obtained from the Cause of Death Register [33], which includes deaths occurring within or outside Sweden for individuals who were registered in Sweden at the time of death [33].

Setting

From the year 1987 until 2010, all men and women above the age of 60 who were resident in Sweden at the beginning of each calendar year were included in the study population (N = between 1 964 990 and 2 354 008 for the calendar years under study). Individuals entered the study cohort as soon as they became 60 years-old, and were followed until they had their first hip fracture (any year between 1987 and 2010), and for case fatality until death occurred 3 months or 1 year after the first hip fracture (any year after first hip fracture between 1987 and 2011) (Fig. 1). A 7-year disease-free period for individuals entering the study population in 1987 was applied in order to capture the first hip fracture event; all individuals with a hip fracture event prior to 1994 were excluded from the analysis (n = 102 904). A similar procedure has been used in our previous studies as well [34,35]. Since it is not possible to distinguish whether the hip fracture cases between 1987 and 1993 refer to first or subsequent hip fractures, the sum of the hip fracture cases prior to 1994 is not comparable with the first hip fracture cases reported between the years 1994 and 2010. Individuals without a hip fracture were censored at the time of death, emigration, the beginning of the year in which they did not receive wages, pensions, or social welfare according to LISA, or end of follow-up (whichever event came first).

Statistical analyses

Hip fracture incidence

The annual age-specific cumulative incidence, later referred to as incidence, was calculated for all ages above 60 and for the years 1995 to 2010. It was computed as number of first hip fracture hospitalization events per year, divided with the number of individuals at risk in the beginning of the year, expressed as events per 1000. Calculations were performed for men and women separately, and are presented as trends for the overall population for each calendar year and for eight age groups: 60–64, 65–69, 70–74, 75–79, 80–84, 85–89, 90–94, and 95 + years. The overall population trends were standardized using the age distribution of the 2010 population included in our study.

In order to estimate how much the incidence has changed over time, the average change in the age-specific annual risk (RR_CI) of having the first hip fracture after the age of 60 was estimated using a discrete time logistic model with a *cloglog* link [36]. The age at first hip fracture (treated as a categorical variable) was used as a time-varying predictor of the outcome in the regression model. The age-adjusted RR_CI was measured for men and women separately and stratified for the eight different age groups. The percentage (%) annual change in the risk was estimated by subtracting one from the relative change (RR_CI − 1).

Lifetime risk and mean age of first hip fracture

The expected lifetime risk and the expected mean age of the first hip fracture after the age of 60 were calculated using multiple decrement period life table methodology, with death being the only competing risk [37]. For each year and age, the number of hip fractures was calculated as the cumulative incidence of hip fracture multiplied with the number of people surviving to that age according to the life table. The lifetime risk was calculated as the sum of the number of cases across all ages (60 to 100 +); this outcome was expressed as a percentage.

The expected mean age of the first hip fracture was calculated for each year by multiplying the number of cases (derived from the life table) in each age group with the age, summing across all ages, and dividing by the total number of cases.

