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Trends in incidence, health care consumption, and medical and productivity costs of femoral shaft fractures in the Netherlands between 2005 and 2019

J. Daniël Cnossen [a], Martien J.M. Panneman [b], Suzanne Polinder [c], Michael H.J. Verhofstad [a], Esther M.M. Van Lieshout [a,*]

[a] Trauma Research Unit Department of Surgery, Erasmus MC, University Medical Center Rotterdam, Rotterdam, the Netherlands
[b] Consumer Safety Institute, P.O. Box 75169, 1070, AD, Amsterdam, the Netherlands
[c] Department of Public Health, Erasmus MC, P.O. Box 2040, 3000, CA, Rotterdam, the Netherlands

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ABSTRACT

Introduction: Population-based knowledge on the occurrence of femoral shaft fractures is necessary for allocation of health care services, optimization of preventive measures, and research purposes. This nationwide study aimed to provide an overview on the incidence of femoral shaft fractures over a 15-year period and to gain insight into health care consumption and work absence with associated costs in the Dutch population.
Methods: Data of patients who sustained an acute femoral shaft fracture in the years 2005–2019 were extracted from the National Medical Registration of the Dutch Hospital Database. The incidence rate, hospital length of stay (HLOS), direct medical costs, productivity costs, and years lived with disability were calculated for age- and gender specific groups.
Results: A total of 15,847 patients with a femoral shaft fracture were included. The incidence rate increased with 13 % over this 15-year period (5.71/100,000 persons per year in 2005 and 6.47/100,000 in 2019). The mean HLOS per patient was 13.8 days in 2005–2009 versus 8.4 days in 2015–2019 for the entire group. Mean HLOS per patient increased with age (10.0 days for age group 0–9 and 12.7 days for age group >80), but declined over time from 13.6 days in 2005–2009 to 8.8 days in 2015–2019 in males, and from 13.7 days and to 8.2 days, respectively, in females. The costs due to work absence was higher in males. Cumulative health care costs were highest in females >80 years (8.4 million euros versus 1.6 million in males).
Conclusion: The incidence rate of femoral shaft fractures increased over the past 15 years in the Netherlands. Mean HLOS per patient has decreased in all age groups and in both sexes. Health care costs were highest for female octogenarians.

Introduction

Femoral shaft fractures are a common injury after high energy trauma (HET), most of these HET are motor vehicle accidents (MVA). The incidence rate of femoral shaft fractures shows a bimodal distribution [1,2]. In the younger population femoral shaft fractures are usually the result of HET and in the elderly the result after low energy trauma (LET). For femoral shaft fractures it is unclear if the differences in trauma mechanism and the associated differences in age are associated with differences in treatment and health care. For achieving the best allocation of health care services, optimization of preventive measures, and research purposes, population-based knowledge on the occurrence and healthcare costs of femoral shaft fractures is crucial. Earlier reports showed incidence rates ranging from 10–21 per 100,000 persons per year [2–5]. Weiss et al. and Lundin et al. showed a stable incidence rate over time in Sweden for two periods, respectively 1998–2004 and 2001–2016 [2,4].

Few studies are available, and most of these tended to focus on only the incidence rate of femoral shaft fractures. Detailed assessment of HLOS, costs of work absenteeism, and health care consumption, such as

* Corresponding author at: Trauma Research Unit Department of Surgery, Erasmus MC, University Medical Center Rotterdam, P.O. Box 2040, 3000 CA, Rotterdam, the Netherlands.
E-mail address: e.vanlieshout@erasmusmc.nl (E.M.M. Van Lieshout).

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hospital stay, physical therapy, home care, nursing care, and rehabilitation are not available. The insight in direct and indirect medical costs and costs for lost productivity could offer tools for cost reduction and gives direction to future demands.

Therefore, the purpose of this nationwide study was to provide an overview on the incidence rate of femoral shaft fractures over a 15-year period and to provide insights in health care consumption and productivity costs in the Dutch population. The hypothesis was that incidence rate is highest in young adult males, and health care costs are highest in the elderly.

Methods

Collecting data

Data were collected for patients who sustained an acute femoral shaft fracture in the period January 1, 2005 to December 31, 2019. The same method from earlier studies was used [6–8]. Injury cases were extracted from the National Medical Registration (LMR) of the Dutch Hospital Database (DHD), Utrecht, the Netherlands. The DHD collects data of all hospitals in the Netherlands with a uniform classification system and has an almost complete national coverage (missing values <5 %, except 12 % in 2007). These figures were extrapolated by the Consumer Safety Institute to full national coverage for each year. An extrapolation factor was estimated by comparing the adherence population of the participating hospitals with the total Dutch population in each year using the population data obtained from Statistics Netherlands [9,10]. Patients are included in the LMR for their main diagnosis at discharge, defined by the International Classification of Diseases (ICD) 9th and (since 2010) 10th revision. The following codes were used for identifying patients with a femoral shaft fracture; ICD-9 codes, group 821 with subgroups 821.01 and 821.11 (closed fracture of shaft of femur and respectively open fracture of shaft of femur) were included. From the ICD-10 database, group S72 with subgroup S72.3 (fracture of shaft of femur) was included. The study was exempted by the local Medical Research Ethics Committee Erasmus MC (No. MEC-2022–0201).

