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ORIGINAL ARTICLE

Predictors of mortality for patients with hip fracture: a study of the nationwide 1-year records of 24,950 fractures in Romania

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Abstract

Summary We conducted a study evaluating incidence rates and influencing factors in Romanian hip fracture patients. Our results showed that the type of fracture and its respective surgical procedure as well as hospital characteristics correlate with mortality. Updated incidences can result in updated treatment guidelines.

Purpose The aim of our study was to assess incidence rates for a revision-calibration of the Romanian FRAX tool and to evaluate particularities of hip fracture cases to determine patient- and hospital-related variables affecting mortality.

Methods We conducted a retrospective study using hospital reports of hip fracture codes to the National School of Statistics (NSS) from January 1, 2019, until December 31, 2019. The study population included 24,950 patients presenting to Romanian public hospitals in all 41 counties: ≥ the age of 40 with diagnostic ICD 10 codes: S72.0 femoral neck fracture, S72.1 pertrochanteric femoral fracture, and S72.2 subtrochanteric femoral fracture and procedure codes: O11104 (trochanteric/sub capital internal fixation), O12101 (hemiarthroplasty), O11808 (closed femoral reduction with internal fixation), O12103 (partial arthroplasty), O12104 (total arthroplasty). Hospital length of stay (LoS) was classified as follows: < 6, 6–9, 10–14, and ≥ 15 days.

Results Incidence of hip fractures was 248/100,000 among those aged 50 + and 184/100,000 within the 40 + age category. Average age of the patients was 77 years (80 for females, 71 for males); 83.7% of the patients were 65 + with equivalent urban–rural distributions. Males had a 1.7 times higher mortality risk. Each year increase in age added a mortality risk of 6.9%. In-hospital mortality was 1.34 times higher among patients living in urban areas. Hemiarthroplasty and partial/total unilateral/bilateral arthroplasty had a lower risk of mortality than trochanteric/sub capital internal fixation ($p < 0.02$, $p < 0.033$).

Conclusion Gender, age, residence, and procedure type had significant impact on mortality. Updated incidence rates will allow the revision of Romania's FRAX model.

Keywords Osteoporotic hip fracture · Romania · Mortality

Introduction

Osteoporotic fractures pose an important economic and health burden in Romania, as well as worldwide. In 2019, osteoporotic fractures accounted for a total cost of 257.3 million euro in Romania, with 103,000 new cases reported [1]. Additionally, Romania has higher annual mortality estimates related to osteoporotic fractures when compared to the European average (EU27 + 2), 148/100,000 individuals and 116/100,000 individuals respectively. The SCOPE 2021 scorecard reported a substantial increase in osteoporotic hip fracture incidence since 2010 when compared with other fracture sites [2]. Osteoporotic hip fractures, usually caused by falls in elderly patients with osteopenia or osteoporosis, are associated with increased morbidity and

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mortality, evidencing the importance of prompt hospitalization and treatment. The hospital treatment of hip fractures is a complex process that involves multiple services. Mortality varies according to patient characteristics and treatment procedures. The National Institute for Health and Care Excellence (NICE) guidelines for the treatment of femoral fractures include a number of standards: prompt admission to orthopedic care; surgery within 36 h and within normal working hours; nursing care aimed at minimizing pressure ulcer incidence; routine access to ortho-geriatric medical care; assessment and appropriate treatment to promote bone health; and falls assessment [3, 4].