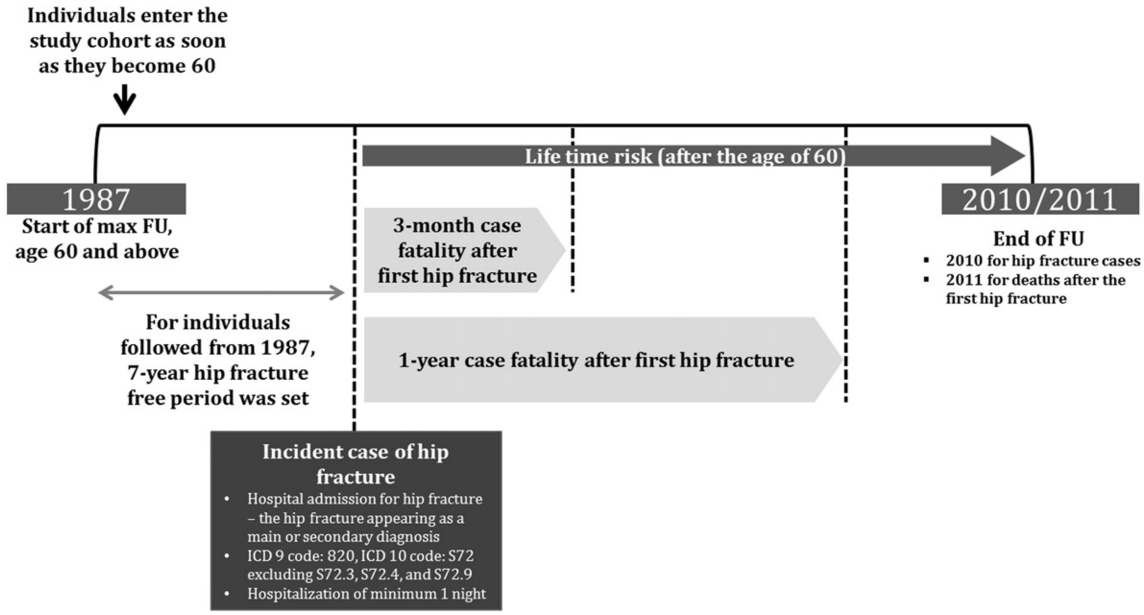

Fig. 1. Study description. Individuals were followed for hip fracture events and death after first hip fracture from 1987 until 2010 (maximum follow up, FU, 23/24 years). Censoring occurred at death without previous hip fracture, emigration, or 31st of December 2011.

Case fatality after incident hip fracture

The age-specific case fatality, i.e. mortality among cases, was defined as death from any cause within 3 months (91 days) and within one year (365 days) respectively, from the admission to the hospital for the first hip fracture. It was estimated by dividing all deaths within 3 months and within one year, with the total number of hip fracture cases for each age and year, and the outcome was expressed as a percentage (%). Results are presented for the years 1995 to 2010, for men and women separately, and are presented as trends for the overall population for each calendar year and for the eight age groups. The overall population trends were standardized using the age distribution of the 2010 population included in our study.

The annual average change in the 3-month and 1-year case fatality was estimated using a discrete time logistic model, similar to the one used for incidence. The change in the age-specific annual risk of dying within 3-months (RR_CF_3months) and 1-year (RR_CF_1year) after first hip fracture was estimated as an average for men and women separately and also stratified in the eight age groups. The percentage (%) annual change in the risk was estimated by subtracting one from the relative change (e.g. RR_CF_3months − 1).

Ethical permission

Prior to study commencement, an ethics approval from the regional ethics committee in Stockholm, Dnr 2011/136-31/5, was obtained.

Results

A summary of our main results, hip fracture incidence, 3-month and 1-year case fatality, and lifetime risk trends are presented in Fig. 2.

