Osteoporosis International (2023) 34:2111–2119
https://doi.org/10.1007/s00198-023-06881-w

ORIGINAL ARTICLE

Costs of incident non-hip osteoporosis-related fractures in postmenopausal women from a payer perspective

Anabela Barcelos[1,2,3] · Judite Gonçalves[1,4,5] · Céu Mateus[6] · Helena Canhão[1,2,7] · Ana Maria Rodrigues[1,2,8]

Received: 26 March 2023 / Accepted: 28 July 2023 / Published online: 19 August 2023

Abstract

Summary Osteoporosis-related fractures lead to high morbidity, mortality, and healthcare costs among post-menopausal women. This study showed that incident non-hip osteoporosis-related fractures are frequent among women aged 50 + in Portugal, leading to excessive healthcare costs of €74 million per year, in a conservative scenario.

Purpose This study aimed to estimate the costs of incident non-hip osteoporosis-related fractures among postmenopausal women living in Portugal from a payer perspective.

Methods The study includes women ≥ 50 years old who participated in the baseline assessment (2011–2013) and the first follow-up wave (2013–2015) of the Epidemiology of Chronic Diseases cohort, a Portuguese community-based longitudinal prospective study ($n = 2{,}762$). Incident non-hip osteoporosis-related fractures were defined as any self-reported low impact non-hip fractures since baseline. Healthcare resource utilization during the year following fracture was obtained from an informal panel of experts. The amounts of resources used were multiplied by the national tariffs practiced in the National Health Service (NHS) to obtain the cost per patient in the year following a wrist, vertebral, or other site fracture, which was subsequently multiplied by the estimated annual number of incident fractures to obtain the total annual cost of incident non-hip osteoporosis-related fractures among postmenopausal women.

Results Each year approximately 5,000 wrist, 3,500 vertebral, and 39,000 other-site osteoporosis-related fractures occur in women aged 50 + in Portugal. Healthcare costs per patient in the year following fracture vary from €2,709.52 for vertebral fractures to €3,096.35 for other fractures. Non-hip incident osteoporosis-related fractures among 50 + women cost approximately €74 million per year. Among all healthcare services, physiotherapy represents the bulk of costs.

Conclusions This study pinpoints the relevance of preventing non-hip osteoporosis-related fractures, as these cost about €74 million per year in direct healthcare costs, a substantial impact on the budget of the Portuguese NHS.

Keywords Cost-of-illness · Healthcare · Non-hip osteoporosis-related fractures · Osteoporosis · Postmenopausal women

✉ Anabela Barcelos
barcelos.anabela@gmail.com

✉ Judite Gonçalves
j.goncalves@imperial.ac.uk

[1] NOVA National School of Public Health, Public Health Research Centre, Comprehensive Health Research Center, CHRC, NOVA University of Lisbon, Lisbon, Portugal

[2] EpiDoC Unit, CEDOC, NOVA Medical School, NOVA University of Lisbon, Lisbon, Portugal

[3] Rheumatology Department, Centro Hospitalar do Baixo Vouga, Rua Artur Ravara, Aveiro 3814-501, Portugal

[4] Nova School of Business and Economics, NOVA University of Lisbon, Lisbon, Portugal

[5] School of Public Health, Department of Primary Care & Public Health, Imperial College London, Charing Cross Campus, London W6 8RP, UK

[6] Faculty of Health and Medicine, Lancaster University, Lancaster, UK

[7] Rheumatology Unit, Centro Hospitalar Universitário Lisboa Central, Lisboa, Portugal

[8] Rheumatology Unit, Hospital dos Lusíadas, Lisboa, Portugal

Introduction

Osteoporosis is a disease characterized by low bone mass and microarchitectural deterioration of bone tissue, resulting in bone fragility and propensity to fractures [1]. With the population aging, osteoporosis became increasingly common and is now a major public health concern. Most individuals are at risk of developing osteoporosis at some point during their lifetime [2]. In 2019, there were approximately 25.5 million women and 6.5 million men with osteoporosis in the EU27 + 2 (European Union plus the United Kingdom and Switzerland), about four times more women than men [3].

The most obvious and serious consequence of osteoporosis is fractures, which result in increased morbidity and mortality, and represent a major and growing economic burden on healthcare systems worldwide [4, 5]. In Portugal, it was estimated that the number of new osteoporosis-related fractures was 70,730 in men and women aged 50 years or more, in 2019 [3]. Although the most well studied fragility fractures are vertebral and hip fractures [6–8], several studies have shown that non-hip and non-vertebral fractures (e.g., lower leg, wrist, humerus, rib, elbow, or clavicle) account for most osteoporosis-related fractures and are associated with an increased risk of subsequent fracture, higher morbidity, higher mortality, and a significant increase in direct and indirect health costs [9–11].

