ORIGINAL ARTICLE

JBMR

Health Service Use and Quality of Life Recovery 12 Months Following Major Osteoporotic Fracture: Latent Class Analyses of the International Costs and Utilities Related to Osteoporotic Fractures Study (ICUROS)

Jason Talevski,[1,2] Kerrie M Sanders,[1,2,3] Ljoudmila Busija,[4] Alison Beauchamp,[1,2,5] Gustavo Duque,[1,2] Fredrik Borgström,[6,7] John A Kanis,[8,9] Axel Svedbom,[10] Catherine Connaughton,[11] Amanda L Stuart,[12] and Sharon L Brennan-Olsen[1,2,3,13]

[1]Department of Medicine – Western Health, The University of Melbourne, Melbourne, VIC, Australia
[2]Australian Institute for Musculoskeletal Science (AIMSS), The University of Melbourne and Western Health, Melbourne, VIC, Australia
[3]School of Health and Social Development, Deakin University, Geelong, VIC, Australia
[4]School of Public Health and Preventive Medicine, Monash University, Clayton, VIC, Australia
[5]School of Rural Health, Monash University, Clayton, VIC, Australia
[6]Quantify Research, Stockholm, Sweden
[7]Department of Learning, Informatics, Management and Ethics, Medical Management Centre, Karolinska Institute, Stockholm, Sweden
[8]Mary McKillop Institute for Research, Australian Catholic University, Ballarat, VIC, Australia
[9]Centre for Metabolic Bone Diseases, University of Sheffield, Sheffield, UK
[10]ICON Plc, Stockholm, Sweden
[11]Melbourne Academic Centre for Health, The University of Melbourne, Melbourne, VIC, Australia
[12]The Institute for Mental and Physical Health and Clinical Translation (IMPACT), School of Medicine, Deakin University, Geelong, VIC, Australia
[13]Institute for Health Transformation, Deakin University, Geelong, VIC, Australia

Abstract

Major osteoporotic fractures (MOFs) are associated with a rapid decline in health-related quality of life (HRQoL); however, there is limited knowledge about which healthcare services positively affect HRQoL postfracture. This study aimed to identify specific combinations of health service use associated with recovery of HRQoL 12 months post-MOF. The analyses included 4126 adults aged ≥50 years with an MOF (1657 hip, 1354 distal forearm, 681 vertebrae, 434 humerus) participating in the International Costs and Utilities Related to Osteoporotic fractures Study (ICUROS), a multinational observational study (Australia, Austria, Estonia, France, Italy, Lithuania, Mexico, Russia, Spain, United Kingdom, and United States). HRQoL at prefracture and 12 months postfracture was measured using the EuroQoL questionnaire (EQ-5D-3L). Health service use data were collected via participant interviews and medical record reviews including in-hospital care; outpatient care; community services; and medication use. Data analyses involved two stages: (i) latent class analyses to identify different combinations of health service use ("classes"); and (ii) logistic regression to assess effects of classes on HRQoL recovery. Analyses were repeated excluding hip fractures (non-hip MOFs). Overall, 2057 MOF participants (49.9%) recovered to their prefracture HRQoL at 12-month follow-up; this proportion was higher for non-hip MOFs ($n = 1439$; 58.3%). Several distinct classes were identified across countries (range, 2–5 classes). Classes that were associated with increased odds of HRQoL recovery were characterized by a combination of hospital presentations without admission; outpatient department visits; allied health visits; vitamin D/calcium supplementation; and/or non-opioid analgesic use. Similar classes were observed for non-hip MOFs. Understanding country-specific healthcare service pathways that influence greater recovery of HRQoL, particularly services that are uncommon in some countries and routine in others, could improve postfracture care on a global scale. © 2020 American Society for Bone and Mineral Research (ASBMR).

KEY WORDS: AGING, FRACTURES; HEALTH SERVICES RESEARCH; OSTEOPOROSIS; QUALITY OF LIFE

Received in original form July 1, 2020; revised form September 8, 2020; accepted September 11, 2020. Accepted manuscript online September 22, 2020.
Address correspondence to: Jason Talevski, BHlthSci, Department of Medicine-Western Health, University of Melbourne C/- Western Health, Sunshine Hospital, WCHRE Building, 176 Furlong Road, St Albans, VIC 3021, Australia. E-mail: jason.talevski@student.unimelb.edu.au
Additional Supporting Information may be found in the online version of this article.

Journal of Bone and Mineral Research, Vol. 00, No. 00, Month 2020, pp 1–10.
DOI: 10.1002/jbmr.4181

Introduction

An estimated 200 million people aged 50 years or older are currently diagnosed with osteoporosis,[1,2] making it the most common skeletal condition worldwide.[3] A fragility fracture of the hip, distal forearm, vertebrae, or humerus—collectively referred to as major osteoporotic fracture (MOF)—is the most prevalent clinical outcome of osteoporosis. It is well-documented that hip fractures are the most severe type of MOF, incurring higher treatment costs[4,5] and imposing a greater burden on health-related quality of life (HRQoL)[6] and physical function.[7] However, fractures at other osteoporotic sites—distal forearm, vertebrae, and humerus—also produce a significant burden on patients and the healthcare system. Non-hip MOFs are associated with substantial pain, limitations in physical functioning, and reduced HRQoL.[6,8,9] Moreover, an increased risk of mortality and subsequent fracture risk has been documented after vertebrae fractures.[10,11] Collectively, MOFs account for >90% of all fracture-related healthcare costs.[5]

Implementation of clinical care pathways for postfracture management, commonly referred to as orthogeriatric services or fracture liaison services, have been expanding globally over the last decade.[12] These services are interdisciplinary, combining orthopedic surgery, geriatric care, primary care, and ancillary services such as physical therapy,[13] and aim to ensure patients aged ≥50 years who present to hospital with a MOF receive the appropriate evaluation and treatment for osteoporosis in accordance with clinical guidelines.[14] Clinical care pathways have shown improvements in recovery of basic activities of daily living,[15] decreased refracture rates,[14] and improved HRQoL in hip fracture patients compared to usual care[16]; however, there is significant variability among these care pathways in terms of the healthcare and community services offered to patients.

Limited knowledge is available about which healthcare and community services, major components of clinical care pathways, can improve the long-term health of older people following a MOF, specifically in non-hip MOF patients. Therefore, the aim of this study was to identify combinations of healthcare and community service use associated with recovery of HRQoL 12 months post-MOF, using data from the International Costs and Utilities Related to Osteoporotic fractures Study (ICUROS).

Patients and Methods

Study design and population

The ICUROS study design has been described elsewhere[6]; however, in brief, ICUROS is a multinational observational study, undertaken from 2008 to 2014, that aimed to quantify the HRQoL impact and cost consequences of fragility fractures across 11 countries (Australia, Austria, Estonia, France, Italy, Lithuania, Mexico, Russia, Spain, United Kingdom, and United States). Identical study designs were applied in all countries. ICUROS adhered to the Declaration of Helsinki and was approved by the relevant research ethics committees in each country. Patients were enrolled in ICUROS if they: were aged ≥50 years; sustained a low-energy fracture that was not caused by a comorbidity (eg, cancer) and confirmed via imaging; were recruited within 2 weeks after the fracture; and lived in their own home prior to the fracture. Patients residing in long-term care prior to the fracture, with cognitive impairment, or who sustained a new fracture during the follow-up period, were excluded.

Study data

Approval for use of ICUROS data was obtained from the principal investigators in each participating country and Melbourne Health Human Research Ethics Committee (2010.115). Data for the current analyses were extracted from the ICUROS central database for each of the participating countries, with the exception of the United States (data on healthcare and community service use were unavailable). Participants who sustained a hip, distal forearm, clinical vertebral, or humeral fracture with complete 12-month data were included in the analyses.