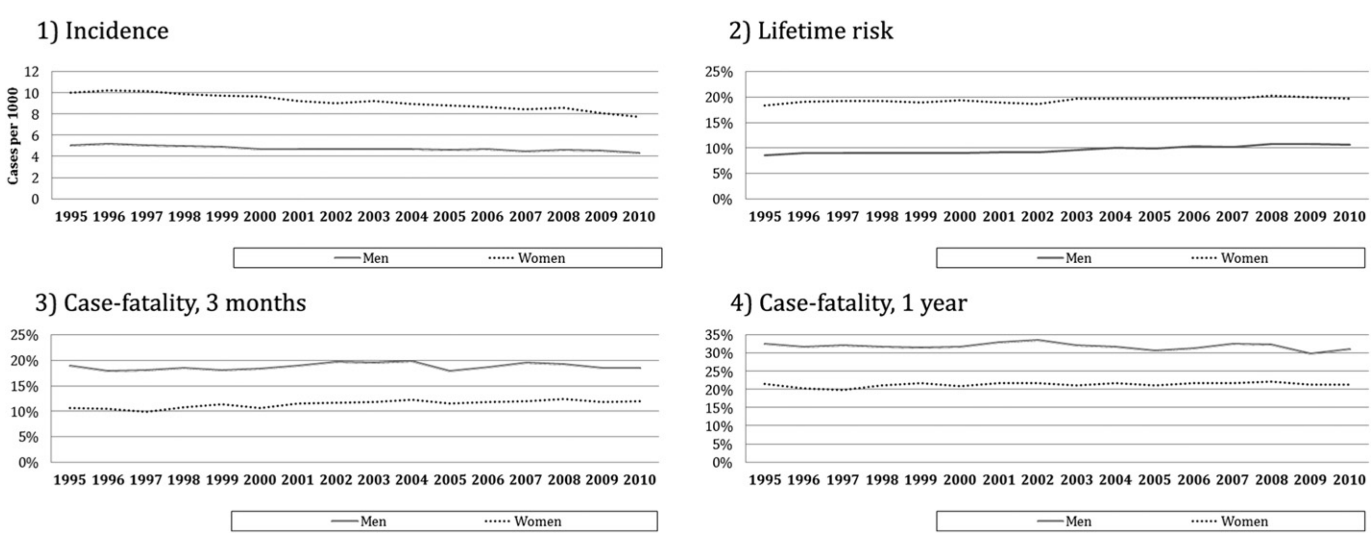

Fig. 2. Summary measures for Men (A) and Women (B) separately: 1) trends in one year incidence of hip fractures, presented as cases per 1000 between the calendar years 1995 and 2010, 2) lifetime risk, presented as percentage between 1995 and 2010, 3) trends in 3-month case fatality (death within 91 days after first hip fracture case), presented as percentage between 1995 and 2010, 4) trends in 1-year case fatality (death within 365 days after first hip fracture case), presented as percentage between 1995 and 2010.

Hip fracture incidence

Overall, the incidence decreased between 1995 and 2010, by approximately 0.8% per year for men and 1.6% for women (Fig. 2, Table 1). In Fig. 3, hip fracture incidence trends are presented for eight age groups (60–64, 65–69, 70–74, 75–79, 80–84, 85–89, 90–94, 95+ years old), for men and women separately. A downward trend was observed for almost all age groups.

Table 1 presents the regression estimates of the trend for all ages and for the eight age groups, and for men and women separately. The rate of decrease gradually declined with advancing age, for both men and women. The average decrease in the hip fracture incidence was 1.5% per year for younger men, 65–79 years old, while it was a little less than 1% for older men, 80–94 years old. Compared to men, the decrease for women was more pronounced for all ages up to 94 years old with almost 2% decrease in ages up to 90 years. For the oldest age group (95+ years old), no incidence reductions were observed for neither men nor women.

Lifetime risk and mean age of first hip fracture

Despite the reduction in the incidence, from 1995 to 2010 the expected lifetime risk of a hip fracture remained stable or increased slightly, from 9% in 1995 to 11% in 2010 for men, and 18% to 20% for women (Fig. 2).

The expected mean age of a first hip fracture increased by 2.5 years for men (from 78.2 to 80.7 years) and by 2.2 years for women (from 80.2 to 82.4 years) from 1995 to 2010.

Case fatality after hip fracture

Overall, no improvements over time were observed for the 3-month case-fatality for men, while for women a 1% increase per year was observed (Fig. 2, Table 2) between the years 1995 and 2010. The 1-year case-fatality slightly decreased over time for men (0.4% per year) while no improvement was observed for women (Fig. 2, Table 2).

The time trends for 3-months and 1-year case fatality are presented in Figs. 4 and 5 respectively, and in Table 2, for eight age groups, for men (a) and women (b) separately, between the calendar years 1995 and 2010. The 3-month case-fatality increased over time for many age groups, while for the 1-year case-fatality no clear indication of improvement over time was observed for both men and women.