Romania reports a higher lifetime probability of hip fractures at the age of 50 in women compared to men (7.0% vs. 3.8%). However, studies have shown that the number of hip fractures in men is expected to increase by 51.8% worldwide by the year 2030 [2, 5]. Men are less likely to be diagnosed and treated for osteoporosis, and studies evidence a higher mortality rate in men compared to women after suffering a hip fracture [5-7]. Mortality rates post hip fracture are reported to be highest in the first year. Additionally, hip fractures are more debilitating than other types of fractures, with 40% of patients unable to walk independently after the first year [8, 9]. The influence of LoS (length of stay) on mortality is unclear based on previous studies. While some report that a LoS of < 10 days is associated with increased 1-year mortality, others report a decrease in early mortality rates with a shorter LoS. In a 2018 study by J Yoo et al., shorter LoS was associated with treatment in primary and secondary surgical centers, femoral neck fractures, and open reduction and pinning procedures [8]. Former studies published debatable results regarding length of stay and its impact on mortality. Numerous risk factors are intertwined, and efforts to disentangle the influence of each factor have proven challenging [10].

The aim of our study was to assess the latest hip fracture incidence rates for the calibration of the FRAX tool as well as to evaluate particularities of the Romanian hip fracture cases with ICD 10 diagnostic codes S72.0, S72.1, and S72.2. We specifically aimed to determine patient- and hospital-related variables affecting mortality and to possibly encourage efficient use of resources. We used hospital records of hip fracture codes reported to the National School of Statistics (NSS) in the year 2019.

Materials and methods

We conducted a retrospective study using hospital reports of hip fracture codes to the National School of Statistics (NSS) from January 1, 2019, until December 31, 2019, obtained in collaboration with Syreon Research Romania. The study population included 24,950 patients presenting to hospitals nationwide. Registered data includes all Romanian public hospitals in the 41 counties.

Variables

We assessed sociodemographic data (age, gender, setting), hospital type, LoS, fracture data (type, treatment procedure), and in-hospital mortality.

Inclusion criteria: patients ≥ the age of 40 with one of three diagnostic ICD 10 codes: S72.0 femoral neck fracture ($n = 11{,}068$), S72.1 pertrochanteric femoral fracture ($n = 12{,}619$), and S72.2 subtrochanteric femoral fractures ($n = 1263$). Hospitals were classified as university (teaching) clinics, or county or local (municipal) hospitals. Patient age was classified into three groups: < 65 years old, 65–79 years old, and ≥ 80 years old. We included the following (Ro DRG) procedure codes: O11104 (trochanteric/sub capital internal fixation), O12101 (hemiarthroplasty), O11808 (closed femoral reduction with internal fixation), O12103 (partial arthroplasty), O12104 (total arthroplasty), and others/unclassified in the study. Length of stay was classified as follows: < 6, 6–9, 10–14, and ≥ 15 days.

Statistical analysis

Statistical analysis was performed using IBM SPSS statistics version 26.0 (Armonk, NY, USA: IBM Corp.). Descriptive statistics was conducted on all variables. Chi^2 was used for the statistical analysis of assessing the relationship between mortality and independent variables. We used one-way analysis of variance (ANOVA) for assessing the variance between the mean length of stay for independent variables. The mean and standard deviation of LoS for all independent variable subgroups were calculated. Regression analysis was used with procedure type and mortality as dependent variables. Multinomial logistic regression was used for determining the predictors for the chosen procedure type. For evaluating the factors predicting mortality, binary logistic regression was used. A confidence interval of 95% was used and p values < 0.05 were considered significant.

Results

Descriptive statistics for demographic characteristics, hospital type, diagnosis, procedures, deaths during the stay, and LoS are illustrated in Table 1 and Figs. 1 and 2.

