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Mini-Review

Multimorbidity is associated with fragility fractures in women 50 years and older: A nationwide cross-sectional study

Anabela Barcelos [a,b,c,d,*], David G. Lopes [b,c], Helena Canhão [a,b,c,e], Jaime da Cunha Branco [b,c,f], Ana Maria Rodrigues [b,c,g]

[a] NOVA National School of Public Health, Public Health Research Centre, Universidade NOVA de Lisboa, Lisboa, Portugal
[b] Comprehensive Health Research Center (CHRC), Universidade NOVA de Lisboa, Lisboa, Portugal
[c] EpiDoC Unit, CEDOC, NOVA Medical School, Universidade Nova de Lisboa, Lisboa, Portugal
[d] Rheumatology Department, CHBV, Aveiro, Portugal
[e] Rheumatology Department, CHULC, Lisboa, Portugal
[f] Rheumatology Department, CHLO, Lisboa, Portugal
[g] Rheumatology Department, Hospital dos Lusíadas, Lisboa, Portugal

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ABSTRACT

Introduction: Multimorbidity is a worldwide health problem, especially in elderly patients who have a higher risk of fragility fracture. Currently, there is insufficient knowledge about the burden of multimorbidity in patients with previous fragility fracture. The aim of this study was to evaluate the association between multimorbidity and previous fragility fracture, and to assess the effect of fragility fracture and/or multimorbidity in the perception of quality-of-life and physical function, in women 50 years of age and older.

Methods: Women aged ≥50 years from the EpiReumaPt study (2011−2013), a nationwide population-based study, were evaluated. Self-reported data regarding sociodemographics, health-related quality of life, physical functioning, fragility fracture, and multimorbidity were collected using a semi-structured questionnaire. Multimorbidity was defined as 2 or more chronic non-communicable diseases. Descriptive exploratory analysis of the data was performed using hypothesis testing. Multiple logistic regression modelling was used to assess the association between multimorbidity and fragility fractures, and linear regression was used for the quality-of-life and physical function outcomes.

Results: The estimated prevalence of fragility fracture in women older than 50 years was 17.5%. A higher prevalence of multimorbidity (74.6%) was found in the group of women with previous fragility fracture than in those without previous fragility fracture. Multivariate logistic regression analysis revealed that women with multimorbidity had a higher odds of fragility fracture (adjusted odds ratio, 1.38; 95% confidence interval, 1.12–1.69), compared with women with 1 or no self-reported non-communicable chronic diseases. In women with previous fragility fracture, rheumatic diseases (62.7%) and hypertension (58.6%) were the most frequently self-reported non-communicable chronic diseases. Both multimorbidity and a previous fragility fracture were independently associated with worse health-related quality of life and physical functioning.

Conclusions: Women 50 years and older with multimorbidity had a significantly increased odds of fragility fracture. Fragility fracture and multimorbidity were negatively associated with quality of life and disability. This study emphasizes the need to redesign health services to care for patients to prevent non-communicable chronic diseases and fragility fracture, particularly in women 50 years and older, in whom these diseases are likely to potentiate the risk of fragility fracture.

* Corresponding author at: Rheumatology Department, Centro Hospitalar do Baixo Vouga, Hospital Infante D. Pedro, EPE, Rua Artur Ravara, 3814-501 Aveiro, Portugal.

E-mail addresses: anabela.barcelos@chbv.min-saude.pt (A. Barcelos), davidgvlopes@nms.unl.pt (D.G. Lopes), helena.canhao@nms.unl.pt (H. Canhão), jaime.branco@nms.unl.pt (J. da Cunha Branco), anamfrodrigues@gmail.com (A.M. Rodrigues).

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1. Introduction

Osteoporosis (OP) is a systemic disease characterized by bone mass reduction and deterioration of bone microarchitecture, which makes bone more fragile and, consequently, more prone to fractures (Kanis et al., 1994). Because of population ageing and changes in professions and lifestyles, the incidence of OP is predicted to exponentially increase in upcoming years (Kanis et al., 2008). Worldwide, OP is a major public health problem responsible for fragility fractures, and there is an urgent need to address this condition as a comorbidity. In Portugal, the incidence of hip fragility fractures was estimated to be 8.000 to 10.000 per year in 2008–2009 (Branco et al., 2009; de Pina et al., 2008). All types of fragility fractures occur annually in Portugal, with an overall estimated 40.000 fragility fractures per year (Rodrigues et al., 2018a).