More than three million osteoporosis-related fractures occur annually in the United States, costing an estimated $25.3 billion in 2025 [12]. The average direct costs during the first year after common fractures (hip, vertebral, and forearm) in Iran were estimated to be $3,030, $2,317, and $925, respectively [13]. In the EU27 + 2, the direct costs of incident osteoporosis-related fractures in 2019 were €36.3 billion [3]. Marques et al. highlight that the economic burden attributable to osteoporotic hip fractures in Portugal could be about €216 million in 2011 [14]. Although the cost of hip fractures in Portugal is relatively well-known [14–16], information about the costs of non-hip osteoporosis-related fractures is lacking, which is a major gap in knowledge given their prevalence. Quantification of fracture-related costs is needed to efficiently allocate resources, for example for fracture liaison services (FLS). FLS improves healthcare for the patient by reducing their risk of a new fracture, with a subsequent cost reduction for the healthcare system [17].

This study aimed to estimate the costs of incident non-hip osteoporosis-related fractures in postmenopausal women living in Portugal, focusing on direct costs from healthcare consumption in the first year following fracture, and distinguishing between the main types of fracture (vertebral, wrist, and others).

Methods

Type of study, population of interest, and methodology

This is a cost-of-illness type study, where the costs associated with non-hip osteoporosis-related fractures were estimated from a payer perspective for the year following the fracture. This study was focused on postmenopausal women, using the lower cut-off age of 50 years to define "postmenopausal".

Throughout the study, non-hip fractures were stratified into three groups based on the location of the fracture: vertebral, wrist, and other fractures (clavicle, humerus, elbow, and lower leg). The same stratification was used in the scorecard for osteoporosis in Europe (SCOPE 2021) [3]. We estimated the number of fractures of each type occurring annually among postmenopausal women in Portugal and consulted with an expert panel to identify the healthcare resource consumption pattern of patients suffering each type of fracture, which we multiplied by the unit costs of each resource, to obtain the costs per patient in the year following a fracture. The number of women in each group of fractures was then multiplied by the costs per patient per year to obtain the total annual cost of incident non-hip osteoporosis-related fractures among postmenopausal women for the Portuguese National Health Service (NHS).

Data

Healthcare use

The following healthcare resources were considered: doctor visits, medical exams, hospitalization, outpatient care, and physiotherapy (e.g., etching and balance exercises, cryotherapy, spine manipulation techniques, ice and heat therapy). Essential technical aids (e.g., orthoses) prescribed in each case were also considered, even though they are purchased out-of-pocket by the patients (i.e., fall outside the payer's perspective). It was not possible to consider nursing home/long-term care or medications because utilization of these is not clearly defined (e.g., nursing home care depends strongly on socioeconomic status and availability of informal care), and we lack individual-level utilization data. Considering that individual level utilization is not available, information on the typical healthcare resources used in the year following each type of fracture was gathered from a panel of experts: two rheumatologists, a physiatrist, and an orthopaedist. Experts discussed typical healthcare use based on their experience and were asked to reach a consensus.

Costs

Medical exams, hospitalization, outpatient care procedures, as well as physiotherapy were valued according to the national tariffs practiced in the NHS: those tariffs are based on Diagnosis Related Groups (DRG), in the case of hospitalization, and fee-for-service, in the case of medical exams, outpatient procedures, and physiotherapy (*Portaria nº 254/2018, de 7 de setembro*).

The prices of doctor visits in the Portuguese NHS are not defined in the same way as for diagnoses and treatment procedures. Specialty consultations were valued according to the terms defined by the Central Administration of the Health System for 2020, which specify the amounts paid to hospitals for each outpatient visit. The lowest price (€39.00) was adopted. For general practice visits, there is no public information on either cost or reimbursement prices. For this work, general practice visits were valued at half the price of a specialty consultation (€19.50).

The tariffs for X-rays varied by type of fracture. For other fractures, the average price between upper and lower limb fractures X-rays (i.e., hand and foot) was considered. The same rationale was applied to estimate the price of outpatient care and technical aids for other fractures. Technical aids purchased out-of-pocket by the patients were valued at market prices extracted from the website *salusa.pt* (also 2020 prices). The national tariffs defined in *Portaria nº 254/2018* were also still applied in 2020, so all costs are at 2020 prices.

Numbers of fractures per year

The annual numbers of incident wrist, vertebral, and other non-hip fractures among postmenopausal women in Portugal were estimated from a population based Portuguese cohort—Epidemiology of Chronic Diseases (EpiDoC) study. EpiDoC is a longitudinal cohort enrolling 10,661 non-institutionalized individuals representative of the adult Portuguese population living in mainland Portugal, Azores, and Madeira islands [18]. A full description of the EpiDoC cohort is provided elsewhere [18, 19].

The sample used in the present study includes women aged 50 years and above who participated in the baseline assessment (2011–2013) and in the first follow-up wave (2013–2015) of the EpiDoC study (EpiDoc 2).