Calculation of incidence rates

Age- and sex-specific incidence rates were calculated in 10-year age groups for each year of the study. In order to adjust for differences in the demographic composition over time, incidence rates were standardized for age (in 10-year age groups) and sex using a direct standardization method, as previously described [11]. In short, the age- and sex-specific incidence rates per 100,000 person years were calculated upon Dutch mid-year standard population, data was retrieved from the Statistic Netherlands database [10].

Trauma mechanism and hospital length of stay

Data regarding trauma mechanism and hospital length of stay (HLOS) were extracted from the LMR database for 10-year age categories and for males and females separately. Trauma mechanisms were grouped into traffic accident versus “other”. Femoral shaft fractures due to falling from standing height or less or fractures sustained due to other low energy trauma was categorized as “other”. In order to assess trends over time, data were averaged over 5-year intervals; 2005–2009, 2010–2014, and 2015–2019.

Health care and productivity costs

Data on patient numbers and health care used were retrieved from the LMR database for 10-year age categories and for males and females separately. These were supplemented with data from a patient follow-up survey with questions relating to health care use outside the hospital, work absence, and health related quality of life (HRQoL) [12]. HRQoL was assessed with the EQ-5D classification, productivity costs were assessed with data from the LMR and a patient follow-up survey on health care use [12]. The EQ-5D is a questionnaire in which health is defined along five dimensions; mobility, self-care, usual activities, pain or discomfort, and anxiety or depression. An extra dimension, cognitive disability, was added in the previous study [12]. The Dutch Burden of Injury Model was used in order to assess the health care costs of injury [11,13,14]. Medical costs included ambulance care, in-hospital care, general practitioner (G.P.) care, home care, physical therapy, and rehabilitation/nursing care. Patients were followed until two years after trauma. Health care costs were calculated by multiplying incidence and health care volumes with unit costs (e.g., costs per day in hospital). National guidelines for health care costing were used in order to estimate unit costs [15]. Productivity costs were determined as described by Putter et al., and were defined as the costs associated with production loss and replacement due to illness, disability, and premature death [16, 17]. To estimate costs for productivity loss for all patients aged 15–64 years the absenteeism model was used. The friction cost method was used because healthcare needs are most substantial in the first year after injury for the majority of injuries [18]. Outcome data were averaged for the last 5 years of the study period (i.e. 2015–2019), the data was calculated for 10-year age categories and for males and females separately.

Years lived with disability

The number of years lived with disability (YLD) was calculated as described in previous studies [7,12,15]. In summary the YLD was calculated based on a generic health-status classification, the EQ-5D, as described above. The YLD was obtained by linking the incidence data (subdivided into injury diagnosis groupings) with disability information that is the proportion of injury cases with lifelong consequences, and injury-specific disability weights of temporary and lifelong consequences. The number of years lived with disability was calculated from the patient follow-up survey mentioned above [12,15]. The model described by Haagsma et al. and Pollinder et al. was used to calculate the disability weights from empirical follow up data on the health-related quality of life of individual trauma patients, and adjusted for population norms, age and sex [12,19]. The disability weight reflects the impact of a health condition in terms of health-related quality of life; it has a value ranging from 1, indicating full health, to 0, worst imaginable health state [19]. Data gathered during the 5-year interval 2005–2019 were used for this study. Data was calculated for 10-year age categories and for males and females separately.

Results

Incidence rates

During the 15-year study period, a total of 15,847 patients sustained a femoral shaft fracture in the Netherlands. The incidence rate increased by 13 % over time, from 5.7 per 100,000 person years in 2005 to 6.5 per 100,000 person years in 2019 (Fig. 1). There is a bimodal distribution of femoral shaft fractures in incidence rates and in sex. Mostly young men (<40 year) account for the first high incidence rate whereas females above the age of sixty mostly account for the second high incidence rate. The second peak of the incidence rate in femoral shaft fractures, is higher than the first, Fig. 1C. This is explained by the smaller group of people of 80+ compared to the younger patients.