Discussion

In this study we have presented declining age-specific incidence trends of hip fractures in Sweden for ages up to 94 years. Similar decreases have been observed in other studies using Swedish register data [5,16], and for other countries in Scandinavia [38–40], even if these studies did not show detailed figures for narrow age groups. We contribute to the existing literature by presenting incidence trends in 5-year age-groups and for all ages up to 95+ years. By doing this we also reveal that the decline has been most prominent in ages up to 80 years for men and up to 90 years for women. For the very oldest no improvement could be observed.

We have no clear answer to why incidence has declined over time, but it is in line with the development of several other health problems [35,41]. Socioeconomic and clinical factors could have contributed to the change. In Sweden the age-specific risk for a first and subsequent hospitalization decreased [41], suggesting that the occurrence of chronic illnesses such as cardiovascular diseases [35,42], which are well known risk factors for hip fractures [43], decreased over time. Changes in lifestyle factors among the elderly, for example smoking cessation, could also reduce the risk of hip fractures [38,44]. Rising trends for body weight among the elderly, a protective factor for hip fractures [38] could also explain some of the decrease in the hip fracture incidence [45].

Another possible explanation for the decrease in the hip fracture incidence could be the increasing use of osteoporotic medication; however a study in Denmark [38] displayed that the use of osteoporotic medication would explain only a minor decrease in the hip fracture incidence during the period 1997–2006.

Even if incidence has declined over time for both men and women, the lifetime risk for hip fracture has not. Previous studies may have overestimated the incidence of hip fractures in the population [22], and as a consequence the lifetime risk, by including all fractures occurring at/near the hip, available from the National Patient Register. In this study, we have selected only fractures of the femur, and we also applied a disease-free period to avoid counting subsequent fractures of the hip instead of incident cases. Therefore, no overestimation of the lifetime risk is expected due to miscounting of incident hip fracture cases.

Lifetime risk is calculated using life tables, taking into account the competing risk of death (improved survival) together with the change in incidence rates. Therefore, even if the incidence of hip fracture cases have decreased over time in all ages up to 94 years, the counteracting impact of improved survival among the old have led to an increase in the probability of getting affected by a hip fracture over the life course. In order to further explore the impact on the life time risk that is attributed to improved survival of the general population, we calculated the lifetime risk for hip fracture keeping the death risk in the population stable over time, at the 1995 levels. For both men and women the lifetime risk would have decreased in that case (from 9% in 1995 to 7% in 2010 for men, and from 18% in 1995 to 14% in 2010 for women). This implies that in order to counterbalance the effect of the improved survival, the incidence need to be reduced substantially (and much more than what we have observed) in order to decrease the life time risk of a hip fracture.

No improvements over time in the 3-month and 1-year survival after an incident hip fracture were observed. To our knowledge, our study is the first that looks into survival trends after an incident hip fracture in Sweden. In a Norwegian study it was found that the 1-year case fatality decreased for men above the age of 50, but no clear improvements was observed for women [30]. However, unfortunately, no age-specific results were available from that study. It is possible that the decrease in mortality observed for men in Norway is largely driven by mortality improvements in the younger individuals in the study population while stability or even worsening in this measure can be expected among the old and very old individuals.

The lack of improvements in the survival after hip fractures over time found in our study could reveal the level of fragility of the population and the high risk profile for other severe conditions, such as cardiovascular diseases, subsequent fractures, infections, malignancies, etc. One could hypothesize that mortality changes in comorbid conditions over time could influence the hip fracture survival trends we observed. However, when we examined causes of death at 3 months and 1 year after the first hip fracture, no changes were observed in the composition

Table 1
Average annual change in incidence of first hip fracture after the age of 60, for men and women.