Participant demographic and fracture details were collected at the baseline interview (within 2 weeks after the fracture) and included: age (years at time of fracture); sex; highest level of educational attainment (primary, secondary, postsecondary); individual income (low, middle, high; country-specific cutoffs); living status (alone, with someone); hospitalization due to the fracture; and fracture history from the previous 5 years.

Data on healthcare and community service use "as a consequence of the fracture" during the 4 months postfracture were collected via telephone interviews and described as in-hospital care (hospital presentations/admissions, inpatient rehabilitation); outpatient care (outpatient clinics, fracture clinics, rehabilitation centers, allied healthcare, general practitioner [GP]/primary care center visits, health professional home visits); supported living (eg, residential aged care); community care (phone counseling, formal home help, informal home help from family/friends, home and equipment modifications); medication use (osteoporosis-related, calcium or vitamin D supplements, opioid analgesics, non-opioid analgesics, anti-depressant/anti-anxiety medications); and imaging (including dual-energy X-ray absorptiometry [DXA]).

Changes in HRQoL were assessed using the EuroQoL questionnaire (EQ-5D-3L)[17] at baseline (including recall of the patient's HRQoL prior to fracture), 4 months, and 12 months postfracture. The EQ-5D-3L measures five dimensions of health (mobility, self-care, usual activities, pain/discomfort and anxiety/depression) at three levels of severity (no problem, some problems, major problems) giving 243 possible health state combinations.[17] To determine the utility index score of the EQ-5D-3L, we used the weights most relevant to each individual country. The UK value set of preference weights were applied for countries where no specific weights have been developed, as recommended.[18] Utility index scores were fixed at 1 (full health) and 0 (dead) with values below 0 indicating a state worse than death. Change in HRQoL over 12 months was calculated according to the following formula:

HRQoL change = EQ-5D-3L utility score$_{(12\ \text{months})}$ − EQ-5D-3L utility$_{(\text{prefracture})}$

HRQoL change was then dichotomized (recovered/not recovered), where a score ≥0 was classified as "recovered" and a score <0 was classified as "not recovered."

Statistical analyses

The statistical analyses involved two stages: (i) identifying the most common combinations of health care and community service use (hereafter referred to as "health service use"); and (ii) analyzing the associations between the identified combinations of health service use and HRQoL recovery 12 months post-MOF.

In stage one, latent class analysis (LCA) was used to classify participants into mutually exclusive groups based on their health service use (categorical indicator variables). These groups are referred to as "classes" and represent different combinations of health service use.[19] The LCA was undertaken without a priori assumption regarding the optimal number of classes, consistent with LCA best practice.[20] We began the class enumeration procedure by estimating a one-class model, and the number of classes was then increased in a stepwise fashion until the optimal number of classes was achieved in the final model (ie, optimal model fit). There is no single indicator reflecting optimal model fit; therefore, this was determined based on a combination of the lowest Bayesian Information Criterion (representative of the most parsimonious solution) and highest entropy value (indicative of clearest separation of individuals in each class).[19] Qualitative assessment of the final classes were also undertaken to determine meaningfulness of the classes (ie, were the classes different enough in terms of health service use). Health service use data were dichotomous (yes/no) and analyses were performed individually for each country using the statistical software Mplus, version 7.3 (Muthén & Muthén, Los Angeles, CA, USA).[21]

In stage two, we analyzed the association between each class and recovery of HRQoL at 12 months post-MOF using logistic regression. Associations were evaluated for MOFs and non-hip MOFs and presented as odds ratios (ORs) with 95% confidence intervals (CIs). Variables that were significantly associated with either HRQoL recovery or latent class membership in univariate analyses were added simultaneously to multivariable regression models. Multiplicative interaction terms were also included in the models to identify potential effect modification between age and sex. A p value of <.05 was considered statistically significant. These analyses were performed using STATA statistical software, version 16 (Stata Corporation, Inc., College Station, TX, USA).[22]

Results

Study population

In total, 6604 participants were enrolled in ICUROS. After removing participants from the United States (n = 256) and excluding ineligible participants such as those who sustained a fracture at a non-MOF site (n = 698), 5650 participants were potentially eligible for these analyses. Among them, a further 1524 participants were excluded based on loss to follow-up (n = 486), withdrawal from the study (n = 351); sustaining a new fracture during follow-up (n = 192), death (n = 246), or other reasons (n = 249). Therefore, a total of 4126 participants with a MOF were eligible from Australia (n = 524), Austria (n = 525), Estonia (n = 146), France (n = 466), Italy (n = 494), Lithuania (n = 340), Mexico (n = 278), Russia (n = 831), Spain (n = 283), and the United Kingdom (n = 239). The mean age of the total population was 71.5 years; participants with a distal forearm fracture were the youngest (n = 1354; mean age: 67.1 years) and hip fracture participants the oldest (n = 1657; mean age: 76.6 years); Russia had the lowest mean age (66.0 years) and Estonia had the highest mean age (77.2 years). The total sample were predominately female (n = 3446; 83.5%) and <20% of participants experienced a previous fracture within the preceding 5 years in each country except for Estonia (24.7%) and Russia (42.1%). Similar characteristics were observed for non-hip MOF participants (n = 2469), although mean age was significantly lower compared to all MOF participants (67.1 versus 71.5 years; p < .001). Participant characteristics are presented in Table 1 by country and fracture group.

Health service use

Country-specific health service use post-MOF is presented in Supplementary Table 1. In terms of in-hospital care, participants from Russia had the highest number of hospital presentations without admission (58.7%); the highest number of hospitalizations were reported in Estonia (97.9%) and Mexico (90.3%); and admission to a rehabilitation ward was the most common in Mexico (40.3%). Outpatient department visits were least common in Russia (32.0%); fracture clinic visits were infrequent across all countries except for the United Kingdom (45.6%); and participants from Estonia reported a considerably lower amount of allied health visits (8.2%) compared to all other countries. A higher proportion of participants reported health professional home visits from France, Italy, and the United Kingdom (47.0%, 44.1%, and 38.1%, respectively); and phone counseling was uncommon across all countries except for Italy (25.3%). France had the highest proportion of participants admitted to a residential aged care facility postfracture (31.6%). Medication use varied between countries. Participants from Russia reported the highest use of osteoporosis-related medications and vitamin D/calcium supplements (62.7% and 81.1%, respectively), whereas participants in Mexico reported the lowest use (4.3% and 16.2%, respectively). Opioid analgesic use was the highest in Australia (42.9%) and the lowest in Lithuania and Estonia (both 0%); all countries had a moderate-high proportion of participants using non-opioid analgesics—highest in Russia (84.1%) and lowest in Lithuania (34.7%). All countries had a low proportion of participants using anti-depressant/anti-anxiety medication (range, 0%–2.1%). DXA scans postfracture were uncommon in all countries (<10%), except in Russia (40.9%).

HRQoL

Mean HRQoL utility scores at each follow-up point are shown in Supplementary Table 2 by country. HRQoL utility scores (mean $\pm$ SD) before study fracture were the highest in Italy (0.95 $\pm$ 0.12) and the lowest in Estonia (0.67 $\pm$ 0.31) and Mexico (0.67 $\pm$ 0.33). Mean HRQoL substantially improved across all countries at 12-month follow-up, although it remained below the prefracture HRQoL mean. Participants from Austria and the United Kingdom were most improved (mean change, −0.04), whereas Lithuania was the least improved (mean change, −0.22). Similar patterns in HRQoL trajectories were seen in non-hip MOF participants.