The social and economic burdens of fragility fractures are very high (Branco et al., 2009). Fragility fracture have a substantial impact on the individual's health-related quality of life and physical functioning (Stanghelle et al., 2019). According to the International Osteoporosis Foundation, up to 20% of patients die within in the first year after a hip fracture, often because of pre-existing medical conditions, and 50% become dependent on others to perform basic self-care (International Osteoporosis Foundation, Facts and statistics, n.d.).

In the past few years, there has also been a higher prevalence of polypharmacy, disability, frailty, comorbidity, and multimorbidity (Xu et al., 2017; Villacampa-Fernández et al., 2017). Currently, the presence of two or more chronic conditions affecting the same patient, defined as multimorbidity, is an important public health concern (Mercer et al., 2014; Palladino et al., 2016). Several studies have identified age, sex, unhealthy lifestyle behaviours, rheumatoid arthritis, diabetes mellitus, hypertension, and menopause as risk factors for OP (Rodrigues et al., 2018a; Abrahamsen et al., 2014; Li et al., 2017).

The prevalence of multimorbidity in European countries is high (Palladino et al., 2016; Glynn et al., 2011; Puth et al., 2017; Garin et al., 2014), and Portugal is no exception. Nicolau et al. (2014) found that 36% of the Portuguese population included in the 2005/2006 National Health Survey (Inquérito Nacional de Saúde) had at least three chronic conditions. According to the 2011/2012 Survey of Health, Ageing and Retirement in Europe (SHARE) data (Palladino et al., 2016), the prevalence of multimorbidity was 39% in Portuguese adults aged 50 years and older. Prazeres et al. (Prazeres and Santiago, 2015) reported that multimorbidity ($\geq$ 2 chronic health problems) was present in 72.7% of patients followed in primary care centres in mainland Portugal across the five Portuguese healthcare administrative regions (i.e., Nomenclature of Territorial Units for Statistical Purposes II [NUTS II] regions). Similarly, Rodrigues et al. (2018b) found a high prevalence of multimorbidity (78.3%) in Portugal among adults aged 65 years and older, particularly in Azores (84.9%) and Alentejo (83.6%). In a study based on National Health Survey with Physical Examination (Inquérito Nacional de Saúde com Exame Físico) data of non-institutionalized patients aged 25 to 74 years living in mainland Portugal, Azores, and Madeira islands, Quinaz Romana et al. (2019) reported that multimorbidity affects more than one third (38.3%) of the Portuguese population.

Portugal is facing a major challenge with multimorbidity in elderly patients because of the economic and social impacts of the combination of diseases in the same patient. Patients with multimorbidity require a multidisciplinary approach to address the complex interactions of their multiple chronic diseases and their complex medication regimens. Multimorbidity has been associated with increased healthcare utilization and costs (Palladino et al., 2016; Cassell et al., 2018), lower self-rated health (Mavaddat et al., 2014), lower quality of care (Zulman et al., 2014), and more disability (Sheridan et al., 2019; Rivera-Almaraz et al., 2018). Furthermore, most elderly patients with multimorbidity have OP, which creates pressure on the healthcare system to achieve the best patient-centred care. Patients, caregivers, and providers are the keys to designing and managing a comprehensive care plan to improve health outcomes.

Considering fragility fractures in isolation, without accounting for multimorbidity, is insufficient. Thus, there is an urgent need to clarify whether an association exists between multimorbidity and fragility fractures in our population in order to establish effective strategies for prevention and treatment. Therefore, the aim of this study was to evaluate the association between multimorbidity and previous fragility fractures in Portuguese women aged 50 years and older and to assess which non-communicable chronic diseases are associated with previous fragility fractures in these women. Additionally, we aimed to evaluate if fragility factures and/or multimorbidity are associated with the perception of quality-of-life and physical function.