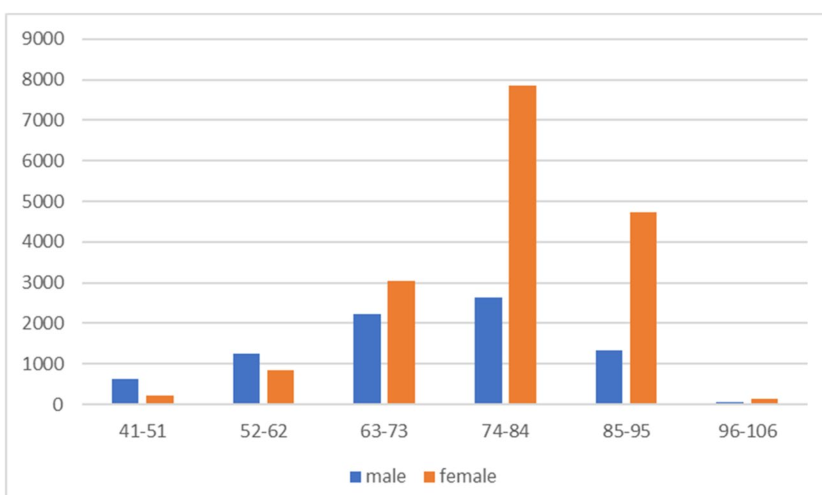
The average age of the patients was 77 years (80 for females, 71 for males); 83.7% of the patients were 65 + with equivalent urban–rural distributions. Sex ratio (67% female) shifted in favor of women at the age of 65 and increased as

Table 1 Baseline characteristics of the study population according to the LoS and mortality

Variables		Total *N* (%) 24,950	LoS			Mortality			
			Mean	ANOVA value	Sign	No	Yes	Chi-square value	Sign
Gender	Male	8132 (32.6)	10.79	0.707	0.401	7678 (94.4)	454 (5.6)	30,724	< 0.001
	Female	16,818 (67.4)	10.88			16,141 (96)	677 (4)		
Age	< 65	4074 (16,3)	10.78	19,209	0	3966 (97.3)	108 (2.7)	285,515	< 0.001
	65–79	8981 (36)	11.26			8668 (96.5)	313 (3.5)		
	≥ 80	11,895 (47.7)	10.57			11,185 (94)	710 (6)		
Setting	Rural	12,058 (48.3)	10.71	6829	0.009	11,606 (96, 0.3)	452 (3.7)	33,188	< 0.001
	Urban	12,892 (51.7)	10.98			12,213 (94.7)	679 (5.3)		
Hospital category	Teaching	10,900 (43.6)	10.72	28,313	0	10,337 (94.8)	563 (5.2)	19,223	< 0.001
	County	9387 (37.6)	10.61			8994 (95.8)	393 (4.2)		
	Local (municipal)	4663 (18.8)	11.65			4488 (96.2)	175 (3.8)		
Diagnosis	S72.0	11,068 (44.4)	11.17	25,526	0	10,550 (95.3)	518 (4.7)	8436	0.015
	S72.1	12,619 (50.6)	10.5			12,081 (95.7)	538 (4.3)		
	S72.2	1263 (5.1)	11.59			1188 (94.1)	75 (5.9)		
Procedures	O11104	8399 (33.6)	10.87	60,346	0	8206 (97.7)	193 (2.3)	554,981	< 0.001
	O12101	2281 (9.1)	13.05			2234 (97.9)	47 (2.1)		
	O11808	1756 (7)	11.46			1710 (97.4)	46 (2.6)		
	O12103	1625 (6.5)	12.26			1594 (98.1)	31 (1.9)		
	O12104	1276 (5.1)	13.59			1255 (98.4)	21 (1.6)		
	Other/blanks	1259/8385							
Death	No	23,819	10.84	2189	0.139				
	Yes	1133 (4.54)	11,02						
LoS	< 6	4809 (19.5)				4394 (91.4)	415 (8.6)	285,515	< 0.001
	6–9	7610 (30.7)				7377 (96.9)	233 (3.1)		
	10–14	7395 (29.8)				7189 (97.2)	206 (2.8)		
	> 15	4883 (19.7) (max 40) 5167				4859 (94.6)	277 (5.4)		

age advanced. The majority (95%) of the patients were diagnosed with femoral neck ($n = 11{,}068$) and pertrochanteric fractures ($n = 12{,}619$). Accurate assignment of the surgical procedures was registered for 15,337 cases with five specific codes. Two-thirds of the patients spent between 1 and 2 weeks in the hospital.