The proportion of participants who recovered HRQoL 12 months postfracture is shown in Fig. 1, by country and fracture group. Overall, 2057 participants (49.9%) recovered to their prefracture HRQoL at 12-month follow-up. France had the lowest proportion of participants with full HRQoL recovery (39.3%), and the United Kingdom had the highest (60.3%). For non-hip MOFs, the proportion of participants with full HRQoL recovery at 12 months was higher across all countries (n = 1439; 58.3%) compared to all MOF participants. Similarly, France had the lowest proportion of participants with full HRQoL recovery (49.5%) and the United Kingdom had the highest (78.1%).

LCA

Tests of the LCA models and optimal model fit statistics and are summarized in Supplementary Table 3, by country and fracture group. Estimated probabilities of using a particular health service in each class are shown in Supplementary Tables 4 and 5 (MOFs and non-hip MOFs, respectively) and summarized in Fig. 2.

Table 1. Participant Characteristics by Country

	Australia		Austria		Estonia		France		Italy	
Characteristic	MOF	Non-Hip MOF	MOF	Non-Hip MOF	MOF	Non-Hip MOF	MOF	Non-Hip MOF	MOF	Non-Hip MOF
Participants, *n*	524	374	525	267	146	–	466	303	494	257
Age (years), mean ± SD	70.2 ± 11.2	67.6 ± 10.6	73.7 ± 9.0	70.7 ± 8.9	77.2 ± 10.7	–	71.9 ± 11.3	69.4 ± 11.0	75.5 ± 10.2	71.3 ± 9.8
Female, *n* (%)	415 (79.2)	298 (79.7)	426 (81.1)	224 (83.9)	105 (71.9)	–	392 (84.1)	263 (86.8)	464 (93.9)	236 (91.8)
Education, *n* (%)										
Primary	38 (7.3)	20 (5.3)	217 (41.4)	116 (43.4)	54 (37.0)	–	162 (37.0)	93 (33.8)	320 (65.0)	133 (52.2)
Secondary	284 (54.3)	186 (49.7)	225 (42.9)	106 (39.7)	69 (47.2)	–	144 (33.0)	89 (32.4)	136 (27.6)	94 (36.9)
Postsecondary[a]	201 (38.4)	168 (44.9)	82 (15.7)	45 (16.9)	23 (15.8)	–	131 (30.0)	93 (33.8)	36 (7.4)	28 (11.0)
Income, *n* (%)[b]										
Low	244 (46.6)	159 (42.5)	195 (37.1)	92 (34.5)	129 (88.4)	–	122 (26.2)	70 (23.1)	232 (47.0)	96 (37.4)
Mid-high	248 (47.3)	194 (51.9)	297 (56.6)	157 (58.8)	17 (11.6)	–	167 (35.8)	98 (32.3)	157 (31.8)	117 (45.5)
Refused to answer	32 (6.1)	21 (5.6)	33 (6.3)	18 (6.7)	0 (0.0)	–	177 (38.0)	135 (44.6)	105 (21.2)	44 (17.1)
Lives alone, *n* (%)	159 (30.8)	103 (27.8)	225 (43.4)	103 (39.3)	65 (44.5)	–	217 (47.2)	134 (44.7)	128 (26.7)	62 (24.9)
Fracture in previous 5 years, *n* (%)	84 (16.0)	59 (15.8)	82 (15.6)	41 (15.4)	36 (24.7)	–	89 (19.1)	55 (18.2)	81 (16.4)	50 (19.5)
Study fracture site, *n* (%)										
Hip	150 (28.6)	-	258 (49.1)	-	146 (100)	–	163 (35.0)	-	237 (48.0)	-
Distal forearm	261 (49.8)	261 (69.8)	109 (20.8)	109 (40.8)	0 (0.0)	–	163 (35.0)	163 (53.8)	129 (26.1)	129 (50.2)
Vertebrae	61 (11.6)	61 (16.3)	82 (15.6)	82 (30.7)	0 (0.0)	–	79 (17.0)	79 (26.1)	116 (23.5)	116 (45.1)
Humerus	52 (9.9)	52 (13.9)	76 (14.5)	76 (28.5)	0 (0.0)	–	61 (13.0)	61 (20.1)	12 (2.4)	12 (4.7)
Admitted to hospital, *n* (%)	300 (57.3)	153 (40.9)	425 (81.0)	173 (64.8)	144 (98.6)	–	383 (82.2)	221 (72.9)	325 (65.8)	90 (35.0)

	Lithuania		Mexico		Russia		Spain		United Kingdom	
Characteristic	MOF	Non-Hip MOF	MOF	Non-Hip MOF	MOF	Non-Hip MOF	MOF	Non-Hip MOF	MOF	Non-Hip MOF
Participants, *n*	340	272	278	120	831	603	283	127	239	146
Age (years), mean ± SD	69.0 ± 10.3	67.8 ± 10.1	73.5 ± 11.2	68.1 ± 10.4	66.0 ± 9.3	64.9 ± 8.9	76.5 ± 10.9	70.6 ± 9.6	72.0 ± 10.7	68.7 ± 10.3
Female, *n* (%)	292 (85.9)	237 (87.1)	235 (84.5)	109 (90.8)	676 (81.3)	515 (85.4)	241 (85.2)	112 (88.2)	200 (83.7)	132 (90.4)
Education, *n* (%)										
Primary	71 (20.9)	50 (18.4)	142 (60.2)	52 (47.7)	58 (7.0)	31 (5.1)	244 (86.5)	100 (79.4)	22 (9.2)	13 (8.9)
Secondary	159 (46.7)	131 (48.2)	52 (22.0)	33 (30.3)	380 (45.8)	248 (41.1)	20 (7.1)	13 (10.3)	176 (73.9)	105 (71.9)
Postsecondary[a]	110 (32.4)	91 (33.5)	42 (17.8)	24 (22.0)	392 (47.2)	324 (53.7)	18 (6.4)	13 (10.3)	40 (16.9)	28 (19.2)
Income, *n* (%)[b]										
Low	9 (2.6)	8 (2.9)	194 (69.8)	66 (55.0)	178 (21.4)	93 (15.4)	207 (73.1)	83 (65.4)	66 (27.7)	37 (25.3)
Mid-high	330 (97.1)	263 (96.7)	81 (29.1)	53 (44.2)	614 (73.9)	477 (79.1)	62 (22.0)	41 (32.3)	149 (62.3)	100 (68.5)
Refused to answer	1 (0.3)	1 (0.4)	3 (1.1)	1 (0.8)	39 (4.7)	33 (5.5)	14 (4.9)	3 (2.4)	24 (10.0)	9 (6.2)
Lives alone, *n* (%)	105 (31.1)	77 (28.5)	32 (11.5)	15 (12.5)	132 (16.5)	94 (16.2)	63 (23.3)	23 (18.9)	97 (41.8)	49 (34.0)
Fracture in previous 5 years, *n* (%)	34 (10.0)	28 (10.3)	34 (12.2)	10 (8.3)	350 (42.1)	295 (48.9)	42 (14.8)	16 (12.6)	30 (12.6)	18 (12.3)
Study fracture site, *n* (%)										
Hip	68 (20.0)	-	158 (56.8)	-	228 (27.4)	-	156 (55.1)	-	93 (38.9)	-
Distal forearm	182 (53.5)	182 (66.9)	58 (20.9)	58 (48.3)	242 (29.1)	242 (40.1)	83 (29.3)	83 (65.4)	127 (53.1)	127 (87.0)
Vertebrae	90 (26.5)	90 (33.1)	34 (12.2)	34 (28.3)	191 (23.0)	191 (31.7)	27 (9.5)	27 (21.3)	1 (0.5)	1 (0.7)
Humerus	0 (0.0)	0 (0.0)	28 (10.1)	28 (23.3)	170 (20.5)	170 (28.2)	17 (6.1)	17 (13.4)	18 (7.5)	18 (12.3)
Admitted to hospital, *n* (%)	148 (43.5)	81 (29.8)	200 (71.9)	68 (56.7)	346 (41.6)	157 (26.0)	209 (73.9)	58 (45.7)	116 (48.5)	25 (17.1)

For education, data were missing for 78 patients (1.9% of total cohort).

