Prof. Dr. med. Ralf Schmidmaier Dr. rer. nat. Hans Derk Pannen Dr. rer. hum. biol. Moritz Hadwiger Dr. rer. nat. Luis Möckel

Use of healthcare resources among patients treated with romosozumab

A retrospective analysis of German health insurance data

Osteoporosis is a systemic skeletal disorder characterised by reduced bone mass and microarchitectural deterioration of bone tissue. This leads to an increased risk of fractures (DVO guideline, 2023). In Germany, approximately 58,851 new femoral fractures and 74,238 hospital-diagnosed fractures occur annually in women aged 50 or older, with up to 145,188 new vertebral fractures occurring regardless of the place of diagnosis (Möckel, 2021; Melnik et al., 2025). Data from the German healthcare context show, depending on the analysis and type of prior fracture, that patients with an existing fracture have a risk of between 18% and 30% of sustaining a subsequent fracture within one year (Hadji et al., 2021; Melnik et al., 2025). A further analysis from the international context also reported that the risk of a subsequent fracture within one year of an initial clinical fracture is increased fivefold (van Geel et al., 2009). This very high fracture risk immediately following a fracture is also referred to as imminent fracture risk. The guidelines of the German Osteology Association (DVO) recommend the use of an osteoanabolic agent in patients with a very high risk of fracture (DVO guidelines, 2023).

>> The monoclonal antibody romosozumab is such an osteoanabolic agent, which can be used in postmenopausal women with established osteoporosis and an increased risk of fracture. Romosozumab is administered as a once-monthly treatment over a period of 12 months, followed by antiresorptive osteoporosis therapy (FI Romosozumab, 2024). In clinical trials, the 12-month romosozumab therapy followed by alendronic acid significantly reduced the risk of vertebral, non-vertebral and hip fractures compared with alendronic acid alone (Saag et al., 2017). Two cost-effectiveness analyses show that romosozumab and the sequential therapy are cost-effective in the UK and Belgium (Bergström et al., 2024; Gielen et al., 2024).

To date , no data are available for Germany that have examined the costs in patients treated with romosozumab. For this reason, the aim of this analysis was to analyse healthcare resource utilizations (HCRUs) for all causes in patients treated with romosozumab. The focus was on the number of doctor visits, length of hospital stay, costs by sector (outpatient, inpatient, medicines) and total costs before and after the index (index = first dispensing of romosozumab).

Summary

Introduction: The aim of this analysis was to describe the costs of care from the perspective of statutory health insurance for osteoporosis patients treated with romosozumab.

Methods: This was a retrospective analysis of data from 19 statutory health insurance funds with a potential total of 6.3 million insured persons. The costs (inpatient, outpatient, medicines) for romosozumab patients (index = date of the first romosozumab dispensing) were analysed for the 2 years prior to and at least one or two years after the index.

Results: Among romosozumab patients who could be observed for at least one year after the index date (n = 71), the mean total costs in the year prior to the index date were €11,109 (SD 13,314; median €8,033) per patient, with the highest costs occurring in the inpatient sector. In the first year after the index, the mean total costs were 18,630 (SD 24,470; median 12,215) EUR per patient, with the largest proportion accounted for by medicines. For patients with a follow-up period of 2 years (n = 22), the average total costs per patient in the second year after index (5,604 [SD 7,778; median 2,740] EUR) fell significantly compared with the mean total costs in the year prior to index (16,390 [SD 15,956; median 11,250] EUR). In both years following the index year, inpatient costs in particular fell.

Discussion: Total costs for patients receiving romosozumab were comparable to or slightly higher in the year following the start of romosozumab treatment compared with the year prior to the index year. In contrast, in the second year following the first administration of romosozumab, costs for patients fell to a lower level than before the start of romosozumab treatment.