Fig. 1 Sex distribution by age groups of the study population



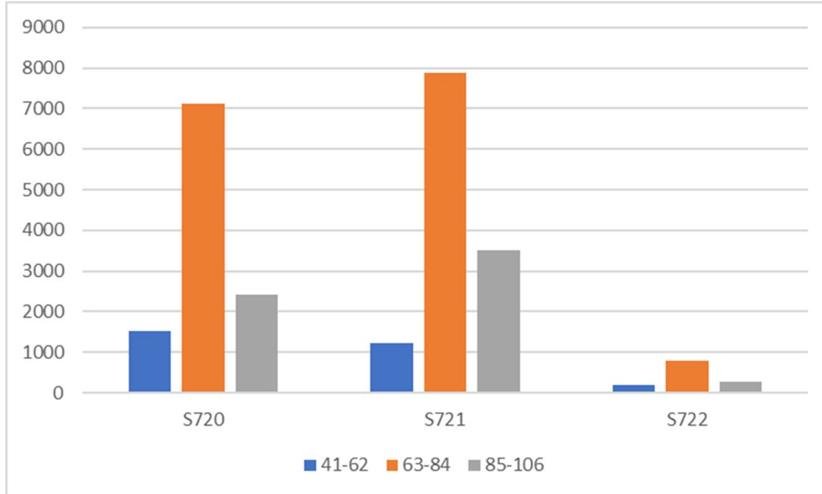


Fig. 2 Diagnosis prevalence by age groups

We conducted a multinomial regression analysis to identify factors associated with the three main procedures. The results are illustrated in Table 2.

In a next phase, we identified the factors that explain the differing mortality among patients referred to hospitals with hip fracture. The results of the binary logistic regression presented in Table 3 show that among the included variables only the type of hospital has no detectable influence on mortality risk. As mentioned earlier, there is a significant connection between mortality and the length of stay—patients with serious, life-threatening conditions obviously have a higher risk of dying in hospitals, and life-saving interventions for these patients take more time. Less common procedures—other than those listed in the table—double the risk of death compared to internal fixation (O11104), while hemiarthroplasty (O12101) and partial/total unilateral/bilateral arthroplasty procedures (O12103_105) turned out to be significantly less life-threatening than trochanteric/sub capital internal fixation (O11104)—all other conditions being equal, including the diagnosis and LoS. Gender, age, and the residence of the patients also significantly influence mortality. In accordance with previous studies, women, patients of rural origin, and younger patients have significantly lower chances of dying in hospitals following these interventions. Finally, those diagnosed with pertrochanteric femoral fractures (S72.1) have considerably higher chances of survival compared to those with subtrochanteric femoral and femoral neck fractures (S72.2 and S72.0).

Discussion

Epidemiology

Incidence of hip fractures according to our data was 248/100,000 among the Romanian population aged 50+ and 184/100,000 within the 40+ age category. According to gender, incidence was the following: 140/100,000 for male and 210/100,000 for female. There is a wide variation of age-standardized annual incidence globally, ranging for females from > 500/100,000 (574/Denmark, 563/Norway, 539/Sweden) to 2/100,000 in Nigeria or 20/100,000 in South Africa [11].

A north–south gradient in age-standardized risk is found in Europe and the USA, with higher rates in the north [12]. Age-standardized number of hip fractures per 10,000 person-years in Norway varied between counties from 69 to 84 in women and from 34 to 41 in men, also with an east–west gradient (lower incidence in the coastal southwest compared with the southeast) [11].

The crude incidence of low-energy hip fractures, based on individual hospital chart analysis among patients aged 40+ in Bucharest and Ilfov county in the period between September 1, 2017, and August 31, 2018, was slightly lower: 171/100,000. However, a similar incidence was found (180/100,000) when including all fractures in that study [13]. Grigorie et al. found an incidence rate of 187/100,000 for females and 97/100,000 for males in 2018 based on the same DRG Database. The database, however, technically improved meantime [14].