Incident non-hip osteoporosis-related fractures were defined as any new self-reported low impact non-hip fractures: fractures that resulted from a fall, from standing height or less, or that occurred in the absence of trauma, since the previous wave (EpiDoC 1, conducted in 2011–2013) [20]. The accuracy of self-reported osteoporosis-related fractures was previously shown to be acceptable [21–23]. For the purposes of this study, it is important to note that women diagnosed with bone metastasis or other bone metabolic diseases, such as Paget's disease of bone, were excluded. Fractures of the face, skull, foot, fingers, and toes were also excluded, as they are usually unrelated with osteoporosis.

The numbers of incident fractures of each type were extracted (i.e., sample totals) and multiplied by the sampling weights to obtain population totals. The sampling weights take into account the stratified sampling design of the EpiDoC study and when applied to the sample, give the same distribution of sex, age, and region of residence (Nomenclature of Territorial Units for Statistics, NUTS II – seven regions in Portugal) as is observed for the total adult Portuguese population (according to the 2011 census).

Healthcare services used after a non-hip osteoporosis-related fracture – expert opinion panel

Experts considered that upon suffering an incident osteoporosis-related fracture, patients require X rays. The percentage of cases that require surgery varied with the type of fracture. Wrist fractures require surgery in about 25% of the cases, vertebral fractures in about 3% of the cases, and other fractures in about 5% of the cases. Moreover, about 5% of the cases of vertebral fractures require hospitalization for further study and observation, but no surgery. In the remaining cases, patients are treated on an outpatient basis (e.g., closed reduction, a non-operative procedure to put bone pieces back into their correct position and alignment).

All fractures should be followed by a rehabilitation program (i.e., physiotherapy) for appropriate recovery, although the exact procedures depend on the fracture site. According to best clinical practice [24], patients are meant to attend 36 sessions of physiotherapy (ideal scenario), although most patients attend fewer sessions (12 sessions), for various reasons such as cost or time constraints.

In the year following a fracture episode, patients typically attend five orthopaedics consultations, three physiatry consultations, and two rheumatology consultations (Table 1). Each rheumatology consultation also involves a check-up X-ray of the site of fracture.

In addition, different fractures require specific technical aids. Wrist fracture patients require wrist orthoses, vertebral fracture patients need support belts, and other fracture patients require corresponding orthoses (e.g., shoulder orthoses, leg orthoses).

Results

A total of 2,762 women aged 50 + were selected (Fig. 1).

Table 1 Standard healthcare services used in Portugal in the year following a non-hip osteoporosis-related fracture, by type of fracture

Type of service	Fracture		
	Wrist fracture	Vertebral fracture	Other fracture
Doctor visits	2 GP visits 5 Orthopedics visits 3 Physiatry visits 2 Rheumatology visits		
Medical exams	2 blood tests 1 DEXA X-rays of fracture site upon fracture Check-up X-rays in each Rheumatology consultation		
Hospitalization	Surgery (25% of the cases)	Surgery (3% of the cases) Further study and observation (5% of the cases)	Surgery (5% of the cases)
Outpatient care	Outpatient treatment (75% of the cases)	Outpatient treatment (92% of the cases)	Outpatient treatment (95% of the cases)
Physiotherapy		36 sessions (ideal scenario)	
Technical aids	Wrist orthosis	Support belt	Shoulder/leg/other orthosis

Source: expert panel. GP: General Practice; DEXA: Dual-energy X-ray Absorptiometry (evaluation of bone densitometry)

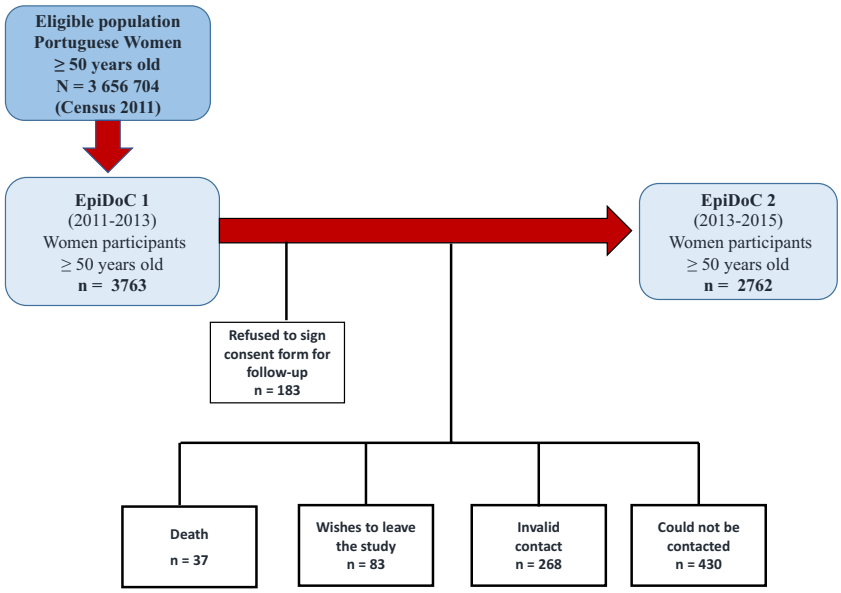

Fig. 1 Flowchart EpiDoC Study

Costs in the year following a non-hip osteoporosis-related fracture

Blood tests encompass a list of 15 + items, which added up to €57.98. The tariff for a bone DEXA was €19.17.

