

Original Article

Health Outcomes in Fragility Fractures in the Spanish Registry of Osteoporotic Fractures According to the FLS Care Model

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Background. Fracture Liaison Services (FLS) are the gold standard for secondary fracture prevention, but their characteristics vary depending on the care model. This study describes the differences between Orthogeriatric (FLS-ORT) and Bone Metabolism (FLS-MET) models in Spain, based on data from the national osteoporotic fracture registry.

Methods. We conducted a retrospective, multicenter cohort study including 8,962 patients aged ≥ 50 years with fragility fractures from 25 active FLS in Spain (2019–2023). Patients were classified based on the care model: FLS-ORT ($n = 3,695$) or FLS-MET ($n = 5,267$). Baseline characteristics, fracture types, treatment initiation, adherence, and 12-month outcomes were compared.

This authors contributed equally to this work.

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Results. FLS-ORT patients were older (85 vs. 78 years, $p < 0.001$), had more comorbidities, and a higher risk of falls. Hip fractures were predominant in FLS-ORT (75.8%), while vertebral fractures were more frequent in FLS-MET ($p < 0.001$). Time from fracture to FLS assessment was shorter in FLS-ORT (0.1 vs. 1.6 months, $p < 0.001$). At 12 months, fracture recurrence was higher in FLS-ORT (7.7 vs. 5.5 per 100 patient-years), and mortality was significantly greater ($p < 0.0001$). However, osteoporosis treatment initiation (84.6%) and adherence (85.2%) were comparable across models.

Conclusions. FLS are the gold standard for secondary fracture prevention. Both FLS care models (FLS-ORT and FLS-MET) were effective in reducing the risk of new fractures in patients and minimizing the impact on the quality of life of patients who suffer a fragility fracture. Future integration into a unified model assessing all fractures is anticipated. © 2025 The Author(s). Published by Elsevier Inc. on behalf of Instituto Mexicano del Seguro Social (IMSS). This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>)

Keywords: Fracture Liaison Services, Bone Metabolism Units, Orthogeriatrics, Secondary prevention, Frailty fractures.

Introduction

Fragility fractures constitute a major epidemiological threat to the elderly population in both Western and emerging countries. In the European Union (EU), fractures are expected to increase by 24.8% between 2019 and 2034 due to an increase in life expectancy (1–4). Recent knowledge about frailty syndrome and falls reveals the opportunity to prevent risk of fractures in both community and institutionalized setting by broad International Health Programs to local authorities mainly focused on clinical, environmental and geriatric interventions (5,6).

Orthogeriatric co-management has elicited great advantages and outcomes when reducing time to surgery less than 48 h, resulting in reduced in-hospital complications, less length of stay, and reaching a better functional recovery (7–9). Nevertheless, there is limited data on non-hip fragility fractures requiring hospitalization, and a lack of qualitative studies that integrate these cases with hip fractures. This gap hinders the development of a comprehensive orthogeriatric team capable of managing all types of fragility fractures—an approach that would likely be highly beneficial. However, to date, robust evidence remains scarce (10).

Moreover, it is worth noting that most hip fracture patients have previously sustained a fragility fracture, with reported rates ranging from 15–50% in the literature (4,11). This highlights a crucial opportunity for early intervention and risk assessment in individuals over 60 years of age who present with initial, often-overlooked fragility fractures. Extending this point to a 24-month follow-up reveals a 35% incidence of new fractures when considering the so-called “imminent risk” of fracture, highlighting the critical importance of making pharmacological decisions earlier upon detection (12). Furthermore, incorporating the concept of “very high risk” for fractures

in this population provides sufficient justification to implement improved algorithms in osteoporosis guidelines as the best strategy to prevent new fractures (13,14).

When analyzed the different international approaches to this health problem, Fracture Liaison Services (FLS) have proven to be the most appropriate care model for the secondary prevention of fractures, both in terms of their clinical effectiveness (reduction of new fractures, therapeutic compliance) and their effectiveness (15–18). The International Osteoporosis Foundation (IOF) established in the last decade a universal accreditation program named “Capture the Fracture” to promote its worldwide dissemination (19,20). This program stresses the importance of closing the treatment gap and encourages the implementation and accreditation of these interdisciplinary units from two setting references: a) hospitalization, based mainly on Orthogeriatric units (ORT) in our environment in a co-operative work between geriatricians, orthopedic surgeons or internal medicine specialists centered on hip fracture, and b) outpatient consultation; mostly Bone Metabolism clinics (MET) lead by rheumatologists, internal medicine, primary care or other medical specialists, attending mainly index sentinel peripheral fragility fractures. Moreover, IOF recommends progressive growth in each model to accommodate as many at-risk populations as possible and insists on improving accreditation according to a star system (from bronze and silver star to gold star) through various resource development strategies (19).