Gender differences

Gender differences in the epidemiology of hip fractures are extensively reported. The age-standardized incidence rates of hip fractures in women, worldwide, are about twice as high as in men. Women represented 67.4% of our study population, in concordance with the values of 65–74% reported by other recent studies [12, 15, 16].

In the < 65 age group, Grigorie et al. reported a higher incidence of hip fractures in males as compared to females; after the age of 65, however, incidence rates in females

Table 2 Multinomial logistic analysis for predictors of the main surgical procedures

	b (SE)	*p* value	Odds ratio	CI—lower bound	CI—upper bound
O12101: Femur hemiarthroplasty versus O11104: Trochanteric/sub capital internal fixation					
Intercept	−14.21 (0.51)	0			
Age	0.04 (0)	0	1.037	1.03	1.045
LoS (days)	0.07 (0.01)	0	1.069	1.058	1.081
Gender	0.01 (0.08)	0.895	1.01	0.867	1.178
Setting	−0.08 (0.07)	0.266	0.923	0.802	1.063
County H	0.26 (0.08)	0.001	1.303	1.118	1.518
Municipal H	0.33 (0.11)	0.003	1.392	1.123	1.725
Diag S721	6.25 (0.16)	0	516.295	374.011	712.709
Diag S722	4.19 (0.22)	0	65.727	42.606	101.397
Death	0.74 (0.23)	0.001	2.095	1.336	3.287
O11808: Closed femoral reduction with internal fixation versus O11104: Trochanteric/sub capital internal fixation					
Intercept	−2.26 (0.33)	0			
Age	−0.01 (0)	0.029	0.994	0.989	0.999
LoS (days)	0.02 (0)	0	1.019	1.01	1.028
Gender	0.09 (0.06)	0.133	1.095	0.973	1.232
Setting	0.06 (0.06)	0.277	1.062	0.953	1.183
County H	1.31 (0.07)	0	3.71	3.265	4.216
Municipal H	0.22 (0.08)	0.006	1.25	1.066	1.467
Diag S721	0.33 (0.08)	0	1.389	1.186	1.627
Diag S722	−0.17 (0.12)	0.145	0.845	0.673	1.06
Death	−0.09 (0.17)	0.603	0.914	0.652	1.282
O12103-105: Partial/total unilateral/bilateral arthroplasty versus O11104: Trochanteric/sub capital internal fixation					
Intercept	−10.89 (0.45)	0			
Age	0 (0)	0.848	1.001	0.994	1.007
LoS (days)	0.06 (0.01)	0	1.065	1.055	1.076
Gender	−0.05 (0.07)	0.503	0.952	0.824	1.1
Setting	0.01 (0.07)	0.863	1.012	0.886	1.155
County H	0.64 (0.07)	0	1.902	1.646	2.197
Municipal H	0.76 (0.11)	0	2.133	1.732	2.626
Diag S721	5.45 (0.11)	0	231.684	186.659	287.569
Diag S722	4.16 (0.2)	0	64.157	43.235	95.203
Death	0.63 (0.22)	0.004	1.881	1.217	2.908

Reference categories: deceased, male, rural, main hospital.

$R^2 = 0.570$ (Cox & Snell), 0.630 (Nagelkerke), model $\chi^2 = 12{,}947.84$.

increased substantially, overtaking those of males, approximately doubling by the 80–85 age group. Our results are congruent with this study [17].

Setting

Secular trends in the incidence of hip fractures have been suggested to follow the rate of urbanization [18]. Several studies have reported higher hip fracture rates in densely populated cities and areas (termed “urban”), as compared with areas with lower population density (“rural”) [19]. Hard surfaces due to soil sealing, lower physical activity, and lower serum levels of vitamin D due to less exposure to sunlight may contribute to the higher fracture risk in urban areas and in countries with higher socioeconomic prosperity [20]. Twelve of 15 studies provided consistent evidence that residents of urban regions had 20–60% higher incidence of hip fractures than residents of rural regions [21].