The treatment of fractures requiring surgery involves pre-surgery routines and procedures such as blood tests, an anesthesiology consultation, a thorax X-ray, and an electrocardiogram, which were valued at €66.50 according to the national tariffs. Surgery prices also varied depending on the type of fracture as depicted in Table 2. Surgery was valued at €1,316.16 for wrist fractures (DRG for hand or wrist procedures), and €644.37 for other fractures (DRG for fractures & dislocations except for femur, pelvis, and back). Vertebral fractures may undergo two different surgical procedures. Among the 3% of the cases of vertebral fractures that require surgery, about 1% involve arthrodesis, valued at €3,205.63 (DRG for dorsal and/or lumbar arthrodesis except for resolution of the vertebral curvature), and 2% require vertebroplasty, valued at €1,573.22 (DRG for other procedures in the musculoskeletal system and/or connective tissue). For the 5% of the cases that require hospitalization for observation, costs were valued at €700.58 (DRG for other diagnoses of the musculoskeletal system and/or connective tissue).

Table 2 Unit costs of each healthcare service/medical equipment by type of fracture

Service or equipment	Wrist fracture	Vertebral fracture	Other fracture
GP visit		€19.50	
Specialist consultation		€39.00	
Blood tests		€57.98	
DEXA		€19.17	
X-rays	Double: €3.70 Single: €2.50	Double, dorsal, and lumbar: €15.00	Double: €4.00 Single: €2.50/€3.00
Hospitalization: pre-surgery routines		€66.50	
Hospitalization	€1,316.16 (25% of the cases)	Arthrodesis (1% of the cases): €3,205.63 Vertebroplasty (2% of the cases): €1,573.22 Hospitalization for observation (5% of the cases): €700.58	€644.37 (5% of the cases)
Outpatient treatment	€78.80	€26.50	€80.50
Physiotherapy (36 sessions)	€1,951.20	€1,807.20	€2,298.60
Technical aids	€19.95	€84.90	€94.85

For other fractures, a 50–50 mix of lower and upper limbs was considered, e.g., the tariff for the X-rays is the average of the tariffs for hand and foot X-rays. GP: General Practice; DEXA: Dual-energy X-ray Absorptiometry (evaluation of bone densitometry)

Table 3 Costs per patient in the year following fracture, by type of fracture

Type of service	Wrist fracture	Vertebral fracture	Other fracture
Doctor visits	€429.00	€429.00	€429.00
Medical exams	€159.83	€263.50	€161.88
Hospitalization	€345.67	€100.54	€35.54
Outpatient care	€59.10	€24.38	€76.48
Physiotherapy (36 sessions)	€1,951.20	€1,807.20	€2,298.60
Technical aids	€19.95	€84.90	€94.85
Total	€2,964.75	€2,709.52	€3,096.35

Outpatient procedures usually involve the reduction and immobilization of the fracture (and later the removal of the plaster), as well as X-rays. This was valued at €78.80 for wrist fractures, €26.50 for vertebral fractures, and €80.50 for other fractures. Physiotherapy includes a range of procedures that together added up to about €2,000 if all 36 sessions were taken. The price varied depending on the fracture site. Concerning technical aid prices at market values, a wrist orthosis costs €19.95, a support belt costs €84.90, and the average between the cost of a foot orthosis and the cost of a shoulder orthosis was €94.85 (Table 2).

Direct healthcare costs in the year following each type of fracture are reported in Table 3.

When a patient suffers a fracture, the costs corresponding to doctor consultations were the same regardless of the type of fracture (€429), and include general practice as well as specialty consultations (Orthopaedics, Physiatry, and Rheumatology). Variations in the costs of medical exams reflected the different costs of X-rays, which vary with the type of fracture. Wrist fractures have the lowest costs with medical exams (€159.83), while vertebral fractures have the highest (€263.50).

For hospitalization costs, the percentages of fractures that require hospitalization were considered, as described previously. For this reason, the seemingly low hospitalization costs reflect the fact that, in most cases, wrist, vertebral, and other fractures do not require surgery.

The bulk of annual healthcare costs arose from physiotherapy, ranging between €1,807.20 for vertebral fractures and €2,298.60 for other fractures. These values reflect scenarios where the patient attended 36 physiotherapy sessions (with the exact treatment depending on the type of fracture). However, patients are likely to attend fewer sessions due to out-of-pocket costs, time constraints, lack of transportation, or other barriers. Lastly, technical aids were valued at €19.95 for wrist orthoses, €84.90 for support belts in the case of vertebral fractures, and €94.85 for various kinds of orthoses in the case of other fractures (weighted average).