2. Materials and methods

2.1. Data source

This study used data from EpiReumaPt, a national cross-sectional study conducted in Portugal from September 2011 to December 2013. The main objective of EpiReumaPt was to estimate the prevalence of 12 rheumatic and musculoskeletal diseases (RMDs), including OP (Branco et al., 2016). In EpiReumaPt, a representative sample of the adult Portuguese population (10,661 participants) was selected to characterize all cases of RMDs (Branco et al., 2016). Details of the protocol have been previously published (Ramiro et al., 2010). The study included non-institutionalized adults (aged $\geq$18 years) living in private households in the Portuguese mainland and islands (Madeira and Azores) (Branco et al., 2016). The study sample was stratified according to the 7 NUTS II regions (Norte, Centro, Lisboa and Vale do Tejo [Lisbon], Alentejo, Algarve, Açores Islands [Azores], and Madeira Islands [Madeira]) and the size of the population within each locality ($<$ 2000, 2000–9999, 10.000–19.999, 20.000–99.999, and $\geq$ 100.000 inhabitants) (Branco et al., 2016). Eligible candidates were visited by a trained team of interviewers in their homes, where face-to-face interviews were conducted. Households where selected randomly within the locations selected as the primary units of sampling. Interviews followed a structured questionnaire aided by a computer platform where answers were registered by the interviewers. Anthropometric measures and the presence of diseases in this phase of the study were self-reported by the participants, and an algorithm was applied to define a positive screening.

Of the 28.502 households eligible to be contacted, 8.041 individuals refused to participate in the study, and 10.661 completed all interviews (Branco et al., 2016). The EpiReumaPt population was similar to the Portuguese population (CENSUS 2011) with respect to age strata, sex, and NUTS II region distribution. This study was performed according to the principles established by the Declaration of Helsinki and revised in 2013 in Fortaleza. The EpiReumaPt study was approved by the Portuguese Data Protection Authority (*Comissão Nacional de Proteção de Dados*) and Ethics Committee of NOVA Medical School. Ethics committees of regional health authorities also approved the study. Written informed consent was obtained from all EpiReumaPt participants before entering the study.

2.2. Study population

The population for the current study included women 50 years and older who participated in the EpiReumaPt study and reported one or more previous fragility fractures by responding to the question "Have you ever suffered from a fracture following a minimum traumatism, after the age of 40 years old?". Fragility fractures was defined as any self-reported low-impact fracture (resulting from a fall from a standing height or less or occurring in the absence of trauma) in individuals older than 40 years (Melton et al., 1997). The accuracy of self-reported fragility fractures was previously demonstrated to be acceptable (Chen et al., n.d.; Ismail et al., 2000; Honkanen et al., 1999). The exclusion criteria included fractures of the face, skull, foot, fingers, and toes, as

Table 1
Sociodemographic and clinical characteristics of women with or without at least 1 previous fragility fracture.

Characteristic	Total ($n = 3624$)	Fragility fracture ($n = 633$)	No-fragility fracture ($n = 2991$)	p value
Sociodemographic characteristics				
Age, y				**<0.001**
50–59	1127 (31.1)	144 (22.7)	983 (32.8)	
60–69	1160 (32.0)	178 (28.1)	982 (32.8)	
70–79	924 (25.5)	203 (32.1)	721 (24.1)	
> 80	413 (11.4)	108 (17.1)	305 (10.2)	
Mean (SD)	66.1 (10.2)	68.8 (10.4)	65.6 (10.1)	
NUTS II region				0.056
Norte	988 (27.3)	170 (26.9)	818 (27.4)	
Centro	692 (19.1)	112 (17.7)	580 (19.4)	
Lisboa and Vale do Tejo	777 (21.4)	149 (23.5)	628 (21.0)	
Alentejo	283 (7.8)	55 (8.7)	228 (7.6)	
Algarve	143 (3.9)	29 (4.6)	114 (3.8)	
Açores Islands	319 (8.8)	37 (5.9)	282 (9.4)	
Madeira Islands	422 (11.6)	81 (12.8)	341 (11.4)	
Marital status				**0.003**
Single	226 (6.2)	35 (5.5)	191 (6.4)	
Married	1997 (55.1)	315 (49.8)	1682 (56.3)	
Divorced	303 (8.4)	53 (8.4)	250 (8.4)	
Widow	1096 (30.3)	230 (36.)	866 (29.0)	
Education level, y				**0.002**
> 12	290 (8.1)	39 (6.2)	251 (8.5)	
10–12	268 (7.5)	39 (6.2)	229 (7.7)	
5–9	492 (13.7)	78 (12.5)	414 (14.0)	
0–4 (complete)	1729 (48.2)	292 (46.7)	1437 (48.5)	
0–4 (incomplete)	812 (22.6)	178 (28.4)	634 (21.4)	
Anthropometric data				
Body mass index (kg/m^2)				0.346
Underweight	35 (1.1)	10 (1.8)	25 (0.9)	
Normal weight	973 (29.8)	164 (29.4)	809 (29.9)	
Overweight	1310 (40.2)	222 (39.8)	1088 (40.3)	
Obese	943 (28.9)	162 (29.0)	781 (28.9)	
Mean (SD)	27.8 (5.1)	27.8 (5.1)	27.8 (5.0)	
Lifestyle behaviours				
Current smoking				0.857
Yes	227 (6.3)	38 (6.0)	189 (6.3)	
No	3395 (93.7)	595 (94.0)	2800 (94.0)	
Alcohol				0.066
Daily	409 (11.3)	57 (9.0)	352 (11.8)	
Occasional	949 (26.2)	158 (25.0)	791 (26.5)	
Never	2262 (62.5)	417 (66.0)	1845 (61.8)	
Regular physical activity				0.498
Yes	1033 (28.5)	184 (28.6)	852 (28.5)	
No	2590 (71.5)	452 (71.4)	2138 (71.5)	