Procedures

Fractures, classified according to the ICD-10 code system, were trochanteric (S72.1) in 50.6% ($n = 11{,}068/24{,}950$) and femoral neck fractures (S72.0) in 44.4% ($n = 12{,}619/24{,}950$) of cases.

Table 3 Logistic model of predictors of death

	B (S.E)	*p*-value	Wald	Odds ratio
Gender	−0.52 (0.11)	0	22.237	0.595
Age	0.07 (0.01)	0	111.591	1.068
Urban	0.32 (0.11)	0.003	8.551	1.371
diagS721	−0.36 (0.17)	0.033	4.522	0.699
diagS722	0.11 (0.24)	0.63	0.232	1.12
County hospital	0.06 (0.12)	0.607	0.265	1.061
Municipal hospital	−0.06 (0.16)	0.723	0.125	0.943
LoS	0.04 (0.01)	0	58.2	1.04
Procedure O12101 Femur hemiarthroplasty	−0.51 (0.22)	0.02	5.405	0.601
Procedure O11808 Closed femoral reduction with internal fixation	0.08 (0.17)	0.623	0.241	1.088
Procedure O12103_105 Partial/total unilateral/bilateral arthroplasty procedures	−0.46 (0.21)	0.033	4.554	0.634
Other procedures	0.71 (0.16)	0	19.657	2.026
Constant	−9.02 (0.54)	0	281.739	0

$R^2 = 0.014$ (Cox & Snell), 0.069 (Nagelkerke), model $\chi^2 = 234{,}464$.

Reference categories: male, rural, diag S72.0, clinical hospital, O11104 (trochanteric/sub capital internal fixation).

According to a study based on the KP (Kaiser Permanent, the largest US integrated health care system, covering > 9.5 million individuals) hip fracture registry: the most common procedures for hip fracture treatment were hemiarthroplasty (33.1%), open reduction of fracture with internal fixation (29.7%), and closed reduction of fracture with internal fixation (23.8%) [15].

LoS

There is a worldwide decrease in hospital LoS. For example, from 1998 to 2017 LoS in Sweden decreased from 14.8 to 10.2 days [22]. We found average LoS of 10.79 and 10.88 days for males and females, respectively, with higher LoS among those with a subtrochanteric fracture (11.59 days). Patients in our study had a longer LoS when treated in a municipal hospital (vs. teaching clinics), living in urban areas, part of an older age group, and undergoing a hemiarthroplasty, or if they died during the hospitalization.

These results are congruent with a 2016 US study that evidenced a shorter LoS in high-volume hospitals. Low-volume hospitals were found mostly in rural areas and showed a longer time between admission and surgical treatment [23].

Another recently published, Romanian, population-based study found important differences in the mortality rates by LoS intervals: 6–10-day interval of LoS being associated with the lowest mortality rate. Also, the authors showed an increased odds ratio (OR) of 1.031 ($p < 0.001$, CI 95% 1.019–1.044) for 1-year mortality with 1-day increase in LoS [24]. At the same time, no important difference was found in mortality rates between LoS intervals in the functionally treated group.

To maximize the use of these results, LoS should be further explored in a future study to identify associations with other factors, such as comorbidities and complications.

Mortality

The time trend of hip fracture incidence is not the main topic of our study; we just mentioned that incidence rates of hip fracture have declined, especially among women during the past 20 years. Still, survival chances among affected individuals did not improve. Possible explanations for the trend reversal in incidence rates include management strategies targeting bone fragility as well as macro-level changes that may have caused decreasing fracture trends as an unpredicted effect (changes in bone mineral density and body mass index, lifestyle, or nutritional status) [12].