Keywords

High-risk osteoporosis, anabolic agents, fracture patients

Crossref/doi

http://doi.org/10.24945/MVF.03.26.1866-0533.2838

Methods

Study design and data source

This study was a retrospective analysis of German health insurance data, based on the anonymised dataset from participating health insurance funds of the Society for Efficiency and Quality in Health Insurance (GWQ ServicePlus AG). The analysed dataset contained anonymised claims data from 19 company and guild health insurance funds covering approximately 6.3 million people with statutory health insurance, spanning the years 2010 to 2023.

Included were all female patients who (i) had received at least one pharmacy dispensing of romosozumab (ATC code: M05BX06), with the date of the first dispensing serving as the index date, who (ii) had a pre-index period of at least 730 days, during which (iii) gender and (iv) birth cohort could be clearly identified, who (v) were continuously insured during the pre-index period (730–0 days prior to the index date) and who (vi) were explicitly available for follow-up in the cost analyses for at least 365 or 730 days following the first dispensing of romosozumab.

Depending on the date of the first prescription, the index date could fall between 15 March 2020 and 31 December 2022 (Fig. 1). The pre-index period was defined as 730 to 0 days prior to the index date, and patients were followed up either for up to 730 days after the index date, until death, until the end of their insurance cover, or until the end of the observation period (31 December 2022), whichever occurred first. Further details on the methodology and the analysis of clinical parameters are described in more detail in Pannen et al. (2025) (Fig. 1).

Data analysis

The characteristics of the patients were described using descriptive statistics based on all patients who had received at least one prescription.

The length of stay (in days) in hospital was calculated based on patients who had at least one inpatient hospital stay in the periods 730–0 and 365–0 before, and 1–365 and 1–730 days after the index date. Furthermore, the number of doctor contacts (total of all inpatient and outpatient treatment cases) for the aforementioned periods was analysed. The median, minimum, maximum and the 25th and 75th percentiles were calculated.

The costs (of all causes and based on data for the years 2020–2022) were calculated by sector (outpatient, inpatient, medicines and total) for the periods 365–0 days before and 1–365 days after the index date, based on all patients who could be followed up for at least 365 days after the index date. Furthermore, costs were calculated for the periods 730–366 and 365–0 days before, and 1–365 and 366–730 days after the index date, based on the patient sub-cohort that could be observed for at least 730 days after the index date. For the analysis of costs by sector, the mean (MW), standard deviation (SD), median, minimum, maximum and the 25th and 75th quantiles were calculated.

Statistical analysis was performed using the ‘R’ programme, version 4.1.2, and the standard packages [R Core Team; Wickham et al., 2019].

Results

Characteristics of the included patients

A total of 138 patients (Table 1) were included in the analysis, the majority of whom were born between 1950 and 1969 (66.0%). The mean Charlson Comorbidity Index was 1.27 (SD 1.30). Only 27.8% of patients had not received any specific prior osteoporosis treatment in the pre-index period. The patients had a total of 387 fractures in the 1.5 years prior to the first romosozumab administration, corresponding to 2.8 fractures per patient. Further information, such as the top 5 comorbidities and ATC codes, is presented in Table 1. A total of 71 patients were followed up for at least 365 days and 22 patients for 730 days after the index event.

In patients admitted as inpatients, the median length of hospital stay was comparable at 5 days before the index date and 4 days after the index date (index = first administration of romosozumab) (Fig. 2A). In the 730 days prior to the index date, a total of 181 inpatient hospital admissions with a discharge diagnosis were observed. Among the five most common discharge diagnoses were