Several groups in different countries, comparing FLS and ORT models, reveal both are similar in increasing adherence and prevent re-fractures and mortality attending hip fractures, but the heterogeneous nature of FLS programs and the study design make the conduction of good meta-analysis difficult to set those results (18,21–23). Strategies to reaching good outcomes have been im-

plemented in UK, Spain and other countries in Europe, looking for benchmarking in hip fracture (24–26), but not including yet other no-hip fractures in the program.

Following IOF guidelines in Spain, since 2019, the Spanish Society for Bone and Mineral Research (SEIOMM, according to its initials in Spanish) has been carrying out an annual scholarship program (FLS-Excellence) for nurse case managers (27), to expand the response capacity of FLS in operation to the growing demand for case evaluation and contribute to the creation of a national registry of fragility fractures (REFRA-FLS) in people over 50 years of age. A first descriptive paper has been published on this program where the activity and best practices of the first ten FLS who opted for it are presented (28). As a next step, the present study aims to analyze the different clinical outcomes between both models of care (ORT and MET), sustained as a working hypothesis that each of them separately does not achieve the objectives of ideal population care at risk, as it maintains over time a natural tendency to preferably include patients partially.

Material and Methods

Design and Subjects

This research is an observational, retrospective, registry-based, multicenter cohort study. The cohort was derived from the SEIOMM REFRA-FLS registry. The main methods and data sources have been extensively explained in the paper by Montoya J, et al. (28) based on data on the inclusion of patients in the national REFRA-FLS database. For this study, all patients included between January 2019 and December 2023 belonging to active 31 FLS have been collected, considering that about 6 new centers have been yearly incorporated through the FLS-Excellence scholarship program (27) (Supplementary Figure 1). 25 of the 31 FLS analyzed in this study are part of the Capture de Fracture program, developed by the IOF.

FLS Units were classified into two different groups based on the predominant patient profile:

- Orthogeriatric units (FLS-ORT): Mainly inpatients that are typically identified by the FLS shortly upon first admission with a fragility fracture (mostly hip). The primary goals for these patients are recovery of functional status and to perform a comprehensive future fracture risk assessment. Multidisciplinary teams in these FLS mostly include geriatricians, internal medicine specialists, trauma and orthopedic surgeons, anesthesiologists and specialists in orthopedic rehabilitation.
- Bone Metabolism clinics (FLS-MET): Mainly outpatients that are identified by FLS from orthopedic surgery wards, accident and emergency departments, rehabilitation outpatient services, or primary care. Teams in

these FLS typically comprise internal medicine specialists, rheumatologists, and endocrinologists.

Ethics Approval and Consent to Participate

The study protocol received approval from the Clinical Research Ethics Committee of Hospital del Mar (Barcelona) (2018/7852/I), and informed consent was obtained from all participants.

Patient Identification and Data Collection

Upon arrival at the FLS units, a research nurse confirmed eligibility criteria and referred eligible participants to the FLS coordinator, who provided detailed study information and obtained written informed consent. Data was extracted from SEIOMM REFRA-FLS Registry, which captured socio-demographic details, fracture characteristics, comorbidities, prescribed treatments, and lifestyle factors such as smoking and alcohol consumption. Fall risk was assessed based on the number of falls within the previous year. Additionally, the FRAX tool was used to estimate the 10-year fracture risk (29).

Baseline assessments included bone mineral density (BMD) measurement, morphometric fracture detection through dual-energy X-ray absorptiometry (DXA), and lateral spine radiographs, along with specific laboratory tests. Patients who underwent DXA were classified according to WHO criteria into osteoporosis, osteopenia, or normal BMD. Clinical and functional status were assessed using appropriate measures: a) the Barthel Index for Activities of Daily Living (30) (ADLs), b) the Lawton Index for Instrumental Activities (IADLs) (31), and c) the Charlson Index to estimate 10-year life expectancy based on comorbidities as explained by on-line calculators (32).