– = not applicable; ED = emergency department; GP = general practitioner; MOF = major osteoporotic fracture; SD = standard deviation; TAFE = technical and further education.

[a]Includes university degree, certificates, TAFE, and professional diplomas.

[b]Different cutoff points for income levels were defined by each participating country.

Results from the logistic regression analyses of participants' class membership and odds of HRQoL recovery are presented in Table 2 and discussed below for each country.

In Australia, a three-class model was deemed the most optimal model fit for MOF participants. Class 2 was associated with increased odds of HRQoL recovery at 12 months postfracture following adjustment for age, sex, education, income, and prefracture HRQoL (adjusted OR = 1.48; 95% CI, 1.00–2.17; p = .049). Conversely, class 1 was associated with decreased odds of HRQoL recovery (adjusted OR = 0.37; 95% CI, 0.23–0.61; p < .001). No associations between classes and HRQoL recovery post-MOF were observed for participants with non-hip MOFs, noting that a two-class model was deemed to have the most optimal model fit (Table 2).

In Austria, a four-class model was deemed the most optimal model fit for MOF participants. Class 4 was associated with increased odds of HRQoL recovery at 12 months (adjusted OR = 2.64; 95% CI, 1.65–4.21; p < .001), whereas class 2 was associated with decreased odds of HRQoL recovery (adjusted OR = 0.39; 95% CI, 0.24–0.64; p < .001). Similar associations between classes and HRQoL recovery were observed for participants with non-hip MOFs (Table 2).

In Estonia, a two-class model had the best fit for MOF participants. There were no significant associations between classes and HRQoL recovery 12 months postfracture in unadjusted (p = .694) and fully adjusted (p = .946) models. There were no analyses for MOF excluding hip fracture because all participants in Estonia suffered a hip fracture (Table 2).

In France, a three-class model was the most optimal fit for MOF participants. Class 1 was associated with increased odds of HRQoL recovery at 12 months post-MOF following adjustment for age, education, income, and prefracture HRQoL (adjusted OR = 2.69; 95% CI, 1.59–4.54; p < .001). Conversely, class 2 was associated with decreased odds of HRQoL recovery in the fully adjusted model (adjusted OR = 0.27; 95% CI, 0.15–0.51; p < .001). Similar associations between classes and HRQoL recovery were found for participants with non-hip MOFs (Table 2).

In Italy, a four-class model was the most optimal fit for participants with a MOF. Class 3 was associated with increased odds of HRQoL recovery at 12 months post-MOF after adjustment for age, education, income, and prefracture HRQoL (adjusted OR = 3.85; 95% CI, 2.50–5.93; p < .001). Classes 1, 2, and 4 were associated with a decreased odds of HRQoL recovery in fully adjusted models ([OR = 0.51; 95% CI, 0.32–0.80; p = .003]; [OR = 0.46; 95% CI, 0.25–0.84; p = .011]; and [OR = 0.29; 95% CI, 0.11–0.76; p = .012], respectively). Similar associations between classes and HRQoL recovery were observed for participants with non-hip MOF, noting that a two-class model was the most optimal model fit (Table 2).

In Lithuania, a four-class model had the most optimal fit for MOF participants. Class 1 was associated with increased odds of HRQoL recovery at 12 months post-MOF in the fully adjusted model (adjusted OR = 4.90; 95% CI, 1.70–6.83; p < .001). Conversely, classes 2 and 4 were associated with a decreased odds of HRQoL recovery in fully adjusted models ([OR = 0.41; 95% CI, 0.23–0.74; p = .003]; and [OR = 0.14; 95% CI, 0.07–0.30; p < .001], respectively). Similar associations between classes and HRQoL recovery were observed for participants with non-hip MOF (Table 2).

In Mexico, a three-class model was the most optimal fit for MOF participants. Class 3 was associated with increased odds of HRQoL recovery at 12 months post-MOF after adjustment for age, sex, education, income, and prefracture HRQoL (adjusted OR = 1.87; 95% CI, 1.15–3.89; p = .045). Class 2 was associated with decreased odds of HRQoL recovery at 12 months in fully the adjusted model (OR = 0.25; 95% CI, 0.09–0.68; p = .006). Similar associations between classes and HRQoL recovery were observed for participants with a non-hip MOF (Table 2).

In Russia, a five-class model was the most optimal fit for MOF participants. Class 4 and class 5 were both associated with increased odds of HRQoL recovery at 12 months postfracture following adjustment ([adjusted OR = 18.88; 95% CI, 11.10–32.30; p < .001]; and [adjusted OR = 2.39; 95% CI, 1.56–3.65; p < .001], respectively). Conversely, classes 1, 2, and 3 were associated with a decreased odds of HRQoL recovery at 12 months ([adjusted OR = 0.44; 95% CI, 0.27–0.72; p < .001]; [adjusted OR = 0.16; 95% CI, 0.10–0.25; p < .001]; and [adjusted OR = 0.13; 95% CI, 0.08–0.21; p < .001], respectively). Similar associations between classes and HRQoL recovery were observed for participants with a non-hip MOF (Table 2).

In Spain, a three-class model was the most optimal fit for MOF participants. Class 3 was associated with increased odds of HRQoL recovery at 12 months following adjustment for age, education, income, and prefracture HRQoL (adjusted OR = 2.00; 95% CI, 1.05–3.83; p = .036). Conversely, class 2 was associated with a decreased odds of HRQoL recovery at 12 months post-MOF (adjusted OR = 0.55; 95% CI, 0.31–0.95; p = .034). For non-hip MOF participants, there were no significant associations between classes and HRQoL recovery in both unadjusted and adjusted models (Table 2).

In the United Kingdom, a three-class model was the most optimal fit for MOF participants. Class 3 was associated with increased odds of HRQoL recovery at 12 months post-MOF after adjustment for age, sex, and prefracture HRQoL (adjusted OR = 2.92; 95% CI, 1.58–5.41; p < .001). Conversely, class 2 was associated with a decreased odds of HRQoL recovery (adjusted OR = 0.24; 95% CI, 0.13–0.47; p < .001). Similar associations were observed for participants with a non-hip MOF within a two-class model (Table 2).

Discussion

Previous publications based on ICUROS data described trajectories of HRQoL for individual fracture sites from 11 different countries, combined[6] and country-specific,[8,23] and showed that fractures incur substantial loss in HRQoL for at least 12 months. The current analyses identified several distinctive health service use pathways that are associated with improved HRQoL recovery 12 months post-MOF across individual countries. Understanding country-specific health service use pathways and their association with HRQoL recovery may facilitate improvements in managing patients following MOF on a global scale.