Charakteristika der Romosozumab-Patientinnen in Prä-Index-Periode sowie zu Index und Frakturinzidenzdichte vor und nach Index		
Charakteristika		N = 138
Weiblich – n (%)		138 (100,0%)
Geburtskohorte – n (%)	1930-1939	12 (8,7%)
	1940-1949	30 (21,7%)
	1950-1959	59 (42,8%)
	1960-1969	32 (23,2%)
	nach 1970	<8
Charlson Comorbidity Index	Mittelwert (SD)	1,27 (1,30)
	Median [Min., Max.]	1,00 [0,00, 6,00)]
Spezifische Osteoporose-Vortherapien 730 Tage vor Index – n (%)	Bisphosphonate	58 (42,0%)
	Bisphosphonate Kombinationen	<8
	Östrogene	32 (23,2%)
	Denosumab	29 (21,0%)
	SERMs	<8
	Teriparatid	<8
	Keine Vortherapie	38 (27,5%)
Top 5 ICD-10-Codes 730 Tage vor Index – n (%)	Z01: Sonst. spez. Untersuchungen und Abklärungen bei Personen ohne Beschwerden oder angegebenen Diagnosen	136 (98,6%)
	M81: Osteoporose ohne pathologische Fraktur	128 (92,8%)
	M80: Osteoporose mit pathologischer Fraktur	117 (84,8%)
	M54: Rückenschmerzen	108 (78,3%)
	Z12: Spez. Verfahren zur Untersuchung auf Neubildungen	86 (62,3%)
Top 5 ATC-Codes 730 Tage vor Index – n (%)	N02: Analgetika	109 (80,0%)
	M01: Antiphlogistika und Antirheumatika	102 (73,9%)
	M05: Mittel zur Behandlung von Knochenkrankheiten	83 (60,1%)
	A02: Mittel bei säurebedingten Erkrankungen	81 (58,7%)
	J01: Antibiotika zur systemischen Anwendung	70 (50,7%)
Indexjahr	2020	16,7%
	2021	36,2%
	2022	47,1%
Anzahl Frakturen im Zeitraum 546 Tage vor Index	Gesamt	387
	Frakturen pro Patientin	2,8

Table 1: Characteristics of romosozumab patients in the pre-index period and at index, and fracture incidence density before and after index. Legend: *in the 730-day period prior to index. Own illustration.

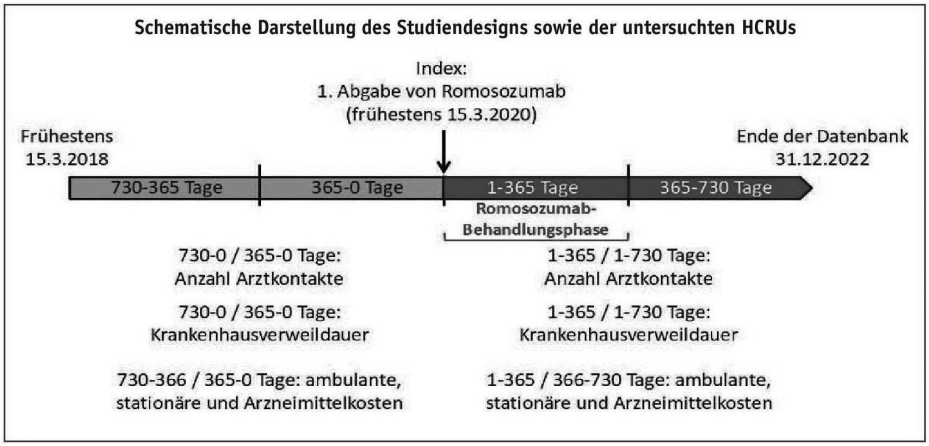


Fig. 1: Schematic representation of the study design and the HCRUs investigated. Source: Own illustration.