The total estimated cost in the year following wrist fracture is €2,964.75 per patient, a vertebral fracture costs €2,709.52, and other fractures cost €3,096.35, in the ideal scenario that patients would attend the recommended 36 sessions of physiotherapy. Alternatively, if patients only attend on average 12 physiotherapy sessions, then the total healthcare costs per patient in the year following fracture decrease

Table 4 Total healthcare costs in the year following fracture, by type of fracture and number of physiotherapy sessions

Number of physiotherapy sessions	Wrist fracture	Vertebral fracture	Other fracture
36-session scenario	€ 2,964.75	€ 2,709.52	€ 3,096.35
12-session scenario	€ 1,663.95	€ 1,504.72	€ 1,563.95

Table 5 Numbers of non-hip osteoporosis-related fractures per year in Portugal

	Sample totals	Population totals
Wrist fractures	12	4,847
Vertebral fractures	9	3,491
Other fractures	93	38,881

Source: author calculations based on EpiDoC data

to €1,663.95 for wrist fractures, €1,504.72 for vertebral fractures, and €1,563.95 for other fractures (Table 4).

Numbers and direct cost of non-hip osteoporosis-related fractures per year in Portugal

The annual number of incident non-hip osteoporosis-related fractures among women aged 50 + are 4,847 wrist, 3,491 vertebral, and 38,881 other fractures (Table 5).

Considering the annual costs per patient presented in the previous section and assuming that all 36 physiotherapy sessions are taken, the total cost is estimated at almost €144 million (Table 6). If the 12-session scenario is adopted, which is likely to be closer to actual utilization patterns, the total cost drops to about €74 million.

Discussion

This study estimated the direct costs of non-hip osteoporosis-related fractures in postmenopausal women in Portugal. Nearly 5,000 wrist, 3,500 vertebral, and 39,000 other-site osteoporosis-related fractures occur per year among women aged 50 + in Portugal. Of these, other-site fractures account for the highest direct healthcare costs per patient (~ €3,096). Vertebral fractures represent the lowest annual direct healthcare costs at €2,710 per patient. Evidence of high costs of non-hip osteoporosis-related fractures is currently available for other countries worldwide, such as the United States of America [25, 26], China [27], South Korea [28] and Canada [29], and are in line with this study. The bulk of healthcare costs per patient per year were related to physiotherapy, as found in other developed countries [29]. Yet, in a recent study published by the same Canadian group, hospitalization accounted for a large portion of annual direct healthcare costs instead of physiotherapy [30]. The same was found by Tran et al. [31] and Rajabi et al. [13]. A possible explanation for the lower relative importance of physiotherapy in these studies is the lower coverage of physiotherapy by health insurance. In our case, physiotherapy was supported by NHS. In our conservative scenario, where patients undergo on average 12 physiotherapy sessions (rather than the 36 sessions in the ideal scenario), this study estimated that non-hip osteoporosis-related fractures among 50 + aged women cost about €74 million per year in direct healthcare costs alone (€144 million in the ideal scenario). Compared with the costs of other non-communicable diseases in Portugal, Gouveia et al. estimated a cost of €152 million associated with heart failure for the same demographic group (women 50 +) [32]. Thus, in line with other non-communicable diseases, osteoporosis has a major economic burden on society.

Comparisons with other studies are difficult due to differences in methodology and data sources. To the best of our knowledge, this is the first study in Portugal that has

Table 6 Direct cost of non-hip osteoporosis-related fractures per year in Portugal

	Wrist fracture	Vertebral fracture	Other fracture
Cost per patient per year (ideal scenario)	€2,964.75	€2,709.52	€3,096.35
Cost per patient per year (conservative scenario)	€1,663.95	€1,504.72	€1,563.95
Number of fractures per year	4,847	3,491	38,881
Total per type of fracture (ideal scenario)	€14,370,143.25	€9,458,934.32	€120,389,184.35
Total per type of fracture (conservative scenario)	€8,065,165.65	€5,252,977.52	€60,807,939.95
Grand total (ideal scenario)			€144,218,261.92
Grand total (conservative scenario)			€74,126,083.12

The ideal scenario includes the recommended 36 sessions of physiotherapy. The conservative scenario includes only 12 physiotherapy sessions, which is likely to be closer to actual utilization

quantified the direct cost of non-hip osteoporosis fractures from a payer perspective.

One of the limitations of this study is the fact that the authors can only estimate costs based on available self-reported data on incident fractures in the years 2013–2015 from the EpiDoC cohort, combined with typical (not actual) utilization based on opinions of an informal panel of experts. Given that osteoporosis prevalence has shown an increasing trend, this is likely to result in the underestimation of the number of fractures, which again translates into conservative estimates of the costs of non-hip osteoporosis-related fractures in our study. Using EpiDoC data to estimate the numbers of non-hip osteoporosis-related fractures is still a major strength of our study because EpiDoC includes a large sample representative of the Portuguese population, and the accuracy of self-reported osteoporosis-related fractures has been shown to be acceptable [21–23]. Another source of underestimation is attrition, i.e., women in the EpiDoC cohort lost to follow-up, due to death or other reasons (Fig. 1).

