Osteoporos Int
DOI 10.1007/s00198-016-3544-4

ORIGINAL ARTICLE

Quality of life, resource use, and costs related to hip fracture in Estonia

M. Jürisson [1] · **H. Pisarev** [1] · **J. Kanis** [2] · **F. Borgström** [3] · **A. Svedbom** [4,5] · **R. Kallikorm** [6] · **M. Lember** [6] · **A. Uusküla** [1]

Received: 27 September 2015 / Accepted: 15 February 2016

Abstract
Summary We assessed the impact of hip fracture on health-related quality of life (HRQoL) and costs in Estonia. The mean 18-month HRQoL loss in quality adjusted life years (QALY) was estimated at 0.31, and the average cumulative cost from a societal perspective was 8146 euros per hip fracture patient.
Introduction The aim of this study is to estimate the impact of hip fracture on HRQoL, resource consumption, and cost over 18 months after the fracture among individuals aged over 50 in Estonia.
Methods A cohort of 205 hip fracture patients ≥50 years was followed up for 18 months. HRQoL was estimated before fracture (recall), after fracture, and at 4, 12, and 18 months using the EQ-5D instrument. Health care utilization and costs were obtained from a public health insurance fund database; social, informal, and indirect costs were estimated using patient-reported data.
Results Hip fracture resulted in the mean 18-month HRQoL loss of 0.31 QALYs. The mean 18-months cumulative cost of hip fracture from a societal perspective was estimated at 8146 (95 % CI 6236–10717) euros per patient. Most of the cost was related to health care (56 %) and informal care (33 %), while social care contributed only 5 %. Utilization of outpatient rehabilitation and nursing care was low (8 % of patients).
Conclusions The impact of hip fracture on HRQoL and cost was substantial. Despite appropriate inpatient care, utilization of rehabilitation, nursing care, and social care were low and potentially insufficient to meet the needs of patients with low HRQoL. The shortfall may partially explain a remarkably high use of informal care.

Keywords Cost of illness · Disease burden · Estonia · Health-related quality of life · Hip fracture · Osteoporosis · Resource use

Electronic supplementary material The online version of this article (doi:10.1007/s00198-016-3544-4) contains supplementary material, which is available to authorized users.

✉ M. Jürisson
mikkjurisson@gmail.com

[1] Department of Public Health, University of Tartu, Ravila 19, 50411 Tartu, Estonia

[2] Centre for Metabolic Bone Diseases, University of Sheffield Medical School, Beech Hill Road, Sheffield S10 2RX, UK

[3] Medical Management Centre, Karolinska Institutet, Stockholm, Sweden

[4] Mapigroup, Klarabergsviadukten 90, Hus D, 111 64 Stockholm, Sweden

[5] Unit of Dermatology and Venereology, Department of Medicine, Karolinska Institutet, Karolinska Universitetssjukhuset, 171 76 Stockholm, Sweden

[6] Department of Internal Medicine, University of Tartu and Tartu University Hospital, L. Puusepa st 8, 51014 Tartu, Estonia

Introduction

Hip fractures are associated with significant excess morbidity, mortality, and cost [1–3]. The lifetime probability of hip fracture at the age of 50 ranges from 11 to 23 % [4] and the excess mortality during the first year after fracture ranges from 8.4 to 36 % [5]. The societal costs of hip fractures are comparable to those of other common non-communicable diseases such as coronary heart disease and cerebrovascular disease [6]. Mean health-related quality of life (HRQoL) loss during the first 4 months after hip fracture has been found to range from 0.12 to 0.21 quality adjusted life years (QALY), exceeding

Published online: 23 February 2016

that of other osteoporotic fractures [7]. The reduced survival, reduction in HRQoL, and high costs make hip fractures a major public health issue, posing a significant burden on both individuals and society [6, 8]. With increased longevity, the number of hip fractures will continue to increase globally in the coming years [6, 9, 10].

Concerns about rising health care costs have been accompanied by a need for cost-effectiveness analyses for hip fracture prevention and treatment [7, 11, 12]. To conduct these evaluations, HRQoL and cost estimates are required. However, country-specific HRQoL and economic data are scarce [6, 7] and cost studies are context-specific and cannot be used to inform policy debate in other populations. HRQoL and cost estimates are also needed to assess disease burden [6, 7], generate public interest, and prioritize research funding [13].

Estonia is a country with low healthcare spending (6.0 % of GDP, equivalent to 1542 US dollars per capita) in comparison to Sweden (11.0 % of GDP, equivalent to 4904 US dollars per capita) or the USA (16.4 % of GDP, equivalent to 8713 US dollars per capita) (2013 data) [14]. Estonia has a universal public health insurance system, covering 94 % of the population [15].

The aim of this paper was to estimate the impact of hip fracture on HRQoL, resource consumption, and cost over 18 months after the fracture among individuals aged over 50 in Estonia.

Methods

We followed a cohort of hip fracture patients in Estonia for 18 months after fracture. The study was part of the International Costs and Utilities Related to Osteoporotic Fractures Study (ICUROS) which has been described elsewhere [7].

Setting and patients

A convenience sample of consecutive consenting patients with low-energy trauma hip fractures attending the departments of traumatology and orthopedics of Tartu University Hospital and East Tallinn Central Hospital was recruited from November 2010 to October 2012. Patients were followed up at 4, 12, and 18 months after the fracture or until death.

Patients aged ≥50 years diagnosed with hip fracture who were interviewed within 2 weeks after fracture were eligible for inclusion. Patients with fractures caused by comorbidities, e.g., cancer, patients with multiple fractures, patients with cognitive disabilities (judged not to be able to complete the questionnaire), and previously institutionalized patients were excluded. In the case of any new fracture during the course of follow-up, the participation was discontinued and the patient excluded from further data collection [7].