Length of hospital stay and number of doctor visits

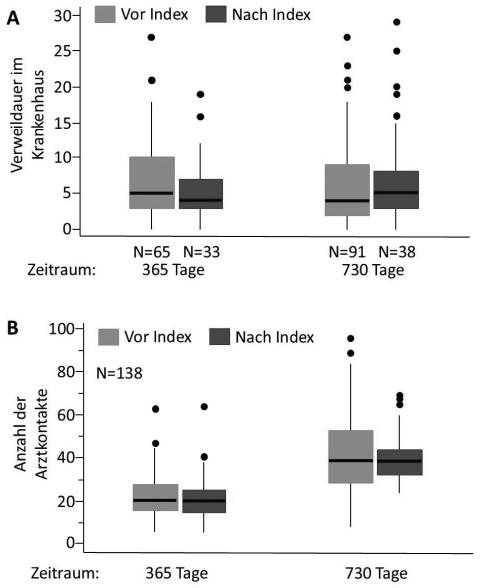


Fig. 2: (A) Length of hospital stay and (B) number of doctor visits among romosozumab patients in the periods 730 and 365 days before and after index (index = first administration of romosozumab). Source: Own illustration.

four of which were associated with osteoporosis (Fig. 3).

The total number of doctor visits (sum of all inpatient and outpatient cases) was also around 20 visits per year both before and after the index (Fig. 2B). In the subgroup of patients who were observable for 365 days after the index date, the mean total costs (for any cause) in the 365 days prior to the first administration of romosozumab were 11,109 (SD 13,314; median: 8,033) EUR, and in the year of romosozumab treatment 18,630 (SD 24,470; median: 12,215) EUR. In the year prior to the index year, the highest costs were attributable to inpatient care (mean 5,834 [SD 8,343] EUR; median: 2,181 EUR), whilst in the year following the index year, the highest costs were attributable to medicines (mean 14,403 [SD 24,025] EUR; median: 9,653 EUR) (Table 2). It should be noted that inpatient costs in particular were lower in the year of romosozumab treatment (1–365 days after index: mean 2,425 [SD 4,269] EUR; median: 0 EUR) than in the year prior to index.

In the sub-cohort of patients who were observable for 730 days after the index date, costs from all causes were comparable to those in the cohort described previously, which was observable for only 365 days after the index date (Table 3 and Fig. 4). The mean total costs (all causes) in the periods 730–366, 365–0, 1–365 and 366–730 days before and after the index were 9,350 (SD 11,483; median: 3,717) EUR, €16,390 (SD 15,956; median: €11,250), €17,165 (SD 8,606; median: €13,069) and €5,604 (SD 7,778; median: €2,740). In this sub-cohort, too, there was a sharp decrease in inpatient costs following the index event, which, compared to the year prior to the index event (365–0 days: mean 9,889 [SD 12,201] EUR; median: 7,190 EUR), fell by a factor of 4 in the first year following the index event (1–365 days: mean 2,975 [SD 5,680] EUR; median: 0 EUR). In the first year post-index, 50% of patients were not admitted to hospital, and in

the second year, 75% were not admitted.

Compared with pharmaceutical and inpatient costs, outpatient costs remained comparable across all time periods and in both cohorts considered (Tables 2 and 3).

Discussion

This retrospective health insurance data analysis presents, for the first time, the costs for patients treated with romosozumab in Germany. The largest cost drivers in the year prior to the first dispensing of romosozumab (index) were inpatient costs, whilst, as expected, drug costs were the largest cost driver in the year of treatment with romosozumab (1st year after index). At the same time, inpatient costs in the first and second years after the index year were lower than in the pre-index period.

For the discussion and interpretation of the results, it is important to note that over 70% of the patients included in the analysis received at least one other osteoporosis treatment in the two years prior to the first administration of romosozumab. Nevertheless, an average of 2.8 fractures per patient occurred in the 1.5 years prior to the start of romosozumab treatment, although it is not known whether all these fractures occurred whilst on prior therapy. Accordingly, the patients studied constituted a severely affected cohort, which may have demonstrated prior treatment failure with other osteoporosis medications (Table 1).