Following this comprehensive evaluation, patients received personalized recommendations regarding lifestyle changes and treatment, in coordination with primary care. A follow-up of at least 12-months was carried out to ensure therapeutic compliance and to collect outcome variables: new fragility fractures and accumulated mortality in that period between the two models of care.

Statistical Analysis

To compare the difference in the variables between the FLS-ORT and FLS-MET groups, quantitative variables were described using mean and standard deviation (SD) when they followed a normal distribution or median and interquartile range (IQR) otherwise. Categorical variables were described using absolute and relative frequency (percentage).

Comparisons between the FLS-ORT and FLS-MET groups were performed using Student's t test or the Mann–

Whitney *U* test for quantitative variables, and the Pearson's χ^2 test or Fisher's exact test for categorical variables.

Unadjusted survival probabilities were estimated using the Kaplan–Meier method, and comparisons between groups were made using the log-rank test. Confounder-adjusted survival curves were estimated using direct standardization based on a previously fitted multivariable Cox regression model. The results of the models were presented as Hazard Ratio (HR) with its 95% Confidence Interval (95%CI), and *p*-value.

All analyses were performed using R for Windows (version 4.0.4).

Results

Patient Characteristics

A total of 8,962 patients were included in the study: 3,695 were managed in 11 FLS-ORT and 5,267 in 20 FLS-MET.

Table 1 summarizes the main characteristics of the patients according to the FLS profile. Overall, 79.7% of the study cohort were women. The mean age was 81 years (interquartile range: 73–87 years), with a significantly higher mean age observed in FLS-ORT compared to FLS-MET (85 vs. 78 years, respectively). Patients aged ≥ 80 years comprised 70.7% of those managed in FLS-ORT. The his-

tory of >2 falls in the previous year was reported in 6.0% of patients. 32.3% had experienced prior fractures. Most patients were not receiving osteoporosis treatment before the index fracture (83.7% in FLS-ORT and 84.2% in FLS-MET). Dependency levels were higher among patients in FLS-ORT compared to FLS-MET. Corticosteroid use prior to the fracture was reported in 1.5% of patients (Table 1).

The most common fracture type was hip fracture (5,204 cases), followed by vertebral fractures (1,477 cases). Significant differences in fracture distribution were observed between the FLS profiles: hip fractures were more prevalent in FLS-ORT, while vertebral fractures were more common in FLS-MET than in FLS-ORT ($p < 0.001$, Figure 1).

The median time from fracture occurrence to FLS assessment was 0.4 months. Patients in FLS-ORT were assessed significantly earlier (median: 0.1 months, IQR 0–0.2) than those in FLS-MET (median: 1.6 months, IQR 0.4–3.5). Hip fractures were the most frequently evaluated within the first two months in both FLS profiles, with a higher percentage in FLS-ORT compared to FLS-MET (95.6 vs. 78.5%).

Only 15.1% of patients underwent bone mineral density (BMD) testing. DXA utilization was significantly lower in FLS-ORT compared to FLS-MET (3.2 vs. 23.4%, $p < 0.001$) (Table 1).

Table 1. Baseline sociodemographic and clinical characteristics by center profile.