Data are number (percentage). NUTS II, Nomenclature of Territorial Units for Statistical Purposes II.
Sample size is not constant due to missing values on some variables: Total – Marital status ($n = 3622$), Education level ($n = 3591$), Body mass index ($n = 3261$), Current smoking ($n = 3622$), Alcohol ($n = 3620$), Regular physical activity ($n = 3623$); Fragility fracture – Education level ($n = 626$), Body mass index ($n = 558$), Alcohol ($n = 632$); No-Fragility fracture – Marital status ($n = 2703$), Current smoking ($n = 2989$), Alcohol ($n = 2988$), Alcohol ($n = 2990$).

well as high-impact traumatic fractures and pathologic fractures.

Women also self-reported the presence or absence of the following chronic non-communicable diseases, by answering the question "Did any doctor ever tell you that you suffered from one of the following chronic diseases?": hypertension, rheumatic disease (rheumatoid arthritis, ankylosing spondylitis, psoriatic arthritis, osteoporosis, osteoarthritis, gout, rheumatic polymyalgia, fibromyalgia, tendinitis or bursitis), diabetes mellitus, mental disease (depression, anxiety, schizophrenia or bipolar disease), pulmonary disease (chronic bronchitis, pulmonary emphysema, cystic fibrosis, bronchiectasis or pulmonary fibrosis), cardiac disease (heart attack, angina pectoris, arrhythmia, heart valves problems, heat failure, hypertrophic cardiomyopathy or stroke), gastrointestinal disease (stomach ulcer, gastritis, reflux disease, ulcerative colitis, Chron's disease or hepatitis), thyroid or parathyroid disease, cancer, and neurologic disease (migraines, multiple sclerosis, Parkinson's disease, peripheral polyneuropathy or myopathy). The number of these diseases was determined for each respondent, with multimorbidity defined as the presence of two or more of these disorders (Mercer et al., 2014).

Study participants were divided into two groups: fragility fracture group (≥ 1 previous fragility fracture) or no- fragility fracture group (no previous fragility fractures). Sociodemographic and clinical data were collected, including anthropometric measures, lifestyle behaviours, health-related quality of life (assessed using the Portuguese validated version of the European Quality of Life-5 dimension [EQ-5D] questionnaire), physical functioning (assessed using the Health Assessment Questionnaire [HAQ]), and the 10 aforementioned self-reported non-communicable chronic diseases.

2.3. Statistical analysis

Sociodemographic data, anthropometric measures, lifestyle behaviours, health-related quality of life, physical functioning, and more frequent self-report non-communicable chronic diseases were characterized for the study population. Categorical variables were described as absolute frequency and percentage and compared using the chi-square independence test and Fisher's exact test. To evaluate risk factors associated with previous fragility fracture, univariate logistic regression

Table 2
Self-reported non-communicable chronic diseases in women with or without at least 1 previous fragility fracture.