A total of 34 health service pathways (or "classes") were observed for MOF participants across countries. Most countries identified one class that was associated with increased odds of HRQoL recovery12 months postfracture and one class associated with decreased odds of HRQoL recovery. Interestingly, the health service use pathways with the greatest proportion of participants were not always associated with increased odds of HRQoL recovery. This was observed for Australia, Austria, Italy, Mexico, Spain, and the United Kingdom, suggesting that common combinations of health service use post-MOF in these countries may not be appropriate to achieve HRQoL recovery. Classes that were associated with increased odds of HRQoL recovery were characterized by individuals with hospital presentations without

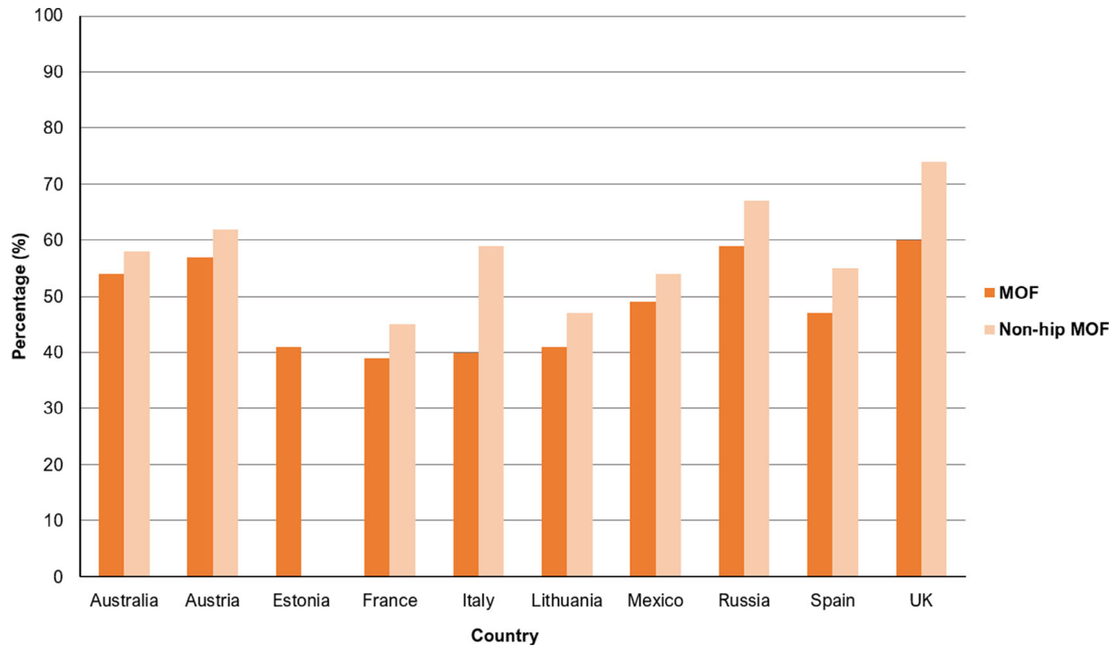

Fig 1. Proportion (%) of participants who recovered to their prefracture HRQoL at 12 months, by country and fracture group.

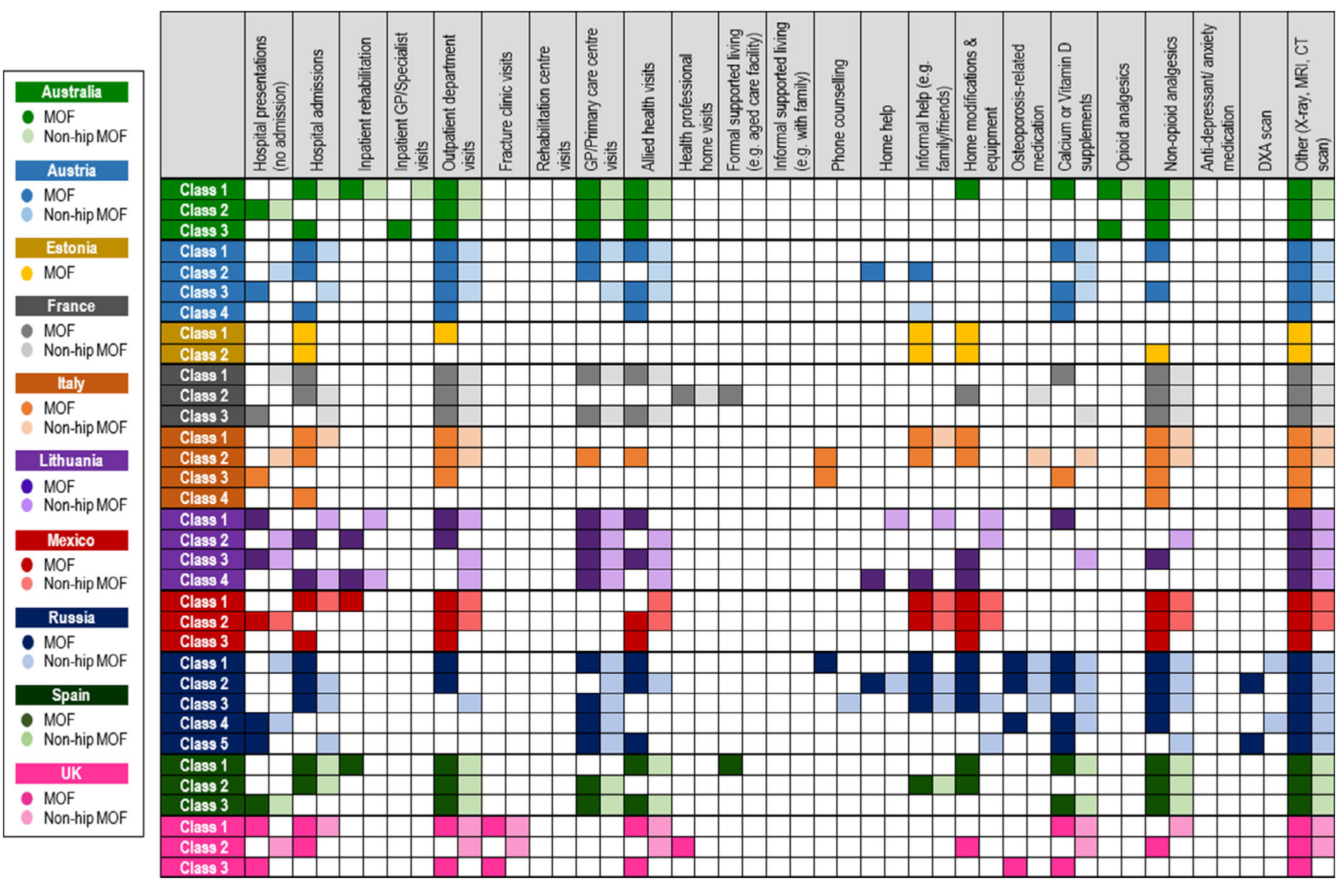

Fig 2. Health service use profiles ("classes") for MOF and non-hip MOF participants, by country.