	Total (n = 8,962)	FLS-MET (n = 5,267)	FLS-ORT (n = 3,695)	p
Sex (% female)	7,149 (79.8)	4,349 (82.6)	2,800 (75.8)	<0.001
Age (years) (Median [IQR])	81.0 [73.0, 87.0]	78.0 [69.0, 85.0]	85.0 [79.0, 90.0]	<0.001
Age category >80 years, n (%)	4,713 (52.6)	2,100 (39.9)	2,613 (70.7)	<0.001
Body mass index (BMI) (kg/m ²) (median [IQR])	26.0 [23.1, 29.4]	27.0 [24.0, 30.4]	24.08 [22.2, 27.9]	<0.001
BMI >30 kg/m ² , n (%)	1,860 (20.7)	1,329 (25.2)	531 (14.4)	<0.001
Previous fracture, n (%)	2,895 (32.3)	1,592 (30.2)	1,303 (35.3)	<0.001
Current smoker n (%)	400 (4.6)	304 (5.8)	96 (2.6)	0.001
Drinks (≥ 3 alcohol units/day) n (%)	122 (1.4)	89 (1.7)	33 (0.9)	0.063
Calcium intake mg/day n (%) $>1,000$ mg	238 (6.8)	184 (8.5)	54 (4.1)	<0.001
Lawton index (Median [IQR])	5.0 [2.0, 8.0]	7.0 [4.0, 8.0]	3.0 [0.0, 7.0]	<0.001
Barthel index (Median [IQR])	89 [60, 100]	90 [60, 100]	85 [60, 100]	<0.001
% Estimated survival at 10 years (Charnson index) (Median [IQR])	21.4 [2.2, 53.4]	53.4 [3.0, 77.5]	2.2 [0.0, 21.4]	<0.001
Falls (previous year) >2 n (%)	534 (6.0)	331 (6.3)	203 (5.5)	0.098
High risk of falls n (%)	1,995 (22.3)	1,106 (21.0)	889 (24.1)	<0.001
10-year risk of fracture (FRAX) major osteoporotic $\geq 10\%$ n	1504	875	629	<0.001
Hip fractures $\geq 3\%$ n	1730	979	751	<0.001
Osteoporosis (BMD diagnosis) n	658 (48.7)	595 (48.4)	63 (52.5)	0.443
Osteopenia (BMD diagnosis) n	552 (43.9)	502 (44.1)	50 (41.7)	0.683
Comorbidities (% Yes)				
Cardiovascular disease	2,288 (25.5)	1,269 (24.1)	1,019 (27.6)	<0.001
Endocrine diseases	1,024 (11.64)	583 (11.1)	441 (11.9)	<0.001
Chronic kidney failure	268 (3)	145 (2.8)	123 (3.3)	0.021
Rheumatoid arthritis	54 (0.6)	24 (0.5)	30 (0.8)	0.018
Concomitant treatment (% Yes)				
Corticosteroids	132 (1.5)	74 (1.4)	58 (1.6)	0.408
Aromatase inhibitors	38 (0.4)	24 (0.46)	14 (0.38)	0.074
Androgen deprivation therapy	9 (0.1)	5 (0.09)	4 (0.11)	1.000

SD, standard deviation, IQR, interquartile range.

Data presented as the number of patients (n) and percentage (%). Osteoporosis BMD, T-score less than -2.5 ; osteopenia BMD, T-score greater than $-2.5 < -1$.

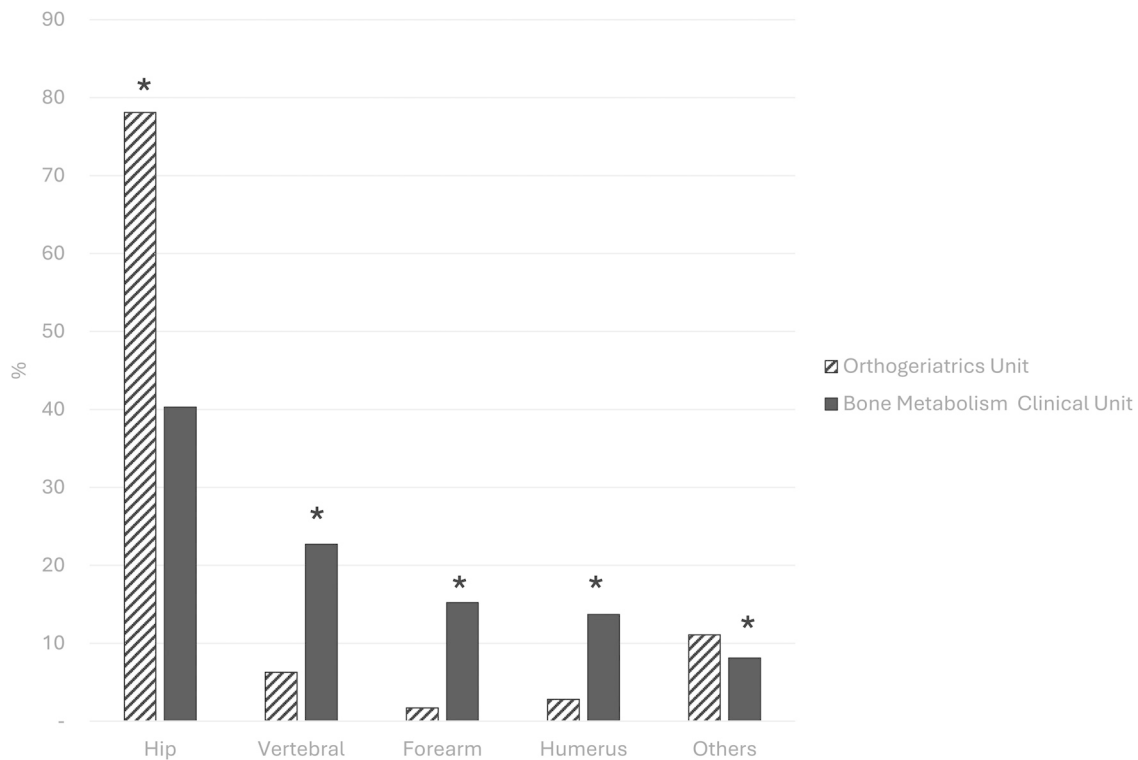


Figure 1. Percentage of fractures according to affected bone and center profile.