No formal statistical power calculation was conducted [7]. Recruiting 200 patients with hip fracture was judged to be an appropriate target sample size to produce stable country estimates of HRQoL and cost based on the experience of previous similar study from Sweden [7, 11, 12]. The recruiting hospitals provided about 40 % of the hip fracture inpatient care in Estonia in 2012 [16].

Informed consent was obtained from all participants, and the study was approved by the Research Ethics Committee of Tartu University.

Data collection

Patient interviews

Information was collected by trained interviewers at the hospital during the initial inpatient stay in face-to-face interviews and by study researchers during follow up at months 4, 12, and 18 post fracture via phone interviews.

Interviews were conducted using a structured questionnaire based on the ICUROS study clinical research form (CRF) (available in English and Russian) [7]. The questionnaire was translated into Estonian; the team of researchers discussed the translations and agreed the “best fits” for items. The Estonian translation was also compared to the original CRF (English version) by back-translation.

The CRF elicited information on patient and socio-demographic characteristics (date of birth, gender, education, working/living status, income), history of previous osteoporotic fractures, history of contacts with health care services for the hip fracture episode, use of non-prescription drugs, non-medical (social care and informal care) and indirect (working status) resource use, HRQoL (the EQ-5D-3L instrument [17]), and contact information. At the first interview in addition to current (after fracture) HRQoL assessment, recall-based pre-fracture estimation of the HRQoL was obtained.

Data from the Health Insurance Fund database

Data on fracture-related health services utilization and costs were abstracted from the Estonian Health Insurance Fund (EHIF) database. The EHIF is practically the sole health insurance provider in Estonia covering 94 % of the population [18].

Health care utilization data (in- and outpatient care, prescription medicines) for all hip fracture patients aged over 50 years receiving care at the two recruiting clinics over the recruitment period were abstracted. For each patient, data were abstracted for the index (hip fracture) episode (using the International Classification of Diseases, Tenth Revision (ICD-10), codes: S72.0—fracture of femoral neck, S72.1—per-trochanteric fracture, and S72.2—sub-trochanteric fracture on the health care claim), and for health services/medications provided 12 months before and up to 18 months after the index episode (dates, services provided, treatment type (in- or outpatient), specialty of the provider, costs), and the date of death. Data on prescription drugs considered relevant for treatment of osteoporotic fractures (bisphosphonates, denosumab, strontium ranelate, teriparatide, estrogens/receptor modulators, glucocorticoids, calcium, vitamin D supplements, analgesics) [7, 12] (ATC-code, date of purchase, cost, cost-sharing (patient/EHIF)) were extracted.

In addition to the data on study participants, data on patients aged over 50 years treated in the same departments during the recruitment period but not recruited in the study (non-participants) were abstracted from the health insurance database. For study participants, the extracted data contained personal identification codes; for non-participants, the data contained pseudo-identification codes which allowed longitudinal tracking of the medical care provided to an individual but did not permit personal identification. For non-participants, information on age and gender was abstracted in addition to health care utilization data.

Measures

HRQoL We used an indirect method to measure HRQoL from the EQ-5D-3L [17] applying preference-based utility values from a UK study [19]. HRQoL loss in QALYs were used as a summary measure of health outcome and calculated as the area under the curve using the trapezoid method [20]. The formulas for calculating HRQoL loss are given below:

$$\text{HRQoL loss}_{0-6m} = \frac{6}{12} Q_B - \frac{4}{12} \frac{Q_A + Q_4}{2} - \frac{2}{12} \frac{Q_4 + \frac{Q_{12} + 3\,Q_4}{4}}{2}$$

$$\text{HRQoL} \quad \text{loss}_{7-12m} = \frac{6}{12} Q_B - \frac{6}{12} \frac{Q_{12} + \frac{Q_{12} + 3\,Q_4}{4}}{2}$$

$$\text{HRQoL} \quad \text{loss}_{13-18m} = \frac{6}{12} Q_B - \frac{6}{12} \frac{Q_{12} + Q_{18}}{2},$$

where Q_B = pre-fracture HRQoL, Q_A = HRQoL after fracture, $Q_{4,\ 12,\ \text{and}\ 18}$ = HRQoL at 4, 12, and 18 months. HRQoL loss in QALYs was estimated among surviving patients who completed the study period and whose HRQoL estimates were available.

Disease burden To estimate the disease burden by hip fracture patient, the mean hip fracture-related QALY loss was calculated by adding the lost life years (until the end of study follow-up) of patients whose death was attributable to hip fracture to the HRQoL loss estimate in survivors. The lost life years attributable to fracture was based on a difference between observed and expected number of deaths (excess mortality). Expected number of deaths was calculated from the Estonian life tables [21]. The cost burden estimate was calculated likewise.

Comorbidities Data on comorbidities was assessed using the Charlson comorbidity index (CCI) to measure burden of disease and case mix [22]. We used the revised coding algorithm that has been validated for estimating comorbidity burden using ICD-10 coded administrative data [23], and the updated disease weighting suggested by Quan in 2011 [24]. The CCI assessment for all hip fracture patients (participants and non-participants) was based on the EHIF health service claims of the index episode and all in- and outpatient health care claims (not only hip fracture care related) from the 12 months before the fracture [25].

Resource use and cost data sources

We considered fracture-related resource use and costs using a societal perspective [26].