Trauma mechanism

Fig. 2 shows the percentage of patients who sustained a femoral shaft fracture due to a traffic accident. The percentage of femoral shaft fractures caused by a traffic accident increases from 14.5 % in patients aged 0–9 years to 78.4 % in patients aged 20–29 years. Above the age of 30

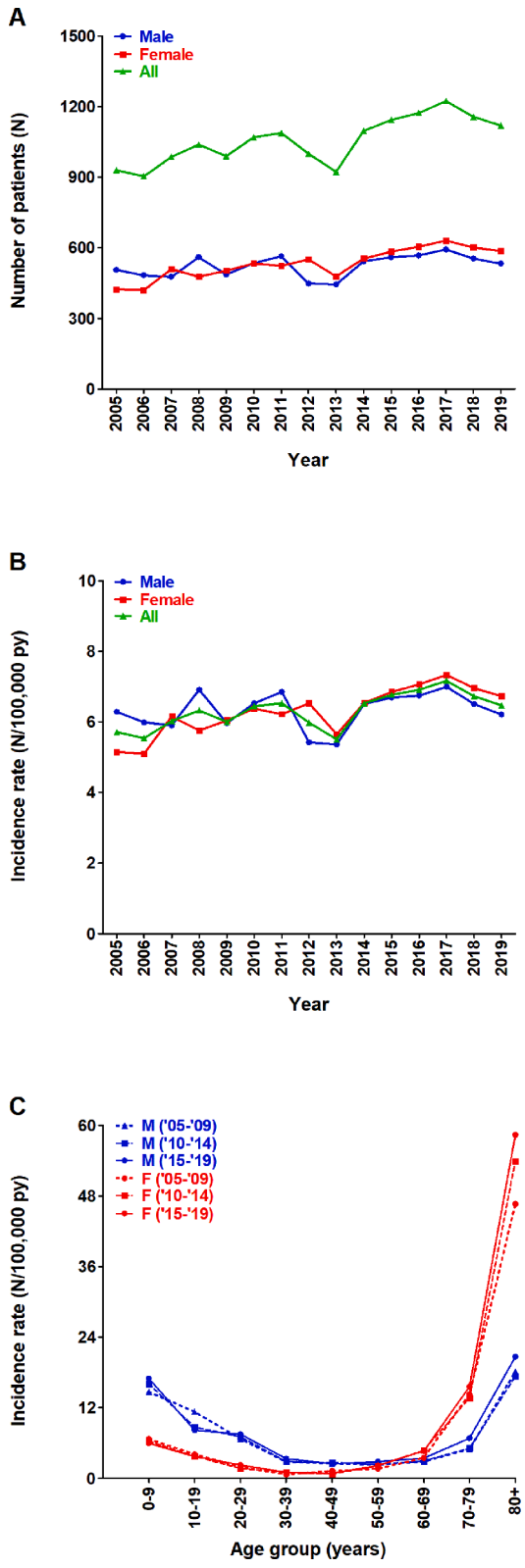

Fig.. 1. Patient numbers in the years 2005–2019 (A), incidence rate (per 100,000 person years) in the years 2005–2019 (B), and age-related incidence (C) of femoral shaft fractures in the Netherlands

Data are shown for all patients (green) and for males (blue) and females (red) separately. Of panel C, data are averaged over 5-year periods (i.e., 2005–2009, 2010–2014, and 2015–2019) and are shown for 10- year age groups.

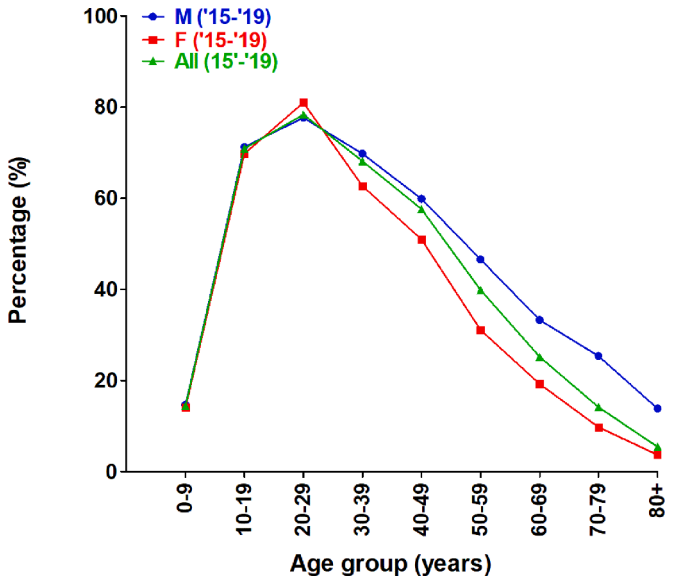

Fig.. 2. Age-related percentage of patients sustaining a femur shaft fracture due to a traffic accident

Data (averaged for the years 2015–2019) are shown for the entire group (green) as well as for males (blue) and females (red) separately for 10-year age groups.

the number of fractures caused by traffic accidents decreased by age, this is more pronounced in females; the percentage declined to 3.7 % in the >80 year group in females versus 13.9 % in males. The distribution in trauma mechanism remained stable over time (data not shown).