Table 2. Treatment after capturing the fracture by center profile.

	Total (n = 8,219)	FLS-MER n = 4,846	FLS-ORT (n = 3,373)	p
Vitamin D supplements	7,819 (95.2)	4,591 (94.8)	3,228 (95.8)	0.043
Calcium supplements	4,936 (60.1)	2,480 (51.2)	2,456 (72.9)	<0.001
Zoledronate	1,003 (12.2)	334 (6.9)	669 (19.9)	<0.001
Oral bisphosphonates	2,460 (30.0)	1,890 (39.0)	570 (17.0)	<0.001
Romosozumab	32 (0.4)	17 (0.4)	15 (0.5)	0.061
Teriparatide	662 (8.1)	472 (9.7)	190 (5.7)	<0.001
Denosumab	2,758 (33.6)	1,441 (29.7)	1,317 (39.2)	<0.001

Data presented as n^o of patients and %.

Following patient enrollment and evaluation, calcium supplementation was provided to 60.1% of patients and 95.2% received vitamin D supplementation. As shown in Table 2, there were no significant differences in vitamin D prescription between FLS profiles; however, calcium supplementation was higher in FLS-ORT (72.9%) compared to FLS-MET (51.2%). Osteoporosis-specific treatments were prescribed to 6,945 patients (84.5%), with antiresorptive agents being the most used drugs in both FLS profiles. Denosumab and zoledronate were more frequently prescribed in FLS-ORT (39.2 vs. 29.7 % and 19.9 vs. 6.9%, respectively), whereas teriparatide was more frequently used in FLS-MET (9.7 vs. 5.7%).

12-Month Follow-Up Outcomes

At 12 months, 3,706 patients (41.6%) remained in follow-up, including 1,386 from FLS-ORT (37.5%) and 2,320

from FLS-MET (44.04%). Discontinuation of follow-up was reported in 35.7% of patients, with a significantly higher rate in FLS-ORT compared to FLS-MET (44.4 vs. 30.5%, $p < 0.001$). The main reasons for discontinuation included death (11.8%), transfer of care to primary care services (11.5%), and patient decision to stop treatment (3.6%).

Overall, 91.5% of patients adhered to healthy lifestyle recommendations, with higher adherence observed in the FLS-MET group (94.1%) compared to the FLS-ORT group (86%). Adherence to osteoporosis-specific pharmacological treatment was also high, reaching 85.2% across the cohort, and was again greater in FLS-MET (88.4%) than in FLS-ORT (78.4%).

Table 3 presents the sociodemographic and clinical characteristics of patients with 1-year follow-up, stratified by center profile. The incidence of new fragility fractures during follow-up was higher in the FLS-ORT group, at

Table 3. Sociodemographic and clinical characteristics of patients with one year follow-up by center profile.