Data on fracture-related health care services and prescription drug use were obtained from the EHIF database using ICD-10 codes (as specified above). Inpatient care was categorized as specialty care (traumatology and orthopedics), nursing care, and rehabilitation (e.g., physiotherapy, occupational therapy) conducted during an overnight stay. Outpatient care comprised family practitioner's/nurse's office and home visits, visits to specialty physicians (orthopedist), home nursing, and rehabilitation. Nursing care is part of the health care system in Estonia, and can be delivered either in licensed nursing care institutions (hospitals) or in patients' homes [18]. Unit costs of health care services are presented in e-Table 1. Patient charges for specialty care (2.50 euros per day for a maximum of 10 days per hospitalization episode; 5.00 euros for the first outpatient visit in 3 months; and 7.38 euros per bed-day in a nursing care institution (at 2014 prices) [18]) were added to each claim from the EHIF. Information on use of non-prescription drugs (e.g., analgesics, calcium, and vitamin D supplements) was collected at each follow up from patient interviews, using 4 weeks recall and extrapolating the reported use over the respective follow-up period.

Data on fracture-related use of social (community) care (days of living in nursing home, hours of home help by social worker per week, use of assistive devices, transportation) and informal care (hours of home help by relatives and friends per week) were collected from patient interviews, using 4 weeks recall at each follow-up data collection time point, and the results were extrapolated over the respective follow-up period, excluding the days of inpatient care, if any. To obtain the cost of social care, unit costs were attributed to the self-reported service use. The cost of living in nursing home/home for the elderly (unit cost = 24 euros per day) was obtained from the Ministry of Social Affairs [27], and the costs of home visit by a social worker (unit cost = 3.45 euros per visit) and transportation (unit cost = 25 euros) were obtained from Tallinn Municipality social welfare services 2014 price list [28]. The cost of assistive devices (walking aids, hygiene, home modifications) was based on data provided by patients during interviews. To estimate the cost of informal care, a replacement cost method was used by assigning a cost of home help by a social worker [28].

The indirect cost (the value of lost production related to sick leave and early retirement) was estimated using the human capital approach by assigning a self-reported net income level and tax (including employer's contribution) for the time spent in the study that patients would have worked had they not sustained a fracture [29]. As with other self-reported resource use, data on the number of days on fracture-related sick leave was collected using 4 weeks recall, and extrapolated using the assumption that the leave started from the beginning of the respective follow-up period. The working status was recorded at each follow-up interview and if retirement was reported, it was assumed to having commenced in the middle of the relevant follow-up period.

All costs were presented in euros at 2014 prices, adjusted for the Estonian consumer price index [30].

Statistical analysis

We present the number of hip fracture patients enrolled, the number of patients in the study at 4, 12, and 18 months, and the number of patients who dropped out by reason (died, were lost to follow-up, left the study at their own request, or had a new fracture). The following patient characteristics are presented: gender (number, proportion of women); age (mean, standard deviation (SD), and distribution by 10-year age groups); CCI (mean, SD, range, proportion by score group (0, 1–2, 3–4, ≥5), and index disease components); previous fracture during 5 years (number, proportion); level of education and income, working and living status; and number of days to interview from the first contact with health care for the fracture (mean, SD). Age-standardized mortality rates per 1000 population along with 95 % confidence intervals at 12 and 18 months after the fracture were estimated using direct standardization to the WHO world standard population [31].

We followed a general rule to include all patients in the analysis while the relevant data for a specific outcome measure were available. The health care resource utilization and cost data from the health insurance database were available for all recruited patients (including patients who died or were lost to follow-up) until the end of the study or until death. The patient reported data on HRQoL, social care, informal care, and working status were available for all patients until the last follow-up, i.e., only for patients who completed the respective follow-up. For each outcome measure, the sample size is presented by follow-up period.

We present EQ-5D estimates at 0, 4, 12, and 18 months stratified by age, gender, and CCI. To estimate the HRQoL loss in QALYs over 18 months, we estimated the difference between linearly interconnected HRQoL time-point estimates and pre-fracture level, using the assumption that the patient would have remained at the pre-fracture level of HRQoL had the fracture not occurred [7]. The follow-up periods varied in duration (from 4 to 8 months); to increase comparability between periods, we calculated the mean HRQoL loss in 6-month periods (0–6, 7–12, and 13–18 months after fracture) by linearly interpolating the 6 month estimate. The estimated HRQoL loss in QALYs is undiscounted.

EQ-5D and HRQoL loss estimates are presented as means with 95 % confidence intervals. Acknowledging the skewed distribution of utilities and HRQoL loss estimates, we used box plots to summarize the data (presenting the medians, quartiles, and range). We also present the proportion of fully recovered patients (who achieved at least 100 % of pre-fracture HRQoL) at 4, 12, and 18 months.

Health care, social care, and informal care resource utilization are presented as the number of patients receiving care and the mean number of service units for patients who used the resource in question (admissions, bed-days, visits, and hours per week) along with bootstrapped bias corrected and accelerated 95 % confidence intervals, by follow-up period (0–4, 5–12, and 13–18 months), and cumulative use over 18 months. Work-related resources are presented as the number of patients and days on sick leave, and the number of patients on early retirement. Resource-related costs are presented in a similar fashion in e-Table 1 (along with the medians, quartiles and ranges). The average cost and cost structure per hip fracture patient is presented for the follow-up periods and as a cumulative cost over 18 months.

Comparison of groups

To interpret generalizability of results, the case mix (gender, age, comorbidity, and mortality) was compared between study participants and other patients (non-participants) aged over 50 years receiving hip fracture care at the two recruiting hospitals (based on data from the EHIF) during the recruitment period. We used a Mann-Whitney non-parametric test for the differences in means (age, CCI score, HRQoL, and costs), X^2 test for categorical variables (age groups, CCI score groups, and disease components), and 95 % CI-s for mortality rates. Age, CCI, and HRQoL were compared between patients who died or were lost to follow-up and those remaining in study using a Mann-Whitney non-parametric test.