Table 2. Logistic Regression Models Showing the Association Between Class Membership and Odds of Health-Related Quality of Life Recovery at 12 Months Postfracture, Unadjusted and Fully Adjusted Models

	MOF					Non-hip MOF				
		Unadjusted		Adjusted			Unadjusted		Adjusted	
Characteristic	*n*	Odds ratio (95% CI)	*p*	Odds ratio (95% CI)	*p*	*n*	Odds ratio (95% CI)	*p*	Odds ratio (95% CI)	*p*
Australia[a]										
Class 1	157	**0.35 (0.23–0.55)**	**<.001**	**0.37 (0.23–0.61)**	**<.001**	198	0.82 (0.55–1.24)	.354	0.82 (0.54–1.25)	.350
Class 2	176	**1.59 (1.10–2.29)**	**.014**	**1.48 (1.00–2.17)**	**.049**	176	1.22 (0.80–1.84)	.354	1.22 (0.80–1.87)	.350
Class 3	191	1.44 (0.95–2.17)	.085	1.32 (0.87–2.02)	.197	–	–	–	–	–
Austria[a]										
Class 1	102	0.94 (0.56–1.56)	.806	0.87 (0.50–1.51)	.625	117	1.59 (0.96–2.63)	.071	**1.99 (1.14–3.47)**	**.015**
Class 2	175	0.72 (0.48–1.07)	.105	**0.39 (0.24–0.64)**	**<.001**	86	**0.57 (0.34–0.97)**	**.036**	**0.63 (0.35–0.83)**	**.020**
Class 3	91	0.88 (0.56–1.38)	.564	0.96 (0.58–1.61)	.888	64	1.06 (0.60–1.90)	**.839**	0.64 (0.32–1.27)	.151
Class 4	157	**1.68 (1.10–2.57)**	**.016**	**2.64 (1.65–4.21)**	**<.001**	-	–	–	–	–
Estonia[b]										
Class 1	74	0.85 (0.39–1.89)	.694	0.97 (0.39–2.44)	.946	-	–	–	–	–
Class 2	72	1.17 (0.53–2.60)	.694	1.03 (0.41–2.60)	.946	-	–	–	–	–
France[c]										
Class 1	228	**2.44 (1.57–3.80)**	**<.001**	**2.69 (1.59–4.54)**	**<.001**	54	0.75 (0.41–1.38)	.359	0.95 (0.48–1.87)	.878
Class 2	181	**0.41 (0.26–0.65)**	**<.001**	**0.27 (0.15–0.51)**	**<.001**	63	0.72 (0.38–1.34)	.295	**0.35 (0.15–0.82)**	**.016**
Class 3	57	0.89 (0.50–1.58)	.689	0.99 (0.52–1.91)	.982	186	1.54 (0.92–2.56)	.100	**1.81 (1.02–3.29)**	**.049**
Italy[c]										
Class 1	193	**0.51 (0.34–0.77)**	**<.001**	**0.51 (0.32–0.80)**	**.003**	95	**0.51 (0.30–0.85)**	**.010**	**0.49 (0.28–0.84)**	**.010**
Class 2	91	**0.40 (0.22–0.70)**	**.001**	**0.46 (0.25–0.84)**	**.011**	162	**1.96 (1.17–3.29)**	**.010**	**2.06 (1.19–3.58)**	**.010**
Class 3	163	**4.70 (3.15–7.02)**	**<.001**	**3.85 (2.50–5.93)**	**<.001**	-	–	–	–	–
Class 4	47	**0.24 (0.10–0.54)**	**.001**	**0.29 (0.11–0.76)**	**.012**	-	–	–	–	–
Lithuania[a]										
Class 1	141	**5.98 (4.88–11.03)**	**<.001**	**4.90 (1.70–6.83)**	**<.001**	27	**0.08 (0.02–0.33)**	**.001**	**0.08 (0.02–0.32)**	**.001**
Class 2	76	**0.41 (0.23–0.74)**	**.003**	**0.41 (0.23–0.74)**	**.003**	44	**0.36 (0.20–0.68)**	**.001**	**0.37 (0.17–0.80)**	**.012**
Class 3	44	0.51 (0.25–1.02)	.057	0.47 (0.22–1.01)	.052	141	**6.60 (3.87–11.25)**	**<.001**	**6.89 (3.88–12.23)**	**<.001**
Class 4	79	**0.15 (0.07–0.30)**	**<.001**	**0.14 (0.07–0.30)**	**<.001**	60	**0.38 (0.20–0.71)**	**.002**	**0.39 (0.21–0.74)**	**.004**
Mexico[a]										
Class 1	204	1.02 (0.60–1.73)	.956	1.23 (0.64–2.35)	.534	93	**4.74 (1.82–12.34)**	**.001**	**5.25 (1.86–14.85)**	**.001**
Class 2	27	0.33 (0.14–0.81)	**.015**	**0.25 (0.09–0.68)**	**.006**	27	**0.21 (0.09–0.55)**	**.001**	**0.17 (0.07–0.54)**	**.001**
Class 3	47	**1.87 (0.98–3.55)**	**.057**	**1.87 (1.15–3.89)**	**.045**	-	–	–	–	–
Russia[a]										
Class 1	96	**0.52 (0.33–0.81)**	**.004**	**0.44 (0.27–0.72)**	<.001	264	**18.8 (10.80–32.50)**	**<.001**	**18.2 (10.10–32.80)**	**<.001**
Class 2	143	**0.15 (0.10–0.24)**	**<.001**	**0.16 (0.10–0.25)**	<.001	66	**0.13 (0.07–0.23)**	**<.001**	**0.17 (0.09–0.33)**	**<.001**
Class 3	138	**0.12 (0.08–0.19)**	**<.001**	**0.13 (0.08–0.21)**	<.001	42	**0.20 (0.10–0.41)**	**<.001**	**0.18 (0.08–0.39)**	**<.001**
Class 4	280	**22.40 (13.40–37.60)**	**<.001**	**18.88 (11.10–32.30)**	<.001	161	0.88 (0.60–1.30)	.529	1.29 (0.83–1.99)	.255
Class 5	175	**1.50 (1.04–2.15)**	**.029**	**2.39 (1.56–3.65)**	<.001	70	**0.10 (0.05–0.19)**	**<.001**	**0.09 (0.05–0.18)**	**<.001**

(Continues)

Table 2. Continued

Characteristic	MOF					Non-hip MOF				
		Unadjusted		Adjusted			Unadjusted		Adjusted	
	n	Odds ratio (95% CI)	p	Odds ratio (95% CI)	p	n	Odds ratio (95% CI)	p	Odds ratio (95% CI)	p
Spain[c]										
Class 1	59	1.02 (0.57–1.82)	.959	1.16 (0.58–2.31)	.685	27	0.85 (0.34–2.09)	.715	0.82 (0.30–2.26)	.703
Class 2	156	**0.55 (0.34–0.89)**	**.014**	**0.55 (0.31–0.95)**	**.034**	37	0.66 (0.30–1.47)	.313	0.69 (0.28–1.70)	.422
Class 3	68	**2.19 (1.25–3.83)**	**.006**	**2.00 (1.05–3.83)**	**.036**	63	1.52 (0.75–3.07)	.243	1.50 (0.68–3.29)	.318
United Kingdom[b]										
Class 1	42	1.62 (0.77–3.40)	.203	1.28 (0.59–2.79)	.535	52	**0.23 (0.10–0.50)**	**<.001**	**0.22 (0.10–0.49)**	**<.001**
Class 2	101	**0.22 (0.13–0.39)**	**<.001**	**0.24 (0.13–0.47)**	**<.001**	94	**4.40 (2.00–9.67)**	**<.001**	**4.63 (2.04–9.50)**	**<.001**
Class 3	96	**3.51 (1.97–6.26)**	**<.001**	**2.92 (1.58–5.41)**	**<.001**	–	–	–	–	–

Bold values are significant at $p < .5$.

[a]Adjusted for age, sex, education, income level, and prefracture EQ-5D utility score.

[b]Adjusted for age, sex, and prefracture EQ-5D utility score.