	Total (n = 3,706)	FLS-MET (n = 2,320)	FLS-ORT (n = 1,386)	p
Sex (% Female)	2951 (79.6)	1906 (82.2)	1045 (75.4)	<0.001
Age (years) Median [IQR]	81.0 [73.0, 87.0]	78.0 [70.0, 85.0]	85.0 [79.0, 89.0]	<0.001
Age category >80 years (%)	1958 (53.6)	957 (41.2)	1001 (72.2)	<0.001
Body mass index (BMI) (kg/m ²) (median [IQR])	26.3 [23.1, 29.7]	27.2 [24.1, 30.7]	24.9 [22.0, 28.1]	<0.001
BMI >30 kg/m ² ; n (%)	813 (21.9)	613 (26.4)	200 (14.4)	<0.001
Current smoker n (%)	150 (4.0)	106 (4.6)	44 (3.2)	0.140
Drinks (≥3 alcohol units/day) n (%)	36 (1.0)	25 (1.1)	11 (0.8)	0.691
Calcium intake >1,000 mg/day n (%)	282 (7.6)	229 (9.9)	53 (4.0)	<0.001
Lawton index (Median [IQR])	5.0 [2.0,8.0]	7.0 [4.0-8.0]	3.0 [0.0-7.0]	<0.001
Barthel index (Median [IQR])	90 [60,100]	90 [65,100]	84 [59,100]	<0.001
% Estimated survival at 10 years (Median [IQR])	21.4 [2.2-53.4]	21.4 [3.0-77.5]	20 [0.0 -53.4]	<0.001
Falls (during follow-up) >2 n (%)	131 (3.5)	73 (3.1)	58 (4.2)	0.005
High risk of falls	1108	617	491	<0.001
10-year risk of fracture (FRAX) major osteoporotic ≥10% n	916	524	392	<0.001
Hip fractures ≥3% n	1,073	595	478	<0.001
BMD diagnosis osteoporosis n (%)	341 (46.6)	299 (46.0)	42 (51.9)	0.380
BMD diagnosis osteopenia n (%)	326 (44.6)	292 (44.9)	34 (42.0)	0.700

SD, standard deviation, IQR, interquartile range.

Data presented as the number of patients (n) and percentage (%). Osteoporosis BMD, T-score less than -2.5; osteopenia BMD, T-score greater than -2.5 < -1.

7.7 per 100 patient-years, compared to 5.5 per 100 patient-years in the FLS-MET group. The most frequently reported sites of new fractures were the hip, followed by the vertebrae and humerus.

In multivariate analysis, factors independently associated with increased mortality included male sex, age >80 years, low body mass index ≤19, and minor Lawton index ($p < 0.001$).

The probability of survival showed as the curve for the FLS-MET remains above, indicating a higher survival rate ($p < 0.0001$) (Figure 2A). Since the proportion of the number of patients with hips differs in both FLS, and that hip fracture is the one with the lowest survival rate, we performed the survival analysis between the two types of FLS only with patients with hip fracture, and we obtained that the FLS-MET presents better survival than the FLS-ORT ($p < 0.0001$) (Figure 2B). After adjusting for the variables that were significant in the multivariate model (sex, age, actual fracture, BMI, number of previous falls, Lawton index, smoking status, dietary calcium intake, cardiovascular diseases, endocrine diseases, chronic kidney failure and rheumatoid arthritis) the FLS-MET maintains better survival compared to FLS-ORT after any fracture (Figure 2C) and after a hip fracture (Figure 2D).

Discussion

After evaluating the data collected through the REFRA registry, we can highlight the usefulness of Fracture Liaison Services. Among the patients who have been treated in different units nationwide, the study results show an improvement in the care provided to those who suffer from a fragility fracture. Previous studies have shown that sec-

ondary fracture prevention care models focused on FLS units are cost-effective (15,33,34).

In patients treated in both models, the most frequent incident fracture was the hip fracture, although in the FLS-ORT units they represent more than three quarters, while in the FLS-MET units they do not even reach half of the fractures treated. One possible explanation for this is that patients attended in FLS-ORT are older (with a high proportion of >80 years old), a high risk of falls, with more comorbidities associated, more concomitant treatment and more frailty associated. The REFReSH study showed that introducing an orthogeriatrician-led or a nurse-led FLS of post-hip fracture care is cost-effective when compared with usual care (18), because of their effects on mortality and refracture incidence.

Median time from fracture to FLS assessment was inferior to 2 weeks, with earlier assessment in FLS-ORT units. Accounting for the imminent risk of subsequent fractures is essential in the assessment of patients within Fracture Liaison Services (FLS), in order to ensure timely initiation of appropriate treatment (35). In our study, the incidence of new fractures after FLS assessment was higher in FLS-ORT. One possible explanation is that these are patients with a higher baseline risk of fracture: older, with higher risk of falls and with a higher risk for major and hip fractures calculated with FRAX® tool, than patients treated in FLS-MET. Previous studies have shown that FLS-centered care models are associated with a significantly lower probability of subsequent fractures (36,37).