Statistical significance was set at 0.05 (5 %). All statistical analysis was performed using Stata version 12.1.

Results

Patient characteristics, recruitment, and retention

Characteristics of participants and non-participants are presented in Table 1.

Of the 767 patients with hip fractures who were treated at the two clinics during the study period, 205 (26.7 %) participated in the study. The retention rate throughout the study was 60 % (154 patients (75 %) at 4 months, 128 patients (62 %) at 12 months, and 123 patients (60 %) at 18 months). Among those not followed up, 33 were lost, 45 died, 1 patient withdrew consent, and 3 sustained a new fracture.

Among the 205 study participants, all were hospitalized as a result of the fracture and 189 (92 %) were admitted via an emergency department; 45 (22 %) reported osteoporotic fracture during the last 5 years; the majority had only primary (70, 34 %) or secondary (100, 49 %) education, low net income (181, 88 %; low defined as ≤500 euros per month), and almost half (96, 47 %) of the patients were living alone. Thirteen (6 %) (mean age 61.7, range 50.1–77.7 years) were working (all full time) before the fracture. On average, study participants were interviewed within 3.9 (SD = 2.5) days of the first healthcare contact for the fracture.

Non-participants were on average 1.7 years older ($p = 0.008$) and had a higher CCI score than participants ($p = 0.004$), predominately reflecting a higher prevalence of heart failure ($p = 0.051$) and dementia ($p = 0.0003$). Age-standardized mortality at 12 and 18 months was (statistically non-significantly) higher among non-participants.

Patients who died during follow-up were older (82.4 vs. 77.0 years, $p = 0.002$) and had higher CCI score (1.7 vs. 1.0, $p = 0.002$) than those who remained in the study. Patients who were lost to follow-up were statistically non-significantly younger (73.6 years, $p = 0.13$) and had similar CCI score (0.95, $p = 0.85$) compared to retained patients.

HRQoL

The HRQoL estimates and loss in QALYs among survived patients are presented in Fig. 1. The mean HRQoL was 0.67 (95 % CI 0.63–0.71) before fracture, 0.07 (95 % CI 0.01–0.12) after fracture, 0.42 (95 % CI 0.36–0.47) at 4 months, 0.54 (95 % CI 0.49–0.60) at 12 months, and 0.60 (95 % CI 0.54–0.65) at 18 months. The mean HRQoL loss was estimated at 0.16 QALYs in the first 6 months, 0.09 in the following 6 months, and 0.06 in the last 6 months, resulting in a mean total of 0.31 QALYs lost during 18 months. Thirty percent of patients were fully recovered at 4 months, 41 % at 12 months, and 49 % at 18 months.

HRQoL estimates stratified by age groups, gender, and CCI groups are presented in Fig. 2. There was a tendency for lower HRQoL among older participants, those with higher CCI scores, and women.

Patients who died during a particular follow-up period had lower HRQoL at the start of the period than patients who completed that period, albeit the differences were not statistically significant (mean HRQoL: pre-fracture 0.63 vs. 0.66 ($p = 0.52$), after fracture −0.06 vs. 0.09 ($p = 0.07$), at 4 months 0.35 vs. 0.42 ($p = 0.35$), and at 12 months 0.39 vs. 0.54 ($p = 0.23$)). There was no difference in HRQoL in patients who were lost to follow-up in a given period and patients who completed the period (mean HRQoL: pre-fracture 0.73 vs. 0.66 ($p = 0.69$), after fracture 0.01 vs. 0.09 ($p = 0.4$), and at 4 months 0.42 vs. 0.42 ($p = 0.79$)).

Disease burden

The mean hip fracture-related QALY loss that accounts for HRQoL loss of survivors and lost life years of patients whose death was attributable to hip fracture was estimated at 0.16 (95 % CI 0.14–0.19) QALYs in the first 6 months, 0.12 (95 % CI 0.10–0.15) in months 7–12, and 0.11 (95 % CI 0.08–0.14) in months 13–18. The accumulated QALY loss during 18 months was 0.39 (95 % CI 0.32–0.47). The number of observed vs. expected deaths in the QALY calculation was 25 vs. 6.5 in months 0–6, 12 vs. 5.7 in months 7–12, 8 vs. 5.9 in months 13–18, and 45 vs. 18.1 in the 18 months follow-up period.

Resource use

The average utilization of health care resources per patient utilizing a specific resource is presented in Table 2 and the utilization of non-medical and indirect resources in Table 3. In months 0–4 after fracture, all patients were admitted to specialty care (traumatology or orthopedics), with a mean number of admissions and mean length of stay of 1.6 (95 % CI 1.5–1.7) and 15.2 (95 % CI 13.2–17.2) days, respectively. Forty percent (82/205) of patients were admitted to inpatient nursing (on average for 32.5 days), whereas 8 % (17/205) were admitted to a rehabilitation department. Although 58 % (119/205) of patients had at least one outpatient care visit, only 5 % of patients visited either rehabilitation or nursing outpatient care. Up to 65 % of patients (133/205) used some type of fracture-related medications: 53 % used analgesics, 18 % used calcium and vitamin D supplements, and 8 % used bisphosphonates. Alendronate accounted for over 90 % of the bisphosphonate use. Among the 45 patients who reported previous osteoporotic fractures in the last 5 years, 2 were on bisphosphonates before the index fracture.