[c]Adjusted for age, education, income level, and prefracture EQ-5D utility score.

admission (seven classes); outpatient department visits (eight classes); allied health visits (eight classes); vitamin D/calcium supplementation (eight classes); and/or non-opioid analgesic use (seven classes). It was not surprising that allied healthcare and non-opioid analgesics were associated with increased HRQoL recovery. Allied health services (eg, physiotherapy) play a key role in early mobilization and functional recovery after MOF in many countries,[24,25] and non-opioid analgesics are widely known to be efficient in reducing pain—pain being a dimension of the EQ-5D-3L utility score used to calculate HRQoL in this study.[26]

Conversely, classes that were associated with decreased odds of HRQoL recovery in MOF participants were characterized by inpatient care (hospitalization, inpatient rehabilitation); outpatient department visits; both formal and informal home care; and home and equipment modifications. It was not unexpected that hospitalization was associated with decreased HRQoL recovery, because hospitalization can be an indicator of a fracture with severe injury. Participants who were hospitalized for their MOF had a lower rate of HRQoL recovery at 12 months compared to those who were not (41.9% versus 67.1%; unpublished data). Furthermore, previous studies have shown that people hospitalized with a hip[27] or vertebral[28] fracture have worse trajectories of HRQoL postfracture than patients not admitted. Similarly, formal home care services may also be an indicator of a patient with poorer health or greater physical frailty, given that these services are only available for those with more complex care needs. Admission to long-term aged care facilities were associated with decreased odds of HRQoL recovery in France and Italy, driven by hip fracture participants. There is a lack of data for HRQoL of residents of aged care facilities,[29] although residents are typically physically frailer than the general older population,[30] thereby impacting their HRQoL. Future research should explore factors that influence HRQoL in people living in long-term aged care facilities postfracture.

Health service use substantially differed between countries as expected, given the geographic variation in healthcare system structure. A variety of factors could also have affected healthcare-seeking behaviors in participants, including availability of universal health care (ie, no out-of-pocket expenses) or proximity and availability to health services. The low proportion of osteoporosis-related medication use across most countries implies that a large proportion of participants were not assessed for osteoporosis—confirming the "osteoporosis care gap."[31] Research has highlighted that pharmacological treatments for osteoporosis are effective at reducing risk of fractures,[32] with some studies also showing they can improve HRQoL postfracture.[33–35] Opioid analgesic use was quite low across countries possibly due to the controversial nature of prescribing opioids for postfracture care.[36,37] However, given that pharmaceutical regulations vary between countries, care should be taken when interpreting these proportions. There was infrequent attendance to fracture clinics across all countries except for the United Kingdom, which may be due to the introduction of fracture liaison services (intimately linked with fracture clinics) in the United Kingdom in the early 2000s. Finally, phone consultations by a healthcare professional following hospitalization was uncommon across countries except for Italy, which was a component of the class associated with improved HRQoL recovery. Understanding the country-specific healthcare services that promote recovery of HRQoL could improve post-MOF care worldwide, particularly for healthcare services uncommon in some countries, yet routine in others.

Limitations

ICUROS is the largest multicountry observational study on HRQoL consequences of fractures conducted to date where all variables in the study are captured using the same protocol. Because of the identical study design applied in all countries, ICUROS provided a unique opportunity to assess associations between different combinations of health service use and HRQoL recovery post-MOF across different countries. However, our study has some limitations. In terms of the ICUROS dataset, HRQoL prior to fracture was determined by recall; therefore, there is a potential risk for recall bias. However, it has been reported that patients can accurately recall their HRQoL up to 6 weeks following surgery.[38] Further to this, mean prefracture HRQoL utility scores were similar to reported EQ-5D index population norms,[39] so substantial recall bias is not likely. Results may not be applicable to several important subpopulations (eg, those with dementia, those living in residential aged care) due to the exclusion criteria of the ICUROS. In terms of our analyses, we were unable to comment on other factors that may influence HRQoL recovery in older adults; eg, multimorbidity. We were unable to complete the analyses by individual fracture site because sample sizes were insufficient to reliably carry out LCA[19]; however, this provided motivation for completing the analyses excluding hip fractures. Given that different fractures incur different disutility, care should be taken when interpreting results as the proportion of fractures at different skeletal sites varied in countries. Finally, there was a high loss to follow-up/dropout rate in ICUROS (~21%), which may reflect that the ICUROS population was, on average, elderly and frail. We did not include these patients in our analyses because it was impossible to impute health service use data beyond this. However, the original ICUROS investigators performed analyses that included data for participants who were lost to follow-up, which produced similar results for trajectories of HRQoL,[6] indicating that these participants may not have substantially impacted our results.

Conclusions

HRQoL 12 months post-MOF typically does not return to prefracture levels in older adults. We identified several, distinct country-specific health service use pathways associated with improved HRQoL recovery. Given that HRQoL encompasses both physical and mental functioning, which are imperative to healthy aging, incorporating our findings into existing clinical practice may result in care pathways that optimize HRQoL recovery for patients with an MOF. Future research should focus on determining the causality of these associations.

Disclosures

All authors declare that they do not have any conflicts of interest. The data for this analysis was accessed from the International Costs and Utilities Related to Osteoporotic fractures Study (ICUROS) central database. Access to this database should be requested from the data custodians (Prof. John Kanis and Prof. Fredrik Borgström) and the principal investigators of each participating country (http://www.icuros.org/).

Acknowledgments

JT is supported by an Australian National Health and Medical Research Council (NHMRC) Postgraduate Scholarship (1151089) and SLB-O is supported by a NHMRC Career Development Fellowship (1107510). We are grateful to the Quality of Life and Epidemiology Working Group of the Committee of Scientific Advisors for the International Osteoporosis Foundation (IOF) under whose supervision this study was undertaken. At the international level, the ICUROS was sponsored by Amgen, Eli Lilly, Medtronic (Kyphon), Novartis, Sanofi-Aventis Wyeth and Servier. We acknowledge the Quality of Life and Epidemiology Working Group: Jonathan Adachi, Frederik Borgström, Patricia Clark, Cyrus Cooper (co-chair), Manuel Diaz Curiel, Hans Peter Dimai, Mickaël Hiligsmann, John Kanis (co-chair), Edith Lau, Paul Lips, Mickael Lewiecki, Roman Lorenc, Eugene McCloskey, Sergio Ortolani, Alexandra Papaioannou, Stuart Silverman, and Pawel Szulc. In Australia, the study was supported by the NHMRC (628422) with subsidiary funding support from Merck Australia Pty Ltd. In Austria, the study was sponsored by Central Association of Austrian Social Security Institution, the Austrian Society for Bone and Mineral Research (AuSBMR), Merck Sharp & Dohme, Nycomed, Roche and Daiichi-Sankyo GmbH. In Mexico, the study was supported by the National Council of Science and Technology (CONACyT) grant EI 2008-01-87106. In Lithuania, the study was supported by the National Osteoporosis Center. In Estonia, the study was supported by Estonian Science Foundation (Grant 9368).

Authors' roles: JK, FB, and AS are integral to the ICUROS international study protocol and are principal investigators and members of the ICUROS Steering Committee. JT, KMS, LB, and SB-O were involved in study conception and design; JT, KMS, and CC were involved in data acquisition; JT, LB, and SB-O were involved in data analysis; JT led the interpretation of findings with input from the all authors; and JT drafted the manuscript, which was critically revised by all authors, who approved the final version and agree to be accountable for it. JT accepts responsibility for the integrity of the data and its analysis.

Author Contributions: **Jason Talevski:** Conceptualization; data curation; formal analysis; methodology; project administration; writing-original draft; writing-review and editing. **Kerrie Sanders:** Conceptualization; data curation; investigation; methodology; supervision; writing-original draft; writing-review and editing. **Ljoudmila Busija:** Formal analysis; methodology; writing-review and editing. **Alison Beauchamp:** Supervision; writing-review and editing. **Gustavo Duque:** Supervision; writing-review and editing. **Frederik Borgstrom:** Data curation; methodology; writing-review and editing. **John Kanis:** Data curation; methodology; writing-review and editing. **Axel Svedbom:** Data curation; methodology; writing-review and editing. **Catherine Connaughton:** Conceptualization; methodology; supervision; writing-review and editing. **Amanda Stuart:** Data curation; project administration; writing-review and editing. **Sharon Brennan-Olsen:** Conceptualization; methodology; project administration; supervision; writing-original draft; writing-review and editing.