Self-report non-communicable chronic diseases	Total (n = 3624)	Fragility fracture (*n* = 633)	No-Fragility fracture (*n* = 2991)	OR[a] (95% CI)	*p* value
Hypertension				1.2 (1.02, 1.48)	**0.028**
Yes	1884 (52.5)	367 (58.6)	1517 (51.2)		
No	1705 (47.5)	259 (41.4)	1446 (48.8)		
Diabetes mellitus				1.2 (0.98, 1.52)	0.072
Yes	668 (18.6)	140 (22.5)	528 (17.8)		
No	2917 (81.4)	481 (77.)	2436 (82.2)		
Rheumatic disease				1.3 (1.11, 1.62)	**0.002**
Yes	1907 (55.1)	383 (62.7)	1524 (53.4)		
No	1556 (44.9)	228 (37.3)	1328 (46.6)		
Gastrointestinal disease				1.3 (1.08, 1.58)	**0.006**
Yes	966 (27.0)	203 (32.6)	763 (25.8)		
No	2617 (73.0)	420 (67.4)	2197 (74.2)		
Mental disease				1.5 (1.23, 1.82)	**<0.001**
Yes	880 (24.6)	185 (29.8)	695 (23.5)		
No	2703 (75.4)	435 (70.2)	2268 (76.5)		
Neurologic disease				1.4 (0.96, 1.90)	0.085
Yes	208 (5.8)	48 (7.8)	160 (5.4)		
No	3373 (94.2)	568 (92.2)	2805 (94.6)		
Cardiac disease				1.4 (1.17, 1.77)	**<0.001**
Yes	766 (21.5)	176 (20.9)	590 (19.96)		
No	2796 (78.5)	430 (71.0)	2366 (80.0)		
Pulmonary disease				1.7 (1.26, 2.21)	**<0.001**
Yes	294 (8.2)	76 (12.3)	218 (7.3)		
No	3298 (91.8)	543 (87.7)	2755 (92.7)		
Cancer disease				1.1 (0.82, 1.59)	0.435
Yes	241 (6.7)	48 (7.7)	193 (6.5)		
No	3362 (93.3)	577 (92.3)	2785 (93.5)		
Thyroid/parathyroid disease				1.4 (1.09, 1.71)	**0.006**
Yes	595 (16.7)	123 (19.9)	472 (16.0)		
No	2976 (83.3)	496 (80.1)	2480 (84.0)		
Multimorbidity				1.4 (1.12, 1.69)	**0.002**
Yes	2440 (67.3)	472 (74.6)	1968 (65.8)		
No	1184 (32.7)	161 (25.4)	1023 (34.2)		

Sample size is not constant due to missing values on some variables: Total – Hypertension (*n* = 3589), Diabetes mellitus (*n* = 3585), Rheumatic disease (*n* = 3463), Gastrointestinal disease (*n* = 3583), Mental disease (n = 3583), Neurologic disease (*n* = 3581), Cardiac disease (*n* = 3562), Pulmonary disease (*n* = 3592), Cancer disease (*n* = 3603), Thyroid/parathyroid disease (*n* = 3571); Fragility fracture – Hypertension (*n* = 2963), Diabetes mellitus (*n* = 621), Rheumatic disease (*n* = 611), Gastrointestinal disease (*n* = 623), Mental disease (*n* = 620), Neurologic disease (*n* = 616), Cardiac disease (*n* = 606), Pulmonary disease (*n* = 619), Cancer disease (*n* = 625), Thyroid/parathyroid disease (n = 619); No-Fragility fracture – Hypertension (*n* = 626), Diabetes mellitus (*n* = 2964), Rheumatic disease (*n* = 2852), Gastrointestinal disease (*n* = 2960), Mental disease (*n* = 2963), Neurologic disease (*n* = 2965), Cardiac disease (*n* = 2956), Pulmonary disease (*n* = 2973), Cancer disease (*n* = 2978), Thyroid/parathyroid disease (*n* = 2952).

[a] Adjusted for age group, marital status, NUTS II region, and education level. OR, odds ratio.

analysis was performed to assess differences between the fragility fracture group and without fragility fracture group. The evaluated independent variables were age group, NUTS II region, marital status, education level, body mass index, smoking habits, alcohol consumption, physical activity, and multimorbidity. Variables with $p < 0.05$ in univariate analysis were included in the multivariate model. To assess the association between fragility fracture and chronic non-communicable diseases, odds ratio was adjusted for age group, NUTS II region, marital status, and education level. For the health-related quality-of-life and physical function outcomes, linear regression models were used. To facilitate clinical interpretation, continuous numerical variables were converted into categorical variables. Statistical models considered only complete cases for all variables included. In the bivariate analysis, individuals with missing values were not considered. For all analyses, *p* values <0.05 were considered significant. The statistical analyses were conducted using STATA IC version 16.1.