The proportions of patients receiving medical care decreased in subsequent study periods. During months 5–12 and 13–18 after fracture, 8 % (14/185) and 5 % (9/168) were admitted to hospital, respectively, and 27 % (50/185) and

Table 1 Characteristics of clinical study participants and non-participants in Estonia (patients with hip fracture aged ≥50 years attending two hospitals)

Characteristic	Study participants	Non-participants[a]	p value study participants vs. non-participants
Number of hip fracture patients	205	562	
Women (%)	72	68	0.302
Mean age, years (SD)	77.5 (9.9)	79.2 (10.5)	0.008
Age groups (%)			
50–59	9	6	0.005
60–69	11	13	
70–79	32	23	
80–89	42	45	
≥90	5	13	
Charlson index score			
Mean (SD)	1.1 (1.3)	1.5 (1.5)	0.004
Range	0–5	0–8	
Charlson index score groups (%)			
0	51	42	0.006
1–2	37	38	
3–4	11	17	
≥5	2	3	
Charlson index components (%)			
Congestive heart failure	33	41	0.051
Any malignancy	10	10	0.999
Chronic pulmonary disease	8	10	0.296
Rheumatologic disease	4	3	0.287
Diabetes mellitus with chronic complications	2	4	0.326
Renal disease	2	4	0.326
Hemiplegia or paraplegia	2	2	0.996
Dementia	1	8	0.0003
Other	0	1	0.891
Age-standardized mortality rate per 1000 person-years (95 % CI)			
12 months	57 (35–129)	125 (78–190)	
18 months	53 (32–115)	90 (60–130)	

[a] Includes data on patients not invited (patients who were admitted for care in periods when recruitment team was not operating; $n = 336$), on patients accessed but deemed to be ineligible ($n = 198$), and refused study participation ($n = 28$)

15 % (25/168) received outpatient care. However, the volumes of services among the treated patients remained stable: 1.5 and 1.4 inpatient care episodes, and 1.9 and 1.6 outpatient care visits per patient in months 5–12 and 13–18, respectively. Utilization of outpatient rehabilitation and nursing care remained low (8 % of patients). The proportion of patients using analgesics was stable, whereas the proportion of calcium and vitamin D users increased to 30 % in months 13–18, while 13 % were on bisphosphonates during the follow-up. No use of estrogen receptor modulators, strontium ranelate, and teriparatide was recorded.

Fewer than 2 % of patients were institutionalized during the follow-up, and the proportion receiving home help by social workers remained below 10 % over the study despite some increase in months 5–18 post fracture. Use of informal home help by relatives and friends was high (reported by 84 % of patients) during the follow up, with an average of 15.4 (95 % CI 13.7–17.3) hours of help per week. Eighty-eight percent of patients used assistance devices during the first 4 months, but use decreased to 13 % during months 12 to 18. Among the 13 patients working before the fracture, 10 were off work due to sick leave (at least once) or took early retirement due to the fracture during the study period.

Cost

The costs per patient utilizing specific resource in question are presented in e-Table. The mean health care cost

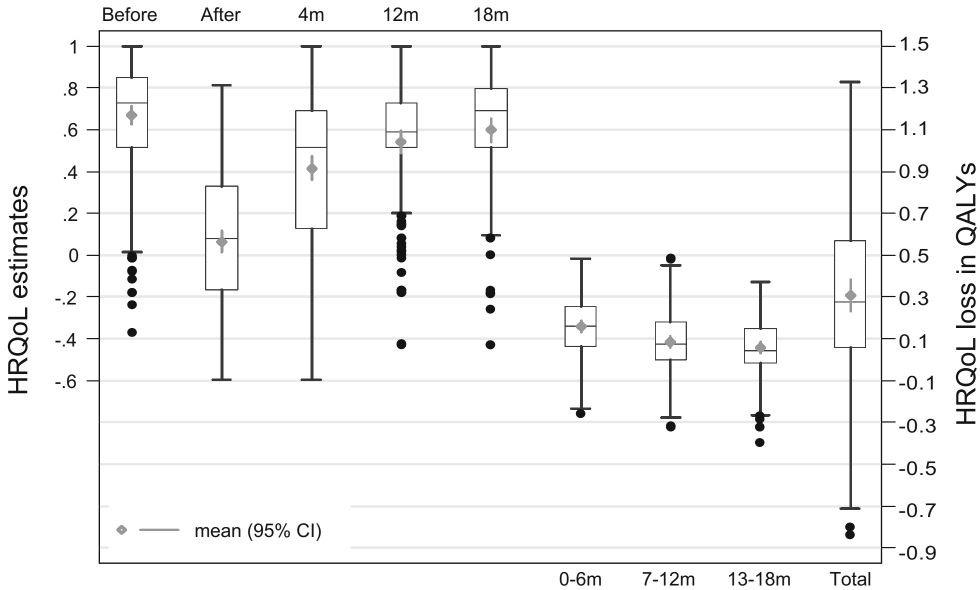

Fig. 1 Health-related quality of life estimates before, directly after, and at 4, 12, and 18 months after fracture (*left hand panels*) and (*right hand panels*) health-related quality of life lost in QALYs (between 0–6, 7–12, 13–18 months, and total) among survived hip fracture patients aged ≥50 years in Estonia

per treated patient was 3760 euros (95 % CI 3450–4192), 1477 euros (95 % CI 640–2496), and 1247 euros (95 % CI 556–2324) during 0–4, 5–12, and 13–18 months, respectively.

The average cost and cost structure per hip fracture patient is presented in Table 4. The mean cumulative 18-month cost related to hip fracture was 8146 (95 % CI 6236–10717) euros per patient. Most costs were related to health care and informal care, 56 and 33 % respectively, whereas social care and indirect costs accounted for less than 5 and 8 %, respectively. Fifty-six percent of the costs (including 84 % of health care costs) were incurred in the first 4 months. Health care costs comprised 83 % of the total costs in the first 4 months, decreasing to 17 % during months 13–18. In contrast, the proportion of informal care cost increased from 11 % in the first period to 62 % in the last period. The proportion of social care cost was only 1 % in the first period, increasing only moderately thereafter. The proportion of indirect cost increased gradually from 5 to 15 %. Patients ≥60 years had higher cumulative health care costs (4496 vs. 3575 euros, $p=0.04$), social costs (254 vs. 9 euros, $p=0.1$), and informal care costs (1811 vs. 1050 euros, $p=0.16$), but significantly lower indirect costs (233 vs. 2110, $p<0.001$) than patients <60 years. The cost burden estimate that also accounts for zero cost of patients whose death was attributed to fracture (from the point of dying until the end of study follow-up) is presented in e-Table 2.