Hospital length of stay

Data of HLOS in three consecutive five-year cohorts are shown in Fig. 3. The mean HLOS per patient declined over time from 13.8 in 2005–2009 to 8.4 in 2015–2019. The HLOS per patient increased with age (mean 10,0 days for age group 0–9 and mean 12.7 days for age group >80).

Due to a higher incidence rate, the cumulative HLOS per year shows a steep increase in female above the age of 60 and in males until 30 years (Fig. 3C and D). Both peaks have declined over time. The biggest decrease was seen in male aged 10–19 year, a decrease of 55 % (from 1039 days in 2005–2009 to 462 days in 2015–2019), for female the biggest decrease was seen in patients >80 year, from 3354 days in 2005–2009 to 2483 days in 2015–2019 (i.e. respectively −26 %).The mean HLOS per case in patients >80 years in 2005–2009 was 18.0 days and in 2015–2019 the mean HLOS per case was 9.0 days.

Total costs and health care costs

The total costs for femoral shaft fractures in the period 2015 and 2019 were €26.4 M (5.3Mper year), of which €14.4 M (54.6 %) were due to femoral shaft fractures in females. The costs per patient and the cumulative costs are shown in Figs. 4 and 5, respectively.

The total costs per patient were €16,000 and are higher for female (€21,000) than male (€12,000); Fig. 4. In both sexes the costs rise with age, up to €29,000 in female patients >80 year. This difference between male and females is mainly due to the higher consumption of rehabilitation and nursing care in the older females (50 % in female patients >80 years). Up to the age of 50 costs made in the hospital were the highest regarding health care costs, this addresses both male and female. Combined with the incidence, the cumulative health care costs for femoral shaft fractures are €19.2 M per year. More importantly, 40 % (€8.4 M) of these cumulative costs were made in female patients >80 year.