Prior to the index fracture, more than 30% of patients had a previous fracture, but just over 15% were receiving a previous anti-osteoporotic medication (AOM). Despite the existence of studies that have demonstrated the

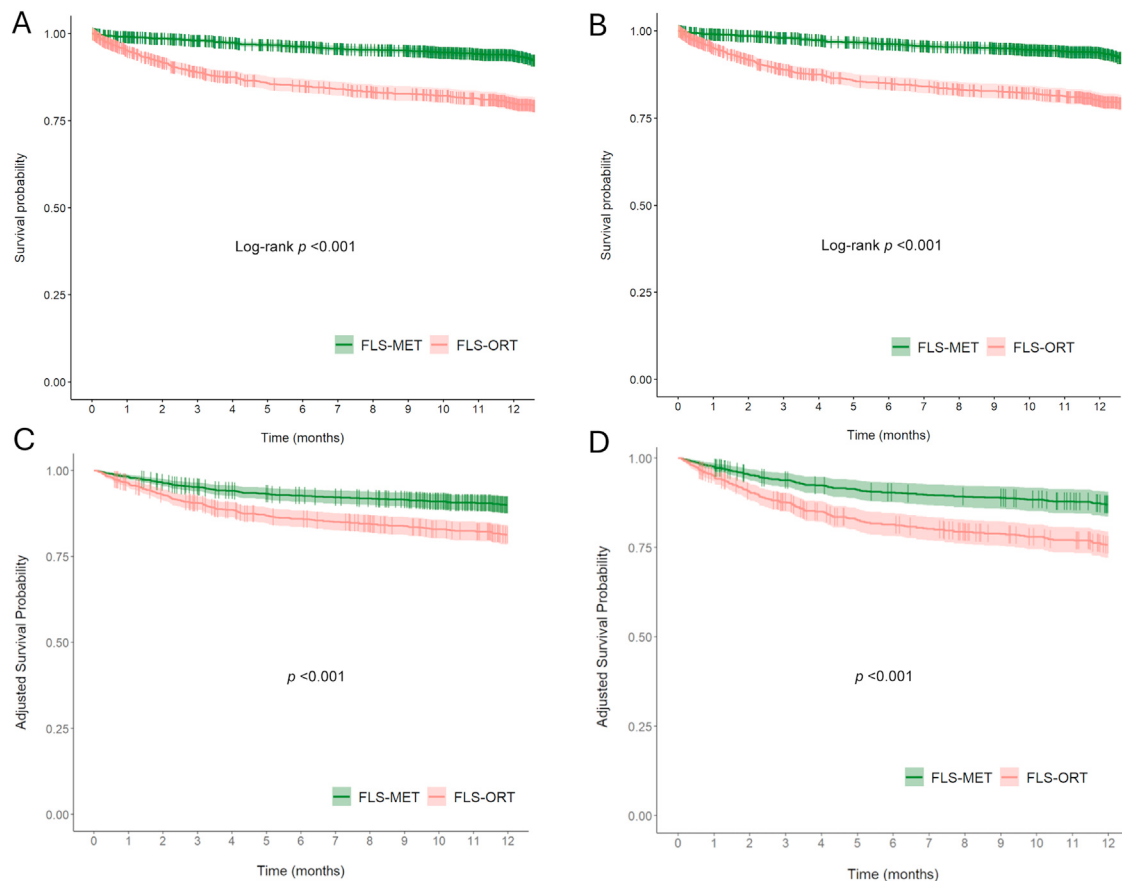


Figure 2. A. 12-month survival rate according to center profile; B. 12-month survival rate according to center profile and patients with hip fracture. After adjusting for the variables that were significant in the multivariate model (sex, age, actual fracture, BMI, number of previous falls, Lawton index, smoking status, dietary calcium intake, cardiovascular diseases, endocrine diseases, chronic kidney failure and rheumatoid arthritis); C. 12-month survival rate according to center profile, and D. 12-month survival rate according to center profile and patients with hip fracture.

cost-effectiveness of treatments for osteoporosis (38,39), the treatment gap for osteoporosis is a very common problem. A study that analyzed the treatment gap in four European countries observed that in the period 2005–2015, between 60 and almost 90% of patients with a fracture did not receive an AOM in the first year (40). Globally, in the EU the treatment gap has increased from 55–2010–71% in 2019 (3). In a recent study carried out in primary care in our country, it was observed that in subjects aged 70 or older, 30% received an AOM after the first fracture, 40% after a second fracture and 60% after a third (40).

In contrast, in our study, after being treated at the FLS more than 84% received an AOM, with a higher proportion of antiresorptive agents, according to national guidelines (41). In a Swedish cohort study the chance of receiving an AOM was 65% higher in the FLS period than in the period before the FLS (36). These data support the recommendation that FLS-centered care models reduce the treatment gap (3).