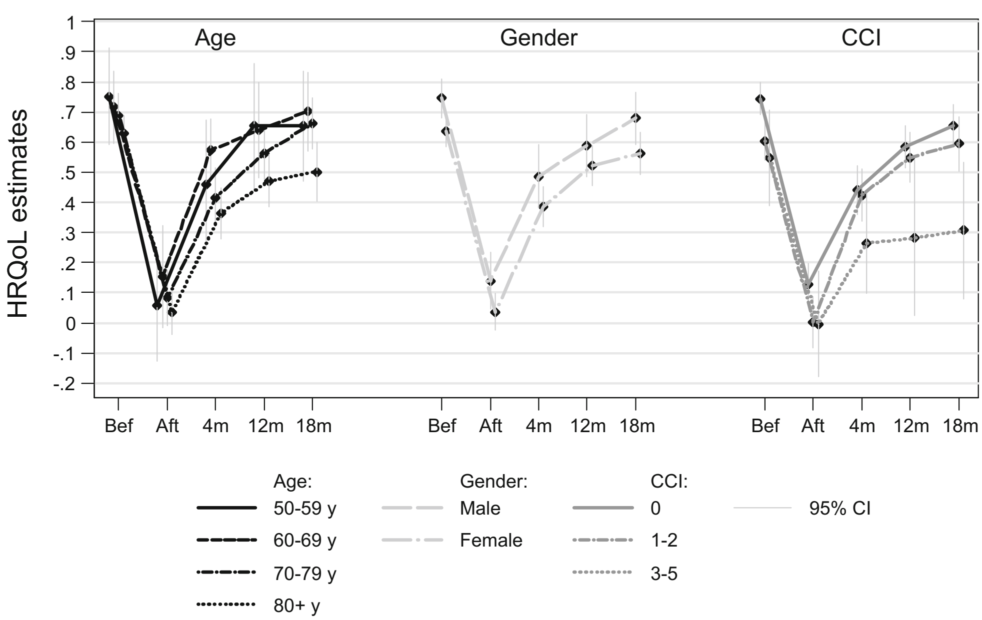

Fig. 2 Health-related quality of life estimates by age, gender, and Charlson comorbidity index score among hip fracture patients aged ≥50 years in Estonia

Table 2 Utilization of health care resources per hip fracture patient receiving care, by study period and cumulatively, among hip fracture patients aged ≥50 years in Estonia

Resource	Measure	0–4 months			5–12 months			13–18 months			Cumulative		
		Patients $N=205$	Mean	(95 % CI[a])	Patients $N=185$	Mean	(95 % CI[a])	Patients $N=168$	Mean	(95 % CI[a])	Patients $N=205$	Mean	(95 % CI[a])
Inpatient care													
All	Admissions	205	2.2	(2.0–2.3)	20	1.6	(1.4–2.1)	11	1.5	(1.3–2.1)	205	2.4	(2.2–2.6)
	Bed-days		29.2	(25.8–32.9)		28.3	(12.5–50.9)		29.0	(17.6–42.2)		33.5	(29.4–38.8)
Specialty care	Admissions	205	1.6	(1.5–1.7)	14	1.5	(1.2–1.7)	9	1.4	(1.1–2.1)	205	1.7	(1.6–1.9)
	Bed-days		15.2	(13.2–17.2)		25.4	(9.9–45.4)		22.4	(10.4–38.1)		17.9	(15.0–21.3)
Nursing care	Admissions	82	1.2	(1.1–1.3)	5	1.2	(1.0–1.4)	4	1.0		86	1.3	(1.1–1.4)
	Bed-days		32.5	(28.3–37.3)		29.6	(9.0–50.2)		29.3	(9.5–51.3)		34.1	(29.7–39.8)
Rehabilitation	Admissions	17	1.4	(1.1–1.9)	6	1.0					19	1.5	(1.2–1.8)
	Bed-days		12.0	(10.5–13.7)		10.2	(8.8–11.8)					13.9	(12.0–15.9)
Outpatient care													
All	Visits	119	1.9	(1.7–2.2)	50	1.9	(1.6–2.4)	25	1.6	(1.2–2.4)	140	2.6	(2.2–3.0)
Family practitioner	Visits	71	1.4	(1.3–1.6)	29	1.2	(1.0–1.3)	7	1.1	(1.0–1.3)	89	1.6	(1.4–1.9)
Specialty care	Visits	80	1.4	(1.3–1.6)	28	1.9	(1.5–2.4)	18	1.5	(1.2–1.9)	100	1.9	(1.7–2.2)
Nursing care	Visits	8	1.9	(1.3–2.5)	3	2.0	(1.0–3.0)	1	4.0		10	2.5	(1.5–3.7)
Rehabilitation	Visits	3	1.3	(1.0–1.7)	3	1.3	(1.0–1.7)	2	1.0		7	1.4	(1.0–1.9)
Drug use													
All	Patients	133			122			105			162		
Bisphosphonates	Patients	16			17			18			26		
Denosumab	Patients				1			1			1		
Oestrogens	Patients	1			3			2			3		
Glycocorticoids	Patients	9			11			9			15		
Analgesics (prescription and non- prescription)	Patients	108			98			90			150		
Prescription NSAIDs	Patients	58			64			44			95		
Prescription opioids	Patients	30			28			25			52		
Non-prescription analgesics	Patients	36			24			32			63		
Calcium and vitamin D (prescription and non-prescription)	Patients	37			41			50			77		