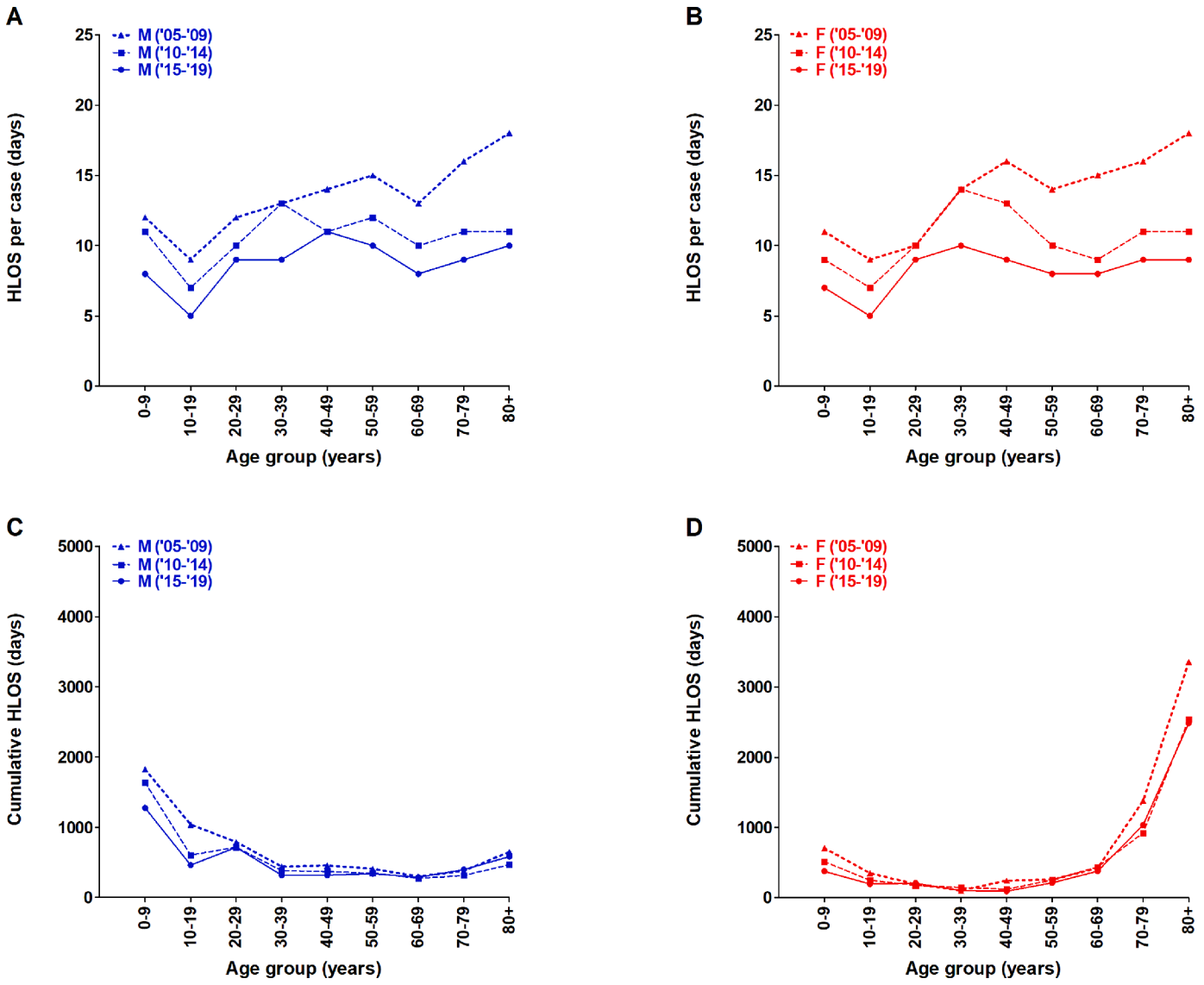

Fig.. 3. Age-related hospital length of stay per patient (A and B) and cumulative hospital length of stay (C and D) of patients with a femoral shaft fracture
Data are shown for 10-year age groups, for males (blue, A and C) and females (red, B and D), and for 5-year time periods (i.e., 2005–2009, 2010–2014, and 2015–2019).

Productivity costs

The total costs for loss of productivity were €7.2 M (€5.4 M for males and €1.8 M for females). The cumulative costs due to work related absence was higher in male, mostly due to the higher incidence of femoral shaft fractures in non-working population of female. Mean costs per patient for lost productivity were €26,000 for males and €17,000 for females, respectively. The costs for loss of productivity were highest for patients between the age of 40–49 and 50–59 for both sexes.

Years lived with disability (YLD)

YLD per patient declined linearly over age, Fig. 6a. There was no relation with gender. The YLD per patient declined from 4.8 years in the age group 0–9 to 0.5 years in the patients >80 years.

Discussion

Between 2005 and 2019 a total of 15,847 patients sustained a femoral shaft fracture in the Netherlands, the incidence rate of femoral shaft fractures increased with 13 % during this 15 years. Current study showed that since 2005 the mean HLOS per patient decreased for both male as female over time, form 13.8 days in 2005–2009 to 8.4 days in 2015–2019. The mean HLOS increases by age. The mean YLD for femoral shaft fractures in the Netherland is 2.6 years, which is higher in the young. The highest health care costs were seen in female patients >80 year, they account for 40 % of the cumulative health care costs.

The increase in femoral shaft fractures may be attributed to the increasing number of elderly and the increasing traffic in the Netherlands [20]. Previous studies showed a higher incidence rate of femoral shaft fractures than what this study revealed; 6.47 per 100,000 person years [2–5]. Overtime the already known bifocal model of age distribution in incidence rates and trauma mechanism remains unchanged. Over time there are two peaks with a higher incidence rate of femoral shaft fractures, the young men (<40 year) as a result of high-energy trauma (i.e. traffic accidents) and in the “elderly” woman (>60 years) usually the result of low-energy trauma.

No studies have previously described a loss of HLOS for femoral shaft fractures, the same phenomenon is seen in other long bone fractures such as humeral fractures and tibia shaft fractures [7,8]. The biggest