The in-hospital mortality rate after hip fracture was 4.5% in our study (5.6% among men and 4% among women). Although postmenopausal women have a higher risk of developing fractures, older men tend to have a worse prognosis after a fracture, particularly of the femur. In our study, men had a 1.7 times higher mortality risk compared to women. In-hospital mortality was 1.34 times higher among those patients living in urban areas. Regarding their age, each year added a 6.9% risk of death. Regarding increased age as a mortality risk factor, Dobre et al. also showed a significant correlation with in-hospital, 30-day, and 1-year mortality rates for all low-trauma hip fractures, with a maximal value for 1-year mortality of almost 45% in patients aged over 85 years [24].

The study published in 2021 that analyzed all charts of the patients (40 +) discharged from hospitals with an orthopedic department in Bucharest and surrounding (Ilfov) county found a slightly lower in-hospital mortality rate of 4.26%, as compared to the national value of 4.5%, while the 30-day and 1-year rates were 9.59% and 29.72%. The same Romanian regional study described 44% of the patients who died in-hospital as conservatively treated [24], with no statistically significant association of the type of fracture with in-hospital mortality rate.

Contrary to our non-significant prediction values regarding hospital type (logistic regression, Table 3), the aforementioned study found that, in Ilfov, there were lower mortality rates in low-volume hospitals (< 150 hip fractures/year), compared to high-volume, university teaching hospitals with emergency trauma centers [24].

Studies have reported an overall in-hospital mortality rate ranging from 1.52 to 11.4% in hip fracture patients that have undergone surgical treatment [25]. Belmont et al. reported a 4.5% in-hospital mortality, with male gender being an independent risk factor for increased mortality [26].

Previous studies have also demonstrated urban–rural variations in hip fracture mortality by degree of urbanization [19].

Without data regarding the post-discharge mortality, it is difficult to compare our results with other studies dealing with different time variables. However, the hazard ratio (HR) of mortality seems to increase with time, which substantiates our results. The HR of mortality in urban compared with rural areas, according to the NOREPOS hip fracture database, peaks during the first 1–2 years post-fracture with a maximum HR of 1.20 (95% CI, 1.10–1.30) in men and 1.15 (95% CI, 1.08–1.21) in women. The differences are significant for ~ 5 years post hip-fracture. The novel findings of a higher long-term mortality in urban hip fracture patients might reflect disparities in health status or lifestyle [27].

We intended to extend the research of a previous pertinent study that assessed the hip fracture incidence in two regions (11.8% of the population), on a national scale. Accepting a correction rate of 0.95% for extracting probably low-energy fractures based on the data found by this research team, we can assume the osteoporotic hip fracture incidence is close to 174.8 among the Romanian population 40 + .

The FRAX model for Romania was developed in 2013 based on 2010 hip fracture data reported to the National Institute of Public Health, with 14,852 cases reported in individuals above the age of 40. Based on the reported rates, hip fracture incidence increased from 171/100,000 to 210/100,000 in women and 116/100,000 to 140/100,000 in men. The country's current FRAX model labels Romania as one of the countries with the lowest hip fracture incidences in Europe. However, the increasing population of the elderly age group and more accurate data reporting to NIPH call for a revision of the current FRAX model [17].

Currently, Romania provides osteoporosis treatment reimbursements based on the presence of fragility fractures, BMD measurements of < -2.5 SD and, more recently, also on FRAX. Despite this, the results of the study conducted by Grigorie et al. [17] suggested that this is no longer an accurate representation of fracture risk. Other factors, such as parental history of fracture and history of previous fractures, play an important role in fracture probability, signifying that practice guidelines should be revised. It was demonstrated that fracture risk was double in younger women with risk factors compared to those without [28]. In order to provide an accurate FRAX predictive model for the country, incidence rates have to be congruent with reality and the changes provided by the increasing elderly population. Therefore, calibration of the FRAX tool plays an important role in the revision of treatment guidelines. Studies have shown that for every 1% change in calibration there are 2.5% and 4.1% changes in treatment guidelines for women and men respectively [29]. Revision of Romania's FRAX model with updated incidence rates should be considered as hip fracture incidence has and is expected to increase with the aging population.

Declarations

Conflicts of interest None.

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