[a] Bootstrapped bias corrected and accelerated 95 % confidence intervals

Table 3 Utilization of direct non-medical and indirect resources per hip fracture patient utilizing resources, by study period and cumulative, among hip fracture patients aged ≥50 years in Estonia

Resource	Measure	0–4 months			5–12 months			13–18 months			Cumulative		
		Patients $N = 154$	Mean	(95 % CI[a])	Patients $N = 128$	Mean	(95 % CI[a])	Patients $N = 123$	Mean	(95 % CI[a])	Patients $N = 154$	Mean	(95 % CI[a])
Nursing home/home for elderly	Bed-days last month	2	28.0	(28.0–28.0)	3	25.7	(23.3–28.0)	1	28.0		3	25.7	(23.3–28.0)
Home help by social worker	Hours per week	3	2.7	(1.0–3.7)	12	9.3	(5.3–14.0)	10	4.9	(2.5–9.6)	14	7.8	(4.4–12.6)
Assisting devices	Patients	135			33			16			143		
Walking aids	Patients	130			29			10			139		
Hygiene	Patients	25			4			5			34		
Other	Patients	3			4			3			10		
Transportation	Units last month	3	2.3	(2.0–3.0)	3	1.7	(1.0–3.0)	2	1.0	(1.0–1.0)	6	1.8	(1.2–2.4)
Informal care	Hours per week	121	16.2	(14.0–18.3)	87	16.3	(13.8–18.9)	91	14.6	(12.6–17.1)	128	15.4	(13.7–17.3)
Work related	Patients	10			4			6			10		
Sick leave	Days last month	7	23.4	(14.9–28.3)	0			0			7	23.4	(13.1–28.3)
Retired	Patients	3			4			6			6		

[a] Bootstrapped bias corrected and accelerated 95 % confidence intervals

Discussion

This is the first prospective observational study designed to estimate the consequences of hip fracture in terms of HRQoL and costs in Estonia.

The results of HRQoL studies are difficult to compare due to differences in methodology, valuation technique, disease management, and respondents. Comparisons between countries participating in ICUROS can be done due to similar methodology, although differences in socio-demographic characteristics, ascertainment, and valuation of health still need to be acknowledged [7].

The pre-fracture HRQoL among hip fracture patients aged ≥50 years was low in Estonia: it was comparable to that in Spain and Mexico which reported the lowest HRQoL estimates from ICUROS [7]. It was also lower than the pooled estimate of 0.78 (95 % CI 0.75–0.80) reported in a recent meta-analysis [32]. The marked decrease after fracture resulted in a post-fracture HRQoL of 0.07, an estimate close to death, that was comparable to generally low estimates from the ICUROS study [7] and significantly lower than the pooled estimate of 0.31 (95 % CI 0.22–0.39) from the meta-analysis [32]. The mean HRQoL nearly reached the pre-fracture levels by the end of follow-up; however, over half of patients (51 %) did not recover in full. Accordingly, the HRQoL loss in QALYs after fracture was substantial (patients lost on average 48 % of the expected HRQoL in the first 6 months). Our results agree with previous findings that hip fractures are associated with substantial reductions in HRQoL [7, 8, 32].

The (non-significant) differences in HRQoL and HRQoL loss by age and Charlson index score were expected as older people with more comorbidities usually have lower HRQoL. It was also expected that the patients who died were older and had higher CCI scores and lower HRQoL than surviving patients. Given that we did not see significant differences in age, CCI score, and HRQoL between those retained and not in study, we believe that our results are not strongly affected by the low retention rate.

Comparing the resource use and cost to other studies is difficult as there are differences in socio-economic characteristics, health systems (including health care prices), and study methods (only a few include social and informal costs), and the evolving advances and efficiencies in treatments also need to be accounted for [12]. However, large disparities may still be noted in the context of population aging and disproportionate health spending between countries.

The utilization of fracture-related specialty and primary care services was comparable to that in a similar Swedish study [12]. One difference of note was low use of bisphosphonates in our study, indicating a large gap between current use and the proportion of the population that could be considered eligible for treatment based on fracture risk [33]. Compared to the Swedish study [12], our results also showed

Table 4 The average cost and cost structure per hip fracture patient by study period and accumulated (costs in euros, at 2014 prices) among hip fracture patients aged ≥50 years in Estonia

	0–4 months		5–12 months		13–18 months		Cumulative	
Resource	Mean	(95 % CI[a])	Mean	(95 % CI[a])	Mean	(95 % CI[a])	Mean	(95 % CI[a])
Health care								
Inpatient care	3722	(3368–4075)	412	(177–756)	208	(75–419)	4342	(3620–5249)
Outpatient care	39	(32–47)	20	(12–32)	7	(3–15)	66	(47–94)
Pharmaceuticals	21	(16–27)	37	(27–48)	37	(28–48)	95	(71–123)
Social care								
Nursing home/home for elderly	22	(0–53)	141	(0–283)	37	(0–184)	199	(0–519)
Home help by social worker	2	(0–6)	104	(47–195)	33	(12–70)	140	(59–271)
Assisting devices	15	(10–28)	1	(0–3)	0	(0–0)	17	(10–31)
Transportation	4	(1–9)	9	(0–24)	3	(1–7)	15	(2–41)
Informal care								
Home help by relatives, friends	521	(439–619)	1231	(1005–1471)	901	(748–1068)	2653	(2192–3159)
Indirect cost								
Loss of production	221	(108–386)	177	(52–406)	223	(73–438)	620	(233–1230)
Total cost	4566	(3974–5249)	2130	(1322–3217)	1449	(940–2251)	8146	(6236–10717)

[a] Bootstrapped bias corrected and accelerated 95 % confidence intervals

low use of rehabilitation, nursing care, and social care (particularly after 4 months after fracture). We know that at 4 and 12 months after fracture, up to 2/3 of patients (70 and 59 % respectfully) were not fully recovered and could therefore assume that a substantial proportion of patients still had difficulties in mobility, self-care, and normal activities at that time. Hence, the use of rehabilitation, nursing care, and social care may potentially be insufficient to meet the needs of patients with low HRQoL.