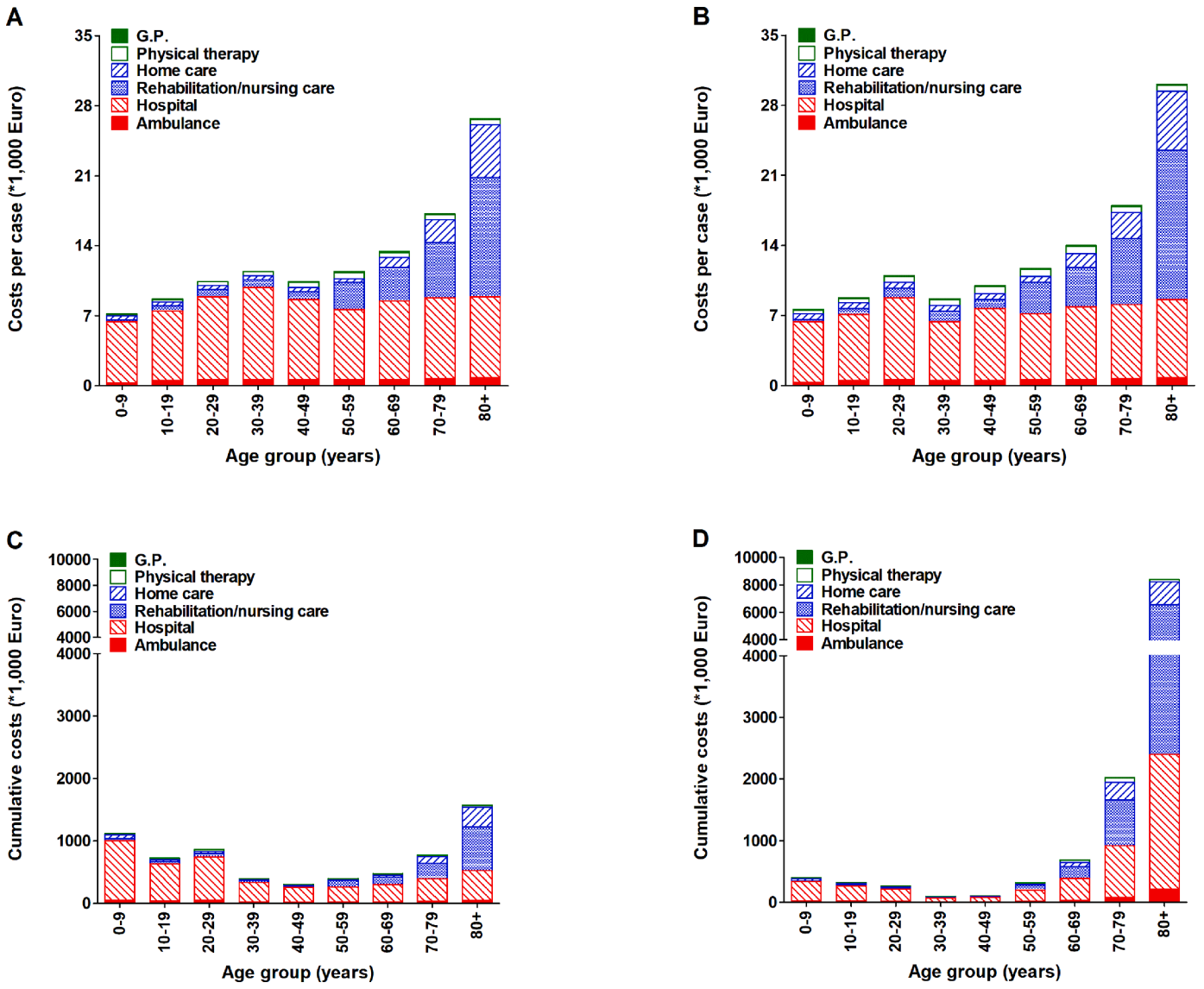

Fig.. 4. Age-related direct and indirect medical costs per patient (A and B) and cumulative cost (C and D) in males (A and C) and females (B and D) with a femoral shaft fracture
Data (averaged for the years 2015–2019) for six main cost categories are shown for 10-year age groups.

decrease of HLOS was seen in females above 80, this is most likely the result of faster postoperative allocation of the patient for rehabilitation over the years. Although current data do not allow to draw a conclusion, the decrease in LOS is most likely attributable to earlier transfer to nursing or rehabilitation facilities, due to advanced hospital protocols and care pathways.

There is a difference in the LOS between elderly males and females. This could be due to the fact that most women outlive their husbands and live alone. Until the end of life, most men who fracture their femur are supported in activities of daily living (ADL) by their spouse. When elderly women fracture their femur, they more often live alone and require home care (or admission in a nursing home with prolonged HLOS) for ADL support.

The somewhat high number of HLOS for femoral shaft fractures may be explained due to the fact that the cohort did not exist of purely isolated shaft fractures, but also included polytrauma patients. This could also explain the small difference in hospital costs per case between young patients and the elderly. Young patients with a femoral shaft fracture are more frequently polytrauma patients, and require more surgical treatment for other injuries.

The present study is the first to describe age- and sex specific outcome on YLD for femoral shaft fractures. Earlier studies did not discriminate between hip and upper leg injuries [21]. For femoral shaft fractures the mean YLD was 2.6 year, the YLD was high in the young population and decreases with age.

With roughly €5.0 million cumulative costs a year and with high costs for lost productivity, femoral shaft fractures pose a serious societal health burden. These high costs are based on loss of productivity in the working population and on substantial health care consumption of elderly. Mean costs per patient due to lost productivity were €14,700 for males and €9400 for females. For health care consumption the mean costs were €12,900 for males and €13,300 for females. The health care costs are slightly higher than earlier reported by a large study from the USA [22]. The difference can partially be explained by inflation, but more important is the length of the study, the study calculated the costs based on six months follow-up. Not 100 % of the patients with a femoral shaft fracture return to work within six months. Compared with other fractures, femoral shaft fractures have higher mean direct health care costs per patient (€13,300 for femoral shaft fractures versus €3461 for foot and ankle fractures, €6785 for rib fractures, and €8864 for humeral