Kosten nach Sektor und gesamt							
Sektor	MW	SD	Median	Min.	Max.	25. Perzentil	75. Perzentil
Zeitraum 365-0 Tage vor Index							
Ambulant	1.801 Euro	1.732 Euro	1.420 Euro	219 Euro	11.928 Euro	920 Euro	1.984 Euro
Stationär	5.834 Euro	8.343 Euro	2.181 Euro	0 Euro	39.282 Euro	0 Euro	8.421 Euro
Arzneimittel	3.473 Euro	9.220 Euro	770 Euro	12 Euro	60.085 Euro	320 Euro / 2.074 Euro	
Gesamt	11.109 Euro	13.314 Euro	8.033 Euro	491 Euro	70.540 Euro	2.005 Euro	14.035 Euro
Zeitraum 1-365 Tage nach Index							
Ambulant	1.803 Euro	1.551 Euro	1.313 Euro	35 Euro	9.295 Euro	955 Euro	2.063 Euro
Stationär	2.425 Euro	4.269 Euro	0 Euro	0 19.556 Euro		0 Euro	3.478 Euro
Arzneimittel	14.403 Euro	24.025 Euro	9.653 Euro	741 Euro	190.437 Euro	7.898 Euro	11.401 Euro
Gesamt	18.630 Euro	24.470 Euro	12.215 Euro	963 Euro	195.503 Euro	9.982 Euro	18.466 Euro

Table 2: Costs by sector and in total for the periods 365 days before and 365 days after the index date, in the subgroup of patients (n = 71) who could be followed up for at least 365 days after the index date (index date = first dispensing of romosozumab). Author's own presentation.

One reason for the high inpatient costs in the 730 days prior to the index date is certainly attributable to osteoporosis, as four of the five most common discharge diagnoses are directly related to osteoporosis. On the one hand, the patients had an average of 2.8 fractures in the 545-day period prior to index, and on the other hand, it is known that, for example, approximately 95% of patients with a femoral neck fracture and 34–44% with a vertebral fracture are admitted to hospital or diagnosed there (Möckel et al. 2021, 2022).

Kosten nach Sektor und gesamt							
Sektor	MW	SD	Median	Min.	Max.	25. Perzentil	75. Perzentil
Zeitraum 730-366 Tage vor Index							
Ambulant	2.053 Euro	2.434 Euro	1.616 Euro	161 Euro	11.607 Euro	854 Euro	2.160 Euro
Stationär	4.584 Euro	8.545 Euro	144 Euro	0 Euro	36.269 Euro	0 Euro	6.240 Euro
Arzneimittel	2.713 Euro	7.061 Euro	943 Euro	76 Euro	33.746 Euro	380 Euro	1.385 Euro
Gesamt	9.350 Euro	11.483 Euro	3.717 Euro	385 Euro	40.121 Euro	1.679 Euro	12.685 Euro
Zeitraum 365-0 Tage vor Index							
Ambulant	2.181 Euro	2.343 Euro	1.740 Euro	275 Euro	11.928 Euro	1.066 Euro	2.022 Euro
Stationär	9.889 Euro	12.201 Euro	7.190 Euro	0 Euro	39.283 Euro	0 Euro	12.237 Euro
Arzneimittel	4.319 Euro	9.370 Euro	1.360 Euro	216 Euro	37.529 Euro	445 Euro	2.008 Euro
Gesamt	16.390 Euro	15.956 Euro	11.250 Euro	491 Euro	49.334 Euro	3.624 Euro	29.722 Euro
Zeitraum 1-365 Tage nach Index							
Ambulant	1.625 Euro	905 Euro	1.330 Euro	603 Euro	4.258 Euro	1.017 Euro	2.094 Euro
Stationär	2.975 Euro	5.680 Euro	0 Euro	0 Euro	19.556 Euro	0 Euro	3.016 Euro
Arzneimittel	12.565 Euro	7.584 Euro	10.971 Euro	2.710 Euro	43.898 Euro	10.383 Euro	12.973 Euro
Gesamt	17.165 Euro	8.606 Euro	13.069 Euro	10.256 Euro Euro	46.017 Euro	12.085 Euro	19.387 Euro
Zeitraum 366-730 Tage nach Index							
Ambulant	1.572 Euro	1.235 Euro	1.149 Euro	0 Euro Euro	4.955 Euro	788 Euro	2.022 Euro
Stationär	1.001 Euro	3.272 Euro	0 Euro	0 Euro Euro	14.090 Euro	0 Euro	0 Euro
Arzneimittel	3.031 Euro	5.854 Euro	1.279 Euro	311 Euro Euro	26.598 Euro	797 Euro	1.759 Euro
Gesamt	5.604 Euro	7.778 Euro	2.740 Euro	328 Euro Euro	28.182 Euro	1.751 Euro	5.202 Euro