The hip fracture-related 18-month cost of 8146 euros was higher than the previous 1-year estimate of 5580 euros (at 2010 prices) that was equal to 40 % of the EU average hip fracture cost [6]. The cost was comparable to those in Slovenia and Czech Republic [6, 34, 35] and lower than in Finland, Sweden, UK, and USA [12, 36–39].

Comparing the cost structure to that in Sweden [12], significant differences were revealed. In our study, the proportion of social cost was below 5 % (compared with almost 30 % in Sweden). The proportion of informal care cost exceeded that in Sweden. A remarkably high use of informal care in Estonia may partly be explained by the shortage of social care. In line with our findings, a large proportion of informal care cost was also noted in a recent study from Austria [40]. Another important finding was an increasing proportion of indirect cost, confirming the understanding that despite the generally advanced age of hip fracture patients, the cost of productivity should not be omitted from hip fracture economic evaluations [6]. In this context, it may be noted that the human capital approach may overestimate costs of productivity losses [41].

Limitations of this study warrant discussion. First of all, a cautious approach should be applied in generalizing results to the total hip fracture population in Estonia as we collected data in two hospitals (but these provide 40 % of hip fracture inpatient care in Estonia). However, we assume that the patients admitted and quality of care provided in these hospitals do not significantly differ from the other clinics in Estonia [42]. Furthermore, the modest sample size increases the likelihood of type II error (for example, the statistically non-significant differences in HRQoL by age, gender, and CCI).

Our results are prone to selection bias—both in relation to recruitment (our sample comprised only 27 % of all hospitalized patients with hip fracture at the recruiting hospitals) and retention (60 %). We acknowledge that low recruitment rate cannot be explained solely by excluding the previously institutionalized and cognitively impaired patients. Non-participants were significantly older, had higher comorbidity burden, and higher risk of death. One might speculate that this would lead to moderately overestimating HRQoL loss (since recruitment of younger and milder cases might have resulted in higher HRQoL before fracture) and underestimating costs. However, the cost consequences of fracture might be lower among previously institutionalized patients who already incur the cost of nursing care before fracture. Furthermore, 22 % of patients died and 16 % were lost during the follow-up, thus the data on social and informal care use for these patients were not available for the non-completed periods. As the respective costs for the patients who died in a given period might have been higher than for patients who remained in the study, exclusion of those costs from analysis probably resulted in a slight underestimation of average hip fracture cost.

Methodological issues in HRQoL measurement could also contribute to possible overestimation of HRQoL loss. First, the initial interview took place right after fracture and patients might have recalled their pre-fracture health better than it actually was. Second, the assumption that the HRQoL pre-fracture level remained constant during the follow-up had the fracture not occurred may not hold in real life, because in older age health might deteriorate over time, reducing the difference between pre-fracture and follow-up estimates. Third, it is possible that most of the HRQoL improvement after fracture happened not in a linear fashion over 4 months, but faster, during 1–2 months, and therefore the HRQoL loss during the first 4 months was overestimated among survivors. Furthermore, we used the EQ-5D UK population values [19] to determine HRQoL. The country comparisons of EQ-5D value sets have shown that there are considerable differences in HRQoL estimations [43]. Thus, from an Estonian perspective, the use of a UK value set increased the uncertainty of HRQoL estimations in our study. When an EQ-5D value set for Estonia becomes available, it will be important to reassess the HRQoL related to fractures [7].

It is worth noting that as costs and QALYs were censored after 18 months, the true disease burden might be underestimated. Furthermore, we need to acknowledge the uncertainty related to proportion of deaths attributable to hip fracture in the calculation of total hip fracture-related QALYs lost.

The strength of our analysis lies in a study design that enabled prospective collection of cost data from a societal perspective. Simultaneous collection of HRQoL and resource use permitted inferences to unmet needs of care in some patient subgroups. Another strength is the use of EHIF data (almost all people receive care via EHIF) for assessing fracture-related health resources and costs, and interpreting validity of study results.

Conclusion

Our results indicate that the impact of hip fracture in Estonia on HRQoL and cost is substantial. In spite of appropriate hip fracture inpatient care, utilization of rehabilitation, nursing care, and social care was low and potentially insufficient to meet the needs of patients with low HRQoL. The shortfall may partly explain the remarkably high use of informal care that we observed.

Acknowledgments ICUROS is a prospective observational study that follows patients for 18 months after a fracture, collecting data on HRQoL, resource utilization, and costs. The study is run under the auspices of the International Osteoporosis Foundation and has enrolled approximately 6000 patients in 11 countries worldwide, including Estonia, since 2007 [7].

The study was supported by the Estonian Science Foundation grant 9368, the Estonian Ministry of Education and Research grant SF0180060s09, the institutional research grants TARTH15017I (Health research in a continuum of the evidence based health practice in Estonia) and IUT 2-8.

Compliance with ethical standards Informed consent was obtained from all participants, and the study was approved by the Research Ethics Committee of Tartu University.

Conflicts of interest None.

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