	Men			Women		
	Mean	95% CI		Mean	95% CI	
age 60–64	0.8%	0.3%	1.3%	−1.5%	−2.0%	−1.1%
age 65–69	−1.4%	−2.0%	−0.9%	−1.7%	−2.1%	−1.2%
age 70–74	−1.5%	−2.0%	−1.1%	−1.8%	−2.1%	−1.5%
age 75–79	−1.4%	−1.7%	−1.0%	−1.9%	−2.1%	−1.6%
age 80–84	−0.9%	−1.2%	−0.6%	−1.9%	−2.1%	−1.7%
age 85–89	−0.8%	−1.1%	−0.5%	−1.7%	−1.8%	−1.5%
age 90–94	−0.5%	−0.9%	−0.1%	−1.2%	−1.4%	−0.9%
age 95+	0.0%	−0.9%	0.9%	−0.1%	−0.5%	0.4%
All ages	*−0.8%*	*−1.0%*	*−0.7%*	*−1.6%*	*−1.7%*	*−1.5%*

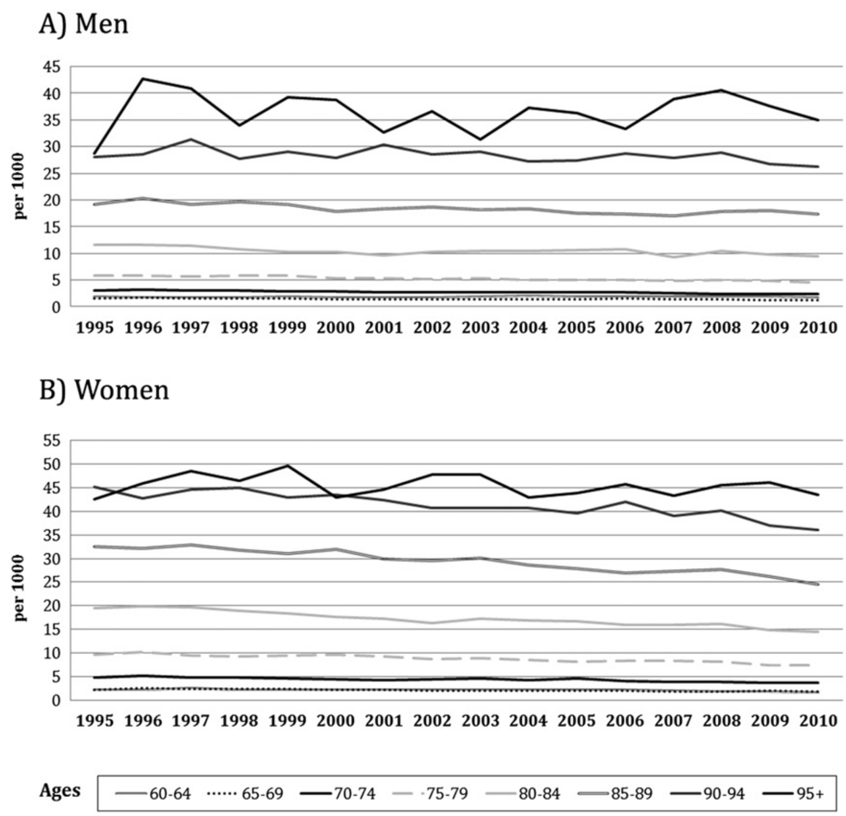

Fig. 3. Age specific trends in one year incidence of hip fractures, presented as cases per 1000 between the calendar years 1995 and 2010, for Men (A) and Women (B) separately.

of underlying causes of death over time. The lack of improvements in survival after the first hip fracture could also be related to the severity of the fracture itself or possibly other factors such as delay in the surgical treatment of the fracture, as a study from Denmark suggests [46], or shortening of the length of stay in the hospital after the fracture, according to a recent study in Sweden [47].

Finally, another potential explanation to the lack of improvement in case fatality could be that with decreasing incidence the hip fracture population potentially becomes more selected and fragile over time – preventing improvements in survival.

Table 2
Average annual change in the 3-month and 1-year case fatality, for men (A) and women (B).