Peer Review

The peer review history for this article is available at https://publons.com/publon/10.1002/jbmr.4181.

References

1. Reginster J-Y, Burlet N. Osteoporosis: a still increasing prevalence. Bone. 2006;38(2):4–9.

2. Johnell O, Kanis JA. An estimate of the worldwide prevalence, mortality and disability associated with hip fracture. Osteoporos Int. 2004; 15(11):897–902.
3. Cosman F, de Beur SJ, LeBoff MS, et al. Clinician's Guide to prevention and treatment of osteoporosis. Osteoporos Int. 2014;25(10):2359–81.
4. Tatangelo G, Watts J, Lim K, et al. The cost of osteoporosis, osteopenia, and associated fractures in Australia in 2017. J Bone Miner Res. 2019;34(4):616–25.
5. Borgström F, Karlsson L, Ortsäter G, et al. Fragility fractures in Europe: burden, management & opportunities. Arch Osteoporos. 2020; 15:1–21.
6. Svedbom A, Borgstom F, Hernlund E, et al. Quality of life for up to 18 months after low-energy hip, vertebral, and distal forearm fractures-results from the ICUROS. Osteoporos Int. 2018;29(3): 557–66.
7. Magaziner J, Chiles N, Orwig D. Recovery after hip fracture: interventions and their timing to address deficits and desired outcomes—evidence from the baltimore hip studies. Nestle Nutr Inst Workshop Ser. 2015;83:71–81.
8. Abimanyi-Ochom J, Watts JJ, Borgstrom F, et al. Changes in quality of life associated with fragility fractures: Australian arm of the International Cost and Utility Related to Osteoporotic Fractures Study (AusICUROS). Osteoporos Int. 2015;26(6):1781–90.
9. Pisani P, Renna MD, Conversano F, et al. Major osteoporotic fragility fractures: risk factor updates and societal impact. World J Orthop. 2016;7(3):171–81.
10. Kanis JA, Oden A, Johnell O, De Laet C, Jonsson B. Excess mortality after hospitalisation for vertebral fractures. Osteoporos Int. 2004;15 (1):108–12.
11. Johnell O, Kanis JA, Oden A, et al. Mortality after osteoporotic fractures. Osteoporos Int. 2004;15(1):38–42.
12. Barker KL, Reid M, Lowe CJ. What does the language we use about arthritis mean to people who have osteoarthritis? A qualitative study. Disabil Rehabil. 2014;36(5):367–72.
13. Akesson K, Marsh D, Mitchell PJ, et al. Capture the fracture: a best practice framework and global campaign to break the fragility fracture cycle. Osteoporos Int. 2013;24(8):2135–52.
14. Ganda K, Puech M, Chen JS, et al. Models of care for the secondary prevention of osteoporotic fractures: a systematic review and meta-analysis. Osteoporosis Int. 2013;24(2):393–406.
15. Nordstrom P, Thorngren KG, Hommel A, Ziden L, Anttila S. Effects of geriatric team rehabilitation after hip fracture: meta-analysis of randomized controlled trials. J Am Med Dir Assoc. 2018;19:840–5.
16. Talevski J, Sanders KM, Duque G, et al. Effect of clinical care pathways on quality of life and physical function after fragility fracture: a meta-analysis. J Am Med Dir Assoc. 2019;20(7):926.
17. Rabin R, de Charro F. EQ-5D: a measure of health status from the EuroQol Group. Ann Med. 2001;33(5):337–43.
18. Szende A, Oppe M, Devlin NJ, EuroQol Group. EQ-5D value sets: inventory, comparative review, and user guide. Dordrecht: Springer; 2007 (EuroQol Group Monographs; 2).
19. Nylund KL, Asparouhov T, Muthén BO. Deciding on the number of classes in latent class analysis and growth mixture modeling: a Monte Carlo simulation study. Struct Equ Modeling. 2007;14(4):535–69.
20. Masyn KE. 25 latent class analysis and finite mixture modeling. In Little TD, ed . The Oxford Handbook of Quantitative Methods. Oxford, UK: Oxford University Press; 2013 p 551.editor
21. Muthén L, Muthén B. Mplus User's Guide. 7th ed. Los Angeles, CA: Muthén & Muthén; 2015.
22. Acock AC. Discovering structural equation modeling using Stata. Stata Rev Press. 2013.
23. Lesnyak O, Svedbom A, Belova K, et al. Quality of life after fragility fracture in The Russian Federation: results from the Russian arm of the International Cost and Utility Related to Osteoporotic Fractures Study (ICUROS). Arch Osteoporos. 2020;15(1):37.
24. Perracini MR, Kristensen MT, Cunningham C, Sherrington C. Physiotherapy following fragility fractures. Injury. 2018;49(8):1413–7.
25. Mehta SP, Roy JS. Systematic review of home physiotherapy after hip fracture surgery. J Rehabil Med. 2011;43(6):477–80.
26. Barker AL, Soh SE, Sanders KM, et al. Aspirin and fracture risk: a systematic review and exploratory meta-analysis of observational studies. BMJ Open. 2020;10(2):e026876.
27. Giles LC, Hawthorne G, Crotty M. Health-related quality of life among hospitalized older people awaiting residential aged care. Health Qual Life Outcomes. 2009;7:71.
28. Suzuki N, Ogikubo O, Hansson T. Previous vertebral compression fractures add to the deterioration of the disability and quality of life after an acute compression fracture. Eur Spine J. 2010;19(4):567–74.
29. Kane RA, Kling KC, Bershadsky B, et al. Quality of life measures for nursing home residents. J Gerontol A Med Sci. 2003;58(3):240–8.
30. Edwards HE, Courtney MD, O'Reilly MT. Involving older people in research to examine quality of life in residential aged care. Qual Ageing. 2003;4(4):38–43.
31. Harvey NC, McCloskey EV, Mitchell PJ, et al. Mind the (treatment) gap: a global perspective on current and future strategies for prevention of fragility fractures. Osteoporos Int. 2017;28(5):1507–29.
32. Murad MH, Drake M, Mullan R, et al. Comparative effectiveness of drug treatments to prevent fragility fractures: a systematic review and network meta-analysis. J Clin Endocrinol Metab. 2012;97(6): 1871–80.
33. Kastelan D, Vlak T, Lozo P, et al. Health-related quality of life among patients with postmenopausal osteoporosis treated with weekly and monthly bisphosphonates. Endocr Res. 2010;35(4):165–73.
34. Marquis P, Roux C, de la Loge C, et al. Strontium ranelate prevents quality of life impairment in post-menopausal women with established vertebral osteoporosis. Osteoporos Int. 2008;19(4):503–10.
35. Maugeri D, Russo E, Luca S, et al. Changes of the quality-of-life under the treatment of severe senile osteoporosis with teriparatide. Arch Gerontol Geriatr. 2009;49(1):35–8.
36. Teng Z, Zhu Y, Wu F, et al. Opioids contribute to fracture risk: a meta-analysis of 8 cohort studies. PLoS One. 2015;10(6):e0128232.
37. Ping F, Wang Y, Wang J, et al. Opioids increase hip fracture risk: a meta-analysis. J Bone Miner Metab. 2017;35(3):289–97.
38. Marsh J, Bryant D, MacDonald SJ. Older patients can accurately recall their preoperative health status six weeks following total hip arthroplasty. J Bone Joint Surg Am. 2009;91(12):2837–7.
39. Szende A, Janssen B, Cabases J. Self-reported population health: an international perspective based on EQ-5D. Dordrecht: Springer; 2014.