This study calculated only the direct medical costs due to healthcare use and only in the year following non-hip osteoporosis-related fractures, again contributing to conservative estimates. Resources not considered include medication, other elective technical aids (e.g., bath aids, walking stick), social care (e.g., sickness benefits, disability pension, dependency supplement, formal caregiver support), and transportation. For these resources, it is difficult to draw a typical utilization profile without actual utilization data. Depending on the socioeconomic background, some individuals will purchase other equipment to make recovery more comfortable, and even hire home care services, while others may rely exclusively on informal care. The loss of productivity at work associated with absenteeism or caregiver burden due to disease loses relevance as this study focused on women close to retirement age, and a significant portion do not participate in the labour market. As for costs for informal caregivers, they are highly dependent on the underlying assumptions (e.g., the value of one hour of informal care) and may represent relatively small portions of the total [33, 34].

Lastly, the existence of comorbidities (and other covariates) was not considered, again because resource use data was obtained from an expert panel. This may further contribute to the underestimation of the costs associated with fragility fractures in Portuguese women because we have not taken into account the costs of possible decompensation of chronic diseases that could occur in a patient after suffering a fragility fracture. A recent Canadian study showed that in patients with fragility fractures cost increased with the number of comorbidities [30].

Conclusion

The results of this study point towards the relevance of preventing non-hip osteoporosis-related fractures among postmenopausal women, as they represent about €74 million per year in direct healthcare costs alone in Portugal. This reveals a substantial impact of treating non-hip osteoporosis-related fractures in the healthcare budget. These data should alert government entities to the importance of preventing first and subsequent osteoporotic fractures, for example through national campaigns to increase health literacy in osteoporosis and promote the implementation of various FLS in the Portuguese territory.

Funding Open access funding provided by FCT|FCCN (b-on). The study was supported by an unrestricted research grant from Amgen.

Data availability The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Declarations

Competing Interests AB—has received consulting fees or acted as a speaker for Abbvie, Amgen, and Janssen.

JG – has none to declare.
CM – has none to declare.
HC– has none to declare.
AR – has received unrestricted grants from Pfizer, Novartis, and Amgen, received consulting fees, or acted as a speaker for Amgen.

References

1. Kanis J, Melton LJ, Christiansen C, Johnston CC, Khaltaev N (1994) The Diagnosis of Osteoporosis. J Bone Miner Res 9:1137–1141
2. Kanis J (2002) Diagnosis of osteoporosis and assessment of fracture risk. Lancet 359:1929–1936. https://doi.org/10.1016/S0140-6736(02)08761-5
3. Kanis JA, Norton N, Harvey NC, Jacobson T, Johansson H, Lorentzon M, McCloskey EV, Willers C, Borgström F (2021) SCOPE 2021: a new scorecard for osteoporosis in Europe. Arch Osteoporos 16. https://doi.org/10.1007/s11657-020-00871-9