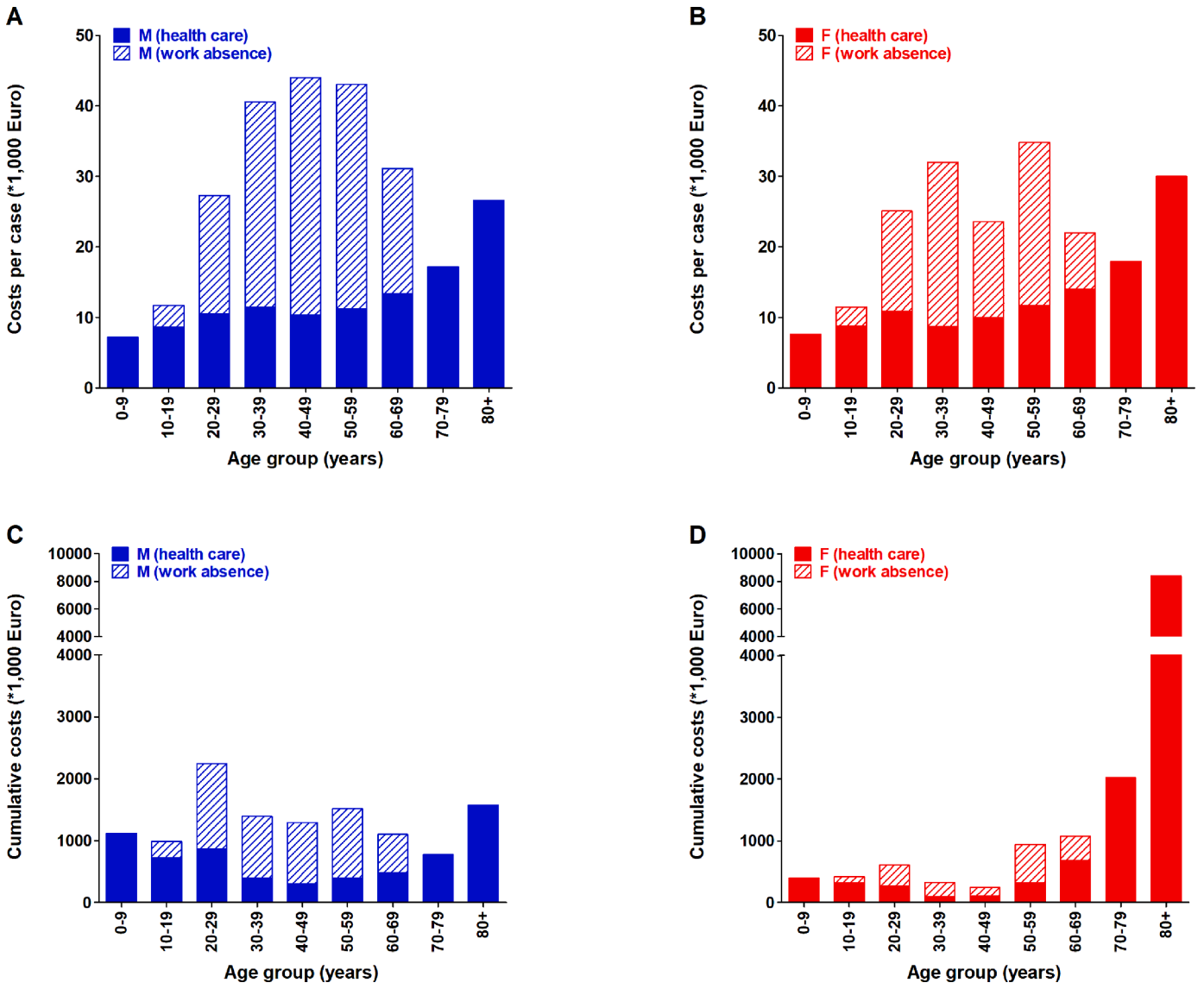

Fig.. 5. Age-related direct and indirect costs per patient (A and C) and cumulative costs (B and D) in males (A and C) and females (B and D) with a femoral shaft fracture

Data (averaged for the years 2015–2019) are shown for 10-year age groups.

fractures (all Dutch studies with the same data source as ours)) [6,8,23]. This could be explained by the LOS for patients with a femoral shaft fracture.

The National Medical registration has a national coverage, thus data from both rural and urban areas and all levels of trauma care are included in this study. This should support generalizability of our findings to developed countries in the world with a similar health care system as the Netherlands.

One strength of this study is the use of population-based data for femoral shaft fractures, this provides long-term trends and reliable data. Secondly, this is the first study to report about years lived with disability, hospital length of stay, and health care costs for femoral shaft fractures derived from a large population based study. Also, this study provided age- and sex specific costs which helps in allocation of health care resources and helps with any improvement if necessary.

The data of this study give insight in health care costs and costs for lost productivity which can be used for cost reduction, especially for future demands with an increasing population and increasing health care costs. Research focus for younger patients could be on identifying the surgical approach and rehabilitation program that are associated with the lowest time to functional recovery and the shortest duration of work absence. For the elderly the focus should be more on prevention of femur fractures, minimally invasive surgical techniques, and rehabilitation.