Table 3: Costs by sector and in total for various time periods in the subgroup of patients (n = 22) who could be followed up for at least 730 days after the index date (index = first administration of romosozumab). Author's own presentation.

At the same time, these fractures are associated with cost-intensive hospital treatments such as total endoprosthesis, kyphoplasty or vertebroplasty (Beschloss et al. 2022; DVO guideline, 2023; Jensen et al. 2024).

In contrast, a sharp decrease in inpatient costs can be observed in the year following the index, both in the year of romosozumab treatment and in the following year. In real-world clinical practice, the fracture data already published from this analysis also showed a 27% reduction in fracture incidence post-index for the 1–365-day period and a 51% reduction for the 366–730-day period compared with the last year prior to the index (Pannen et al. 2025). In the clinical trial programme, romosozumab demonstrated a significant reduction in fracture rates compared with both placebo and the bisphosphonate alendronic acid (Cosman et al. 2016; Saag et al. 2017). It can be assumed that this cost reduction is due, among other things, to fewer fractures, particularly as the annual costs following a vertebral or femoral neck fracture amount to between €9,400 and €16,800 in Germany (Pannen et al. 2021).

Overall, it can be noted that the total costs in the romosozumab treatment year were slightly higher or comparable to those of the last year prior to the index year, depending on the cohort analysed. The largest cost factor during the first year after the index year is the cost of medicines. The previously published persistence data from this analysis showed a median romosozumab treatment duration of 355 days (Pannen et al. 2025). Outpatient costs play a relatively minor role both before and after the index year and are relatively comparable across all analysed periods. Across all four years considered, total costs were lowest in the second year after index, which is particularly related to the reduced inpatient costs as well as the discontinuation of costs for romosozumab therapy after one year.

Top 5 discharge diagnoses from inpatient hospital stays in the period 730–0 days prior to index

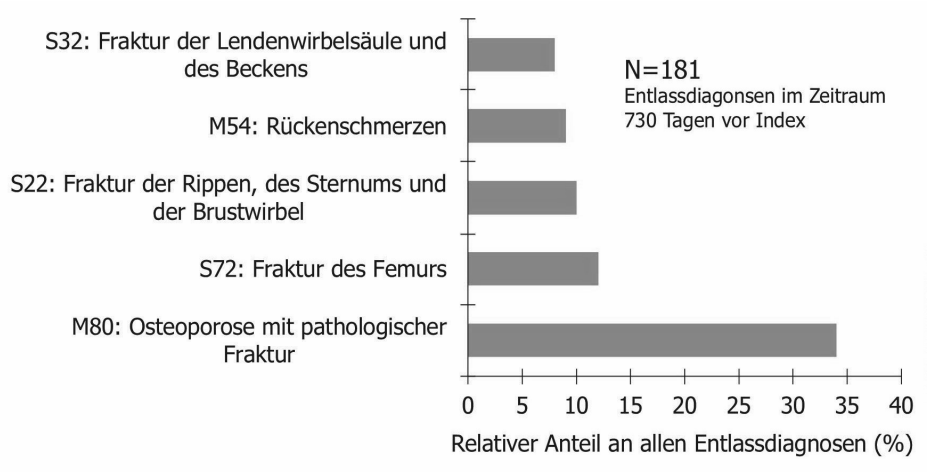


Fig. 3: Top 5 discharge diagnoses for inpatient hospital stays in the period 730–0 days prior to index. Source: Author's own representation.