4. Frost SA, Nguyen ND, Center JR, Eisman JA, Nguyen Tv (2013) Excess mortality attributable to hip-fracture: A relative survival analysis. Bone 56:23–29. https://doi.org/10.1016/j.bone.2013.05.006
5. Bliuc D, Nguyen ND, Nguyen Tv, Eisman JA, Center JR (2013) Compound risk of high mortality following osteoporotic fracture and refracture in elderly women and men. J Bone Miner Res 28:2317–2324. https://doi.org/10.1002/jbmr.1968
6. Kanis JA, Odén A, McCloskey EV, Johansson H, Wahl DA, Cooper C (2012) A systematic review of hip fracture incidence and probability of fracture worldwide. Osteoporos Int 23:2239–2256. https://doi.org/10.1007/s00198-012-1964-3
7. Sing CW, Lin TC, Bartholomew S, Bell JS, Bennett C, Beyene K, Bosco-Lévy P, Chan AHY, Chandran M, Cheung CL, Doyon CY, Droz-Perroteau C, Ganesan G, Hartikainen S, Ilomaki J, Jeong HE, Kiel DP, Kubota K, Lai ECC, Lange J, Lewiecki EM, Liu J, Man KKC, Mendes De Abreu M, Moore N, O'Kelly J, Ooba N, Pedersen AB, Prieto-Alhambra D, Shin JY, Sørensen HT, Tan KB, Tolppanen AM, Verhamme KMC, Wang GHM, Watcharathanakij S, Zhao H, Wong ICK (2021) Global epidemiology of hip fractures: A study protocol using a common analytical platform among multiple countries. BMJ Open 11. https://doi.org/10.1136/bmjopen-2020-047258.
8. Yang J, Mao Y, Nieves JW (2020) Identification of prevalent vertebral fractures using Vertebral Fracture Assessment (VFA) in asymptomatic postmenopausal women: A systematic review and meta-analysis. Bone 136:115358. https://doi.org/10.1016/j.bone.2020.115358
9. Ioannidis G, Flahive J, Pickard L, Papaioannou A, Chapurlat RD, Saag KG, Silverman S, Anderson FA, Gehlbach SH, Hooven FH, Boonen S, Compston JE, Cooper C, Díez-Perez A, Greenspan SL, Lacroix AZ, Lindsay R, Netelenbos JC, Pfeilschifter J, Rossini M, Roux C, Sambrook PN, Siris ES, Watts NB, Adachi JD (2013) Non-hip, non-spine fractures drive healthcare utilization following a fracture: The Global Longitudinal Study of Osteoporosis in Women (GLOW). Osteoporos Int 24:59–67. https://doi.org/10.1007/s00198-012-1968-z
10. Holloway KL, Henry MJ, Brennan-Olsen SL, Bucki-Smith G, Nicholson GC, Korn S, Sanders KM, Pasco JA, Kotowicz MA (2016) Non-hip and non-vertebral fractures: the neglected fracture sites. Osteoporos Int 27:905–913. https://doi.org/10.1007/s00198-015-3322-8
11. Borgström F, Karlsson L, Ortsäter G, Norton N, Halbout P, Cooper C, Lorentzon M, McCloskey Ev, Harvey NC, Javaid MK, Kanis JA, Reginster JY, Ferrari S (2020) Fragility fractures in Europe: burden, management and opportunities. Arch Osteoporos 15. https://doi.org/10.1007/s11657-020-0706-y
12. Burge R, Dawson-Hughes B, Solomon DH, Wong JB, King A, Tosteson A (2007) Incidence and economic burden of osteoporosis-related fractures in the United States, 2005–2025. J Bone Miner Res 22:465–475. https://doi.org/10.1359/jbmr.061113
13. Rajabi M, Ostovar A, Sari AA, Sajjadi-Jazi SM, Fahimfar N, Larijani B, Daroudi R (2021) Direct costs of common osteoporotic fractures (Hip, Vertebral and Forearm) in Iran. BMC Musculoskelet Disord 22. https://doi.org/10.1186/s12891-021-04535-8
14. Marques A, Lourenço Ó, da Silva J (2015) The burden of osteoporotic hip fractures in Portugal: costs, health related quality of life and mortality. Osteoporos Int 26:2623–2630. https://doi.org/10.1007/s00198-015-3171-5
15. Vaz AL (1993) Epidemiology and costs of osteoporotic hip fractures in Portugal. Bone 14:9. https://doi.org/10.1016/8756-3282(93)90342-8
16. Oliveira CM, Alves SM, Pina MF (2016) Marked socioeconomic inequalities in hip fracture incidence rates during the Bone and Joint Decade (2000–2010) in Portugal: Age and sex temporal trends in a population based study. J Epidemiol Community Health (1978). https://doi.org/10.1136/jech-2015-206508
17. Curtis JR, Silverman SL (2013) Commentary: The five ws of a fracture liaison service: Why, who, what, where, and how? in osteoporosis, we reap what we sow. Curr Osteoporos Rep 11:365–368. https://doi.org/10.1007/s11914-013-0177-9
18. Rodrigues AM, Gouveia N, Costa LP, Eusébio M, Ramiro S, Machado P, Mourão AF, Silva I, Laires P, Sepriano A, Araújo F, Coelho PS, Gonçalves S, Zhao A, Fonseca JE, Caldas JM, de Almeida V, Tavares JA, Silva P, Barros H, Cerol J, Mendes J, Carmona L, Canhão H, Branco JC (2015) EpiReumaPt- the study of rheumatic and musculoskeletal diseases in Portugal: a detailed view of the methodology. Acta Reumatol Port 40:110–124
19. Gouveia N, Rodrigues A, Ramiro S, Machado P, da Costa L, Mourao A, Silva I, Rego T, Laires P, Andre R, Mauricio L, Romeu J, Tavares V, Cerol J, Canhao H, Branco J, Grp ES (2015) EpiReumaPt: how to perform a national population based study - a practical guide. Acta Reumatol Port 40:128–136
20. Melton LJ, Thamer M, Ray NF, Chan JK, Chesnut CH, Einhorn TA, Johnston CC, Raisz LG, Silverman SL, Siris ES (1997) Fractures attributable to osteoporosis: Report from the national osteoporosis foundation. J Bone Miner Research 12:16–23. https://doi.org/10.1359/jbmr.1997.12.1.16
21. Chen Z, Kooperberg C, Pettinger MB, Bassford T, Cauley JA, LaCroix AZ, Lewis CE, Kipersztok S, Borne C, Jackson RD (2004) Validity of self-report for fractures among a multiethnic cohort of postmenopausal women: results from the Women's Health Initiative observational study and clinical trials. Menopause 11:264–274. https://doi.org/10.1097/01.GME.0000094210.15096.FD
22. Ismail AA, O'Neill T, Cockerill W, Finn JD, Cannata JB, Hoszowski K, Johnell O, Matthis C, Raspe H, Raspe A, Reeve J, Silman AJ (2000) Validity of self-report of fractures: results from a prospective study in men and women across Europe. EPOS Study Group European Prospective Osteoporosis Study Group. Osteoporos Int 11:248–54. https://doi.org/10.1007/s001980050288
23. Honkanen K, Honkanen R, Heikkinen L, Kröger H, Saarikoski S (1999) Validity of self-reports of fractures in perimenopausal women. Am J Epidemiol 150:511–516. https://doi.org/10.1093/oxfordjournals.aje.a010040
24. Pinto D, Alshahrani M, Chapurlat R, Chevalley T, Dennison E, Camargos BM, Papaioannou A, Silverman S, Kaux JF, Lane NE, Morales Torres J, Paccou J, Rizzoli R, Bruyere O, Blank R, Buehring B, Cooper C, Ferrari S, Kanis JA, Messina OD, Reginster JY, Tüzün (2022) The global approach to rehabilitation following an osteoporotic fragility fracture: A review of the rehabilitation working group of the International Osteoporosis Foundation (IOF) committee of scientific advisors. Osteoporos Int 33:527–540. https://doi.org/10.1007/s00198-021-06240-7
25. Pike C, Birnbaum HG, Schiller M, Sharma H, Burge R, Edgell ET (2010) Direct and indirect costs of non-vertebral fracture patients with osteoporosis in the US. Pharmacoeconomics 28:395–409. http://www.embase.com/search/results?subaction=viewrecord&from=export&id=L358700846%5Cn. https://doi.org/10.2165/11531040-000000000-00000
26. Williams SA, Chastek B, Sundquist K, Barrera-Sierra S, Leader D, Weiss RJ, Wang Y, Curtis JR (2020) Economic burden of osteoporotic fractures in US managed care enrollees. Am J Manag Care 26:e142–e149. https://doi.org/10.37765/ajmc.2020.43156
27. Qu B, Ma Y, Yan M, Wu H-H, Fan L, Liao D-F, Pan X-M, Hong Z (2014) The economic burden of fracture patients with osteoporosis in western China. Osteoporos Int 25:1853–1860. https://doi.org/10.1007/s00198-014-2699-0