Population-based studies also have limitations. First, the data presented on health care and productivity costs are best estimates and not exact numbers for these specific patients but data based on validated models and calculations. An important limitation is the patient selection with the ICD codes in the LMR. Patients are included in the LMR for their main diagnosis at discharge only, which is generally the most severe injury. Patients with more severe injury than a femoral shaft fracture could be missing. This could be another explanation for the lower incidence rate compared to other studies. Another limitation is the lack of information regarding the clinical details of the patient and the injury. Since most patients who sustain a femoral shaft fracture are young and healthy, no major variation is to be expected between patients. The last limitation is the fact that femoral shaft fractures are usually the result of high-energy trauma and are accompanied with other injuries. These injuries may increase the HLOS, therefore the results of HLOS need to be interpreted with care.

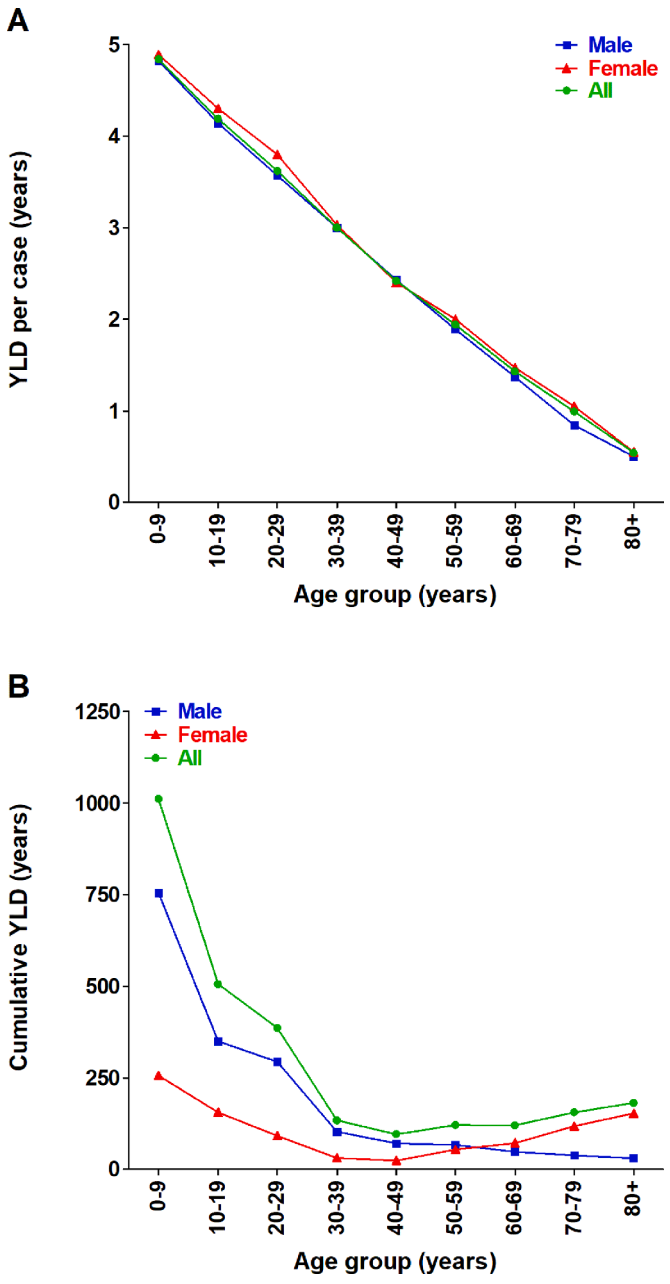

Fig.. 6. Age-related years lived with disability per patient (A) and cumulative years lived with disability (B) in patients with a femoral shaft fracture
Data (averaged for the years 2015–2019) are shown for the entire group (green) as well as for males (blue) and females (red) separately for 10-year age groups.

Conclusion

Current study showed an increase of 13 % in the incidence rate of femoral shaft fractures over the last 15 years in the Netherlands, whereas the HLOS decreased the last 15 years in all age groups and for both sexes. The total health care costs per patient were €16,000 and were higher for females (€21,000) than males (€12,000). In both sexes, both more pronounced in females, the costs rise with age up to €29,000 in patients >80 year. Combined with the incidence rate, the cumulative health care costs for femoral shaft fractures are €19.2 million per year, female patients >80 years accounted for 40 % of these costs (€8.4 million). Costs for lost productivity were €26,000 per patient for males and €17,000 for females, the highest costs were seen in the age of 40–49 and 50–59 for both sexes.

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Code availability

Not applicable.

Declaration of Competing Interest

All authors declare that they have no conflict of interests or any competing interests.

Data availability

Data is available when needed.

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