In addition, adherence to AOM was higher to 85% (similar in both models). Adherence to AOM is a criti-

cal problem; a previous work that analyzed the persistence to AOM in our country showed that less than 50% persist at one year and 30% at 2 years and higher adherence rates were observed with parenteral anti-osteoporotic drugs (42). Other studies have shown that monitoring by a FLS is associated with better treatment adherence rates (43,44), particularly in parenteral AOM.

Despite the overall improvement in treatment initiation and adherence, the rate of bone mineral density (BMD) testing was low in our cohort (15.1%), with a notable difference between FLS models: only 3.2% in FLS-ORT compared to 23.4% in FLS-MET. This likely reflects real-life limitations in orthogeriatric settings, where many patients are frail, cognitively impaired, or not fit for DXA during admission. Some FLS units have addressed this by incorporating post-discharge referral pathways or outpatient strategies. It is important to note that according to international and national guidelines, the diagnosis of osteoporosis does not require BMD testing in older adults with fragility fracture. In these cases, the fracture itself justifies initiating secondary prevention. While BMD

may help guide treatment choices or follow-up, fracture risk stratification should rely primarily on clinical factors, especially in frail populations. Moreover, most fractures occur in patients without densitometric osteoporosis, supporting a broader and more individualized FLS approach (45).

In the first year of follow-up, approximately 11% of patients die, with a high mortality rate in patients treated in FLS-ORT units. We observed that age >80 years old, male sex, a lower Lawton index and BMI $\leq 19\text{Kg/m}^2$ were associated with an increase in mortality, and patients who were evaluated in the FLS-ORT units presented a higher proportion of these variables. In addition, the proportion of proximal femoral fractures in this group was higher, and this fracture is known to be associated with higher mortality than other fractures (46–48). In contrast, many studies have shown that the assessment of patients in FLS is associated with a decrease in mortality, both in the FLS-ORT (49) and FLS-MET models (37,50,51). It should be taken into account when evaluating this data that ORT centers probably included hip fractures that resulted in death in the hospital, while FLS-MET never included deaths in that context, but rather those who, despite having comorbidities, survived admission (selection bias). This could explain the difference in mortality over the first 6 months. Subsequently, they equalize the data.

Probably, the natural tendency will be for all FLS models to converge into a single model that addresses both femoral fractures (currently assessed in the FLS-ORT) and vertebral and other peripheral fractures (assessed in the FLS-MET). Based on our findings and national experience with the REFRA-FLS network, the following recommendations are proposed to enhance the performance of Fracture Liaison Services (FLS): integration of acute (FLS-ORT) and outpatient (FLS-MET) models to ensure comprehensive identification and management of all fragility fractures; strengthening post-discharge coordination between hospital-based FLS and primary care to support long-term follow-up; systematic assessment of patients' quality of life; and the promotion of fall prevention programs and occupational therapy.

Our study has some limitations. Patient follow-up is relatively short (12 months), which makes it difficult to draw conclusions about the prevention of new fractures and decreased mortality rates. Our population sample is heterogeneous, comprising the various FLS nationwide that are part of the REFRA registry. This characteristic can also be recognized as a strength, as it is a representative reflection of the national FLS.

Some of the data collected are self-reported by the patient, and the veracity of this information cannot be verified with certainty, such as the number of falls they have suffered prior to the index fracture. For future analysis, a tool that allows the collection of these variables with greater specificity should be considered.

Conclusions

FLS are multidisciplinary care models that have demonstrated effectiveness in reducing the risk of subsequent fractures in patients with a history of fragility fractures. This study found that both FLS models—FLS-ORT and FLS-MET—were effective not only in lowering the incidence of new fractures but also in mitigating the impact on patients' quality of life. Looking ahead, the integration of these two models into a unified, comprehensive care pathway appears both promising and necessary to optimize outcomes for this vulnerable patient population.

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Data availability

Please contact the author for data requests.

Declarations of ethics approval and consent to participate

The study protocol was approved by the Clinical Research Ethics Committee of Hospital del Mar (Barcelona) (2018/7852/I) and informed consent was obtained from all the study participants.

Data Available

Supplementary data is available at Age and Ageing online.

Conflict of Interest

None declared.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at [doi:10.1016/j.arcmed.2025.103302](https://doi.org/10.1016/j.arcmed.2025.103302).

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