28. Park JA, Nam JH, Hong SH, Shim YB, Jeong J, Shin JY (2020) Economic burden of subsequent fracture in osteoporosis patients in South Korea. J Med Econ 23:1598–1605. https://doi.org/10.1080/13696998.2020.1831517
29. Hopkins RB, Burke N, von Keyserlingk C, Leslie WD, Morin SN, Adachi JD, Papaioannou A, Bessette L, Brown JP, Pericleous L, Tarride J (2016) The current economic burden of illness of osteoporosis in Canada. Osteoporos Int 27:3023–3032. https://doi.org/10.1007/s00198-016-3631-6
30. Tarride J-É, Adachi JD, Brown JP, Schemitsch E, Slatkovska L, Burke N (2021) Incremental costs of fragility fractures: a population-based matched -cohort study from Ontario, Canada. Osteoporos Int 32:1753–1761. https://doi.org/10.1007/s00198-021-05877-8
31. Tran O, Silverman S, Xu X, Bonafede M, Fox K, McDermott M, Gandra S (2021) Long-term direct and indirect economic burden associated with osteoporotic fracture in US postmenopausal women. Osteoporos Int 32:1195–1205. https://doi.org/10.1007/s00198-020-05769-3
32. Almeida Gouveia de MR e Silva Ascenção RMS, Fiorentino F, da Costa JNMPG, Broeiro-Gonçalves PM, da Fonseca MCFG, de Fátima Palma Feria Borges M (2020) Os custos da insuficiência cardíaca em Portugal e a sua evolução previsível com o envelhecimento da população. Rev Port Cardiol 39:3–11. https://doi.org/10.1016/j.repc.2019.09.006
33. Eekman DA, ter Wee MM, Coupé VMH, Erisek-Demirtas S, Kramer MH, Lems WF (2014) Indirect costs account for half of the total costs of an osteoporotic fracture: A prospective evaluation. Osteoporos Int 25:195–204. https://doi.org/10.1007/s00198-013-2505-4
34. Caeiro JR, Bartra A, Mesa-Ramos M, Etxebarría Í, Montejo J, Carpintero P, Sorio F, Gatell S, Farré A, Canals L (2017) Burden of First Osteoporotic Hip Fracture in Spain: A Prospective, 12-Month, Observational Study. Calcif Tissue Int 100:29–39. https://doi.org/10.1007/s00223-016-0193-8