	3-month			1-year		
	Mean	95% CI		Mean	95% CI	
A) Men						
age 60–64	3.7%	0.2%	7.3%	2.0%	−0.1%	4.2%
age 65–69	0.8%	−1.3%	3.0%	0.5%	−1.0%	2.0%
age 70–74	−0.2%	−1.6%	1.2%	−0.9%	−1.9%	0.1%
age 75–79	0.4%	−0.6%	1.4%	−0.3%	−1.0%	0.4%
age 80–84	−0.4%	−1.1%	0.2%	−0.9%	−1.4%	−0.4%
age 85–89	0.3%	−0.3%	0.9%	−0.3%	−0.8%	0.1%
age 90–94	1.0%	0.2%	1.8%	0.2%	−0.4%	0.8%
age 95+	−0.3%	−1.6%	1.1%	−0.7%	−1.8%	0.5%
All ages	*0.2%*	*−0.1%*	*0.6%*	*−0.4%*	*−0.6%*	*−0.1%*
B) Women						
age 60–64	1.0%	−2.1%	4.2%	0.2%	−1.8%	2.3%
age 65–69	1.5%	−0.9%	3.8%	1.9%	0.3%	3.5%
age 70–74	1.6%	0.1%	3.1%	1.4%	0.3%	2.4%
age 75–79	−0.5%	−1.5%	0.4%	−0.8%	−1.5%	−0.2%
age 80–84	1.1%	0.4%	1.7%	−0.1%	−0.6%	0.4%
age 85–89	1.2%	0.6%	1.7%	0.4%	0.0%	0.7%
age 90–94	1.0%	0.4%	1.6%	0.2%	−0.3%	0.6%
age 95+	1.4%	0.5%	2.3%	0.6%	−0.1%	1.4%
All ages	*1.0%*	*0.7%*	*1.3%*	*0.2%*	*0.0%*	*0.4%*

Strengths and limitations

A distinct advantage of this study is the very large sample size – the entire population in Sweden above the age of 60 was included in the analysis – together with the high quality data of hip fractures. This enabled us to calculate valid estimates of hip fracture incidence, lifetime risk, and survival. In addition, with this study we are able to capture morbidity and mortality from hip fractures over a long period, and conclude regarding the observed the trends of hip fractures in the Swedish population, without the need of making projections for future estimating trends (cohort life table instead of a period life table).

Since our definition of a hip fracture case may differ from previously published studies, we also considered the impact this definition may have had on the observed hip fracture morbidity and mortality trends. We ran a sensitivity analysis where the way hip fractures were defined was changed (main cause only in the hospitalization register instead of main or secondary diagnoses). However, this did not change the results.

We also applied a 7-year disease-free period for individuals entering the study population in 1987 in order to capture the first event. Since the National Patient Register has nationwide coverage since 1987, no information was available for hospital admissions before that year. For younger individuals in the population, ages 60 to 69, who have a low risk for hip fracture, the age-specific hip fracture incidence estimates would not have been diluted due to capturing re-admissions instead of first hip fracture cases. However, at ages 70 years and older, hip fractures become more frequent and therefore recorded hip fracture cases could actually have been second cases instead of first events. Without applying a disease-free period, age-specific hip fracture incidence would have been overestimated.