Total costs for patients receiving romosozumab treatment

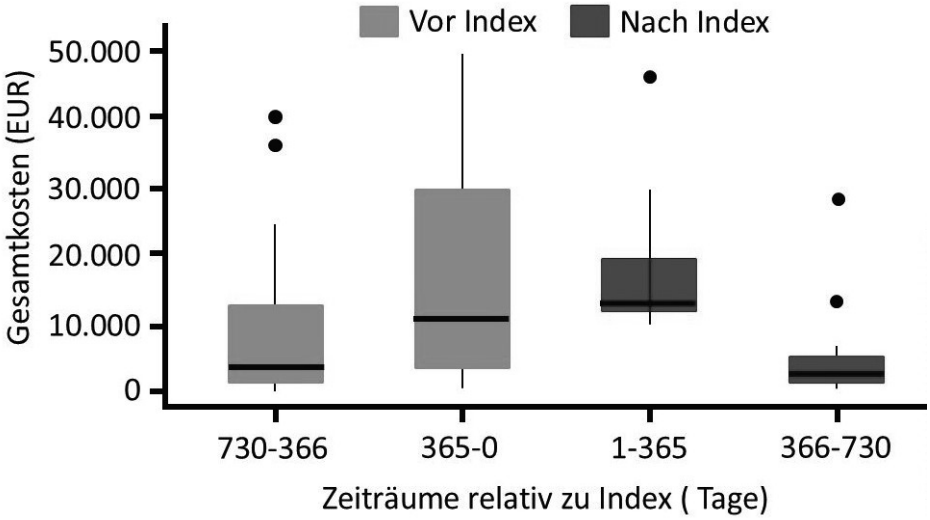


Fig. 4: Total costs for patients receiving romosozumab treatment who could be followed up for at least 730 days after the index date (index = first dispensing of romosozumab) (n = 22). The costs are shown for defined periods before and after the index date. Source: Author's own figure.

This analysis has several limitations. Firstly, the infrequent use of romosozumab in clinical practice resulted in an overall low number of insurants who could be observed during the period from 15 March 2020 to 31 December 2022. An over- or underestimation of healthcare costs cannot therefore be ruled out. This is further supported by the fact that the estimated annual treatment costs for romosozumab in 2024 were approximately one-third lower than at the time of the active substance's market launch (G-BA, 2020; 2024).

Secondly, the analysis was conducted using data from the first patients treated with romosozumab following its authorisation (15 March 2020), which may mean that, due to a channeling bias, the patient cohort was significantly more severely affected than would be the case in an analysis using data from 2025. This is also indicated by the 2.8 fractures per patient in the 1.5 years prior to the start of romosozumab treatment. Thirdly, only the two years following the first administration of romosozumab could be considered, meaning that no conclusions can be drawn regarding the longer-term development of care for insured patients with osteoporosis and romosozumab. However, based on the clinical trials, positive effects, such as a reduction in the fracture rate, are also to be expected beyond the two-year period (Cosman et al., 2016; Saag et al., 2017). Fourthly, no data were collected on a comparison group, such as untreated patients or patients receiving other osteoporosis medications, which would have allowed the costs to be considered in the appropriate context. Among other reasons, a comparison group was not included because

(i) the number of romosozumab patients was too small for a valid comparison and

(ii) the first romosozumab patients were more severely affected than patients on other osteoporosis therapies (Pannen et al. 2025).

Conclusion

The patients treated with romosozumab and included in the analysis were severely affected by osteoporosis andhad multiple fractures prior to thefirst administration of romosozumab ( ). Total costs were driven in particular by high inpatient costs. Total costs in the year before and after the index year are comparable, particularly in the cohort with a two-year follow-up period. In the second year after the index year, total costs reached their lowest level across the entire observation period. This coincided with the completion of the romosozumab therapy administered in the first year and a decline in inpatient costs. <<