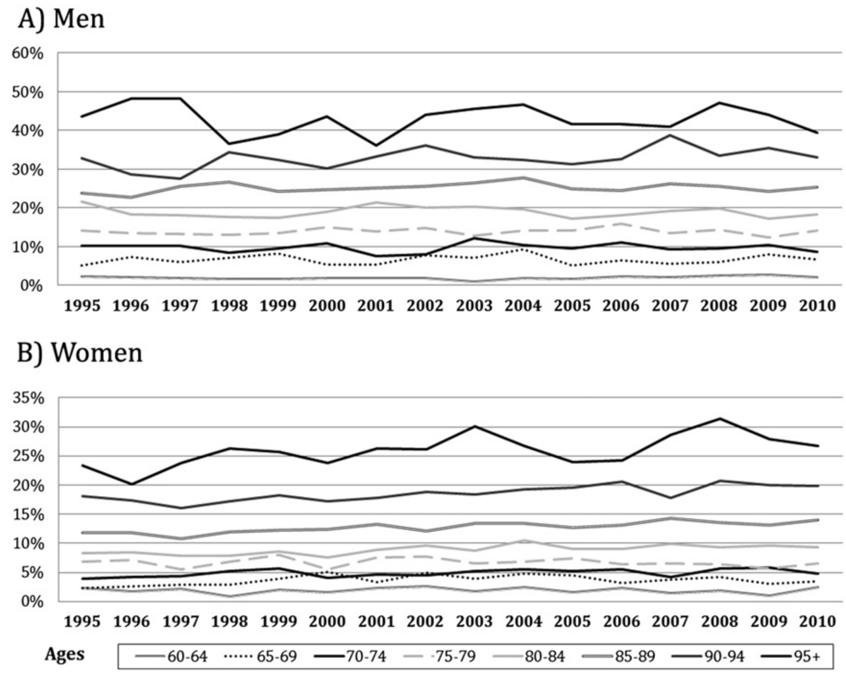

Fig. 4. Age specific trends in 3-month case fatality (death within 91 days after first hip fracture case), presented as percentage between 1995 and 2010 for men (A) and women (B).

In this study we only used information from administrative registers in Sweden to study the hip fracture incidence, lifetime risk, and case fatality. However, some of the associations we observed could be better explained with more detailed individual information. e.g. comorbidities, medication for other diseases, level of stress, dietary habits, etc. Additional research is needed in order to link this study's outcomes with more detailed individual information and possibly shed light in the exact reasons for the lack of improvements for case fatality.

Conclusions

The age-specific hip fracture incidence has decreased for all ages up to 94 years, for both men and women, although considerably less in the upper age range. No improvements in the survival after hip fracture were observed, suggesting that frailty among these individuals is high. The lifetime risk of a hip fracture remained unchanged or slightly increased over time due to lack of improvement in hip fracture risk

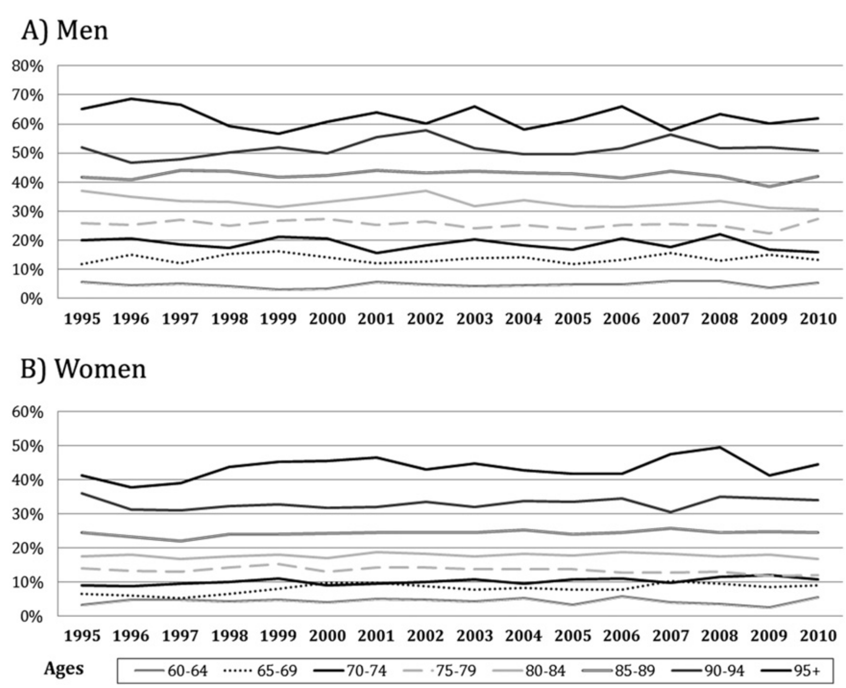

Fig. 5. Age specific trends in one-year case fatality (death within 365 days after first hip fracture case), presented as percentage between 1995 and 2010 for men (A) and women (B).

among the oldest, and the increase in life expectancy of the general population.

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Competing interests: None.

Ethics approval: An ethics approval for this study was obtained from the Regional Ethics Committee in Stockholm, Dnr 2011/136-31/5.

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