3. Results

Of the 3624 women included in this study, 633 had at least 1 previous fragility fracture, representing an estimated 17.5% prevalence of fragility fracture in Portuguese women 50 years and older. Wrist fractures were the most common fracture (18.6%), followed by vertebral fractures (7.0%) and hip fractures (5.4%). Of the 633 women in the fragility fracture group, 57.1% (362) reported 1 fragility fracture, 20.7% (131) reported 2 fragility fractures, and 22.2% (140) reported 3 or more fragility fractures. At least 1 fall in the previous 12 months was reported by 43.7% (275) of women in the fragility fracture group.

Table 1 summarizes the sociodemographic and clinical characteristics of the study population. Most women were married, overweight, and had a low education level (0–4 years). In both the fragility fracture and no-fragility fracture groups, the highest proportion of women lived in the northern region of Portugal and lowest percentage lived in the Algarve region. The majority of women in both the fragility fracture and no-fragility fracture groups did not smoke, consume alcohol, or participate in regular physical activity.

Of the 3624 women in the study, 2440 (67.3%) had multimorbidity and 1184 (32.7%) did not. We also found that 1714 (47.3%) had three or more comorbidities and 1129 (31.2%) had four or more. Multimorbidity was more frequent in the fragility fracture group (74.6%; 472/633) than in the no-Fragility fracture group (65.8%; 1968/2991), after adjusting for age group, marital status, NUTS II region, and education level. Rheumatic disease, hypertension, gastrointestinal disease, mental disease, cardiac disease, pulmonary disease, and thyroid/parathyroid disease were the most frequently self-reported non-communicable chronic diseases in women with at least 1 previous fragility fracture.

We examined the association between specific non-communicable chronic diseases and previous fragility fracture in our study population. Except for neurologic disease, cancer disease, and diabetes, the other diseases were associated with a significantly increased odds of

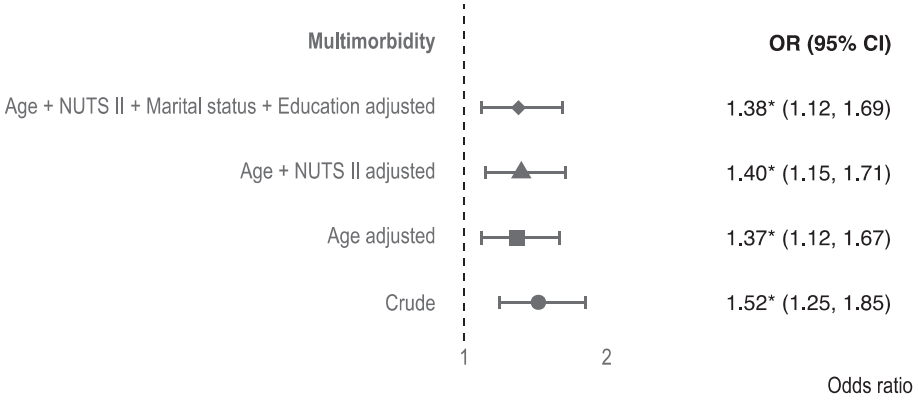

Fig. 1. Forest plot of crude and adjusted odds ratios (with 95% confidence intervals) from logistic regression analysis. Sample size for crude, age adjusted and age + NUTS II adjusted models is $n = 3624$, for the age + NUTS II + marital status + education model, $n = 3622$. Statistically significant result (*).

fragility fracture, after adjusting for age group, marital status, NUTS II region, and education level (Table 2).

After univariate analysis of factors associated with self-reported fragility fractures, age group, NUTS II region, marital status and education level were the only variables included as potential confounders for the multivariate analysis (Fig. 1). Women with multimorbidity had a 38% higher odds of fragility fracture (OR, 1.38), compared with women with 1 or no self-reported non-communicable chronic diseases.

As shown in Table 3, the presence of fragility fracture was negatively associated with health-related quality of life. Specifically, women with fragility fracture had a 0.062-points lower mean EQ-5D score (representing worse quality of life) than those with no fragility fracture, after adjusting for all other variables. Women with multimorbidity had an even lower EQ-5D score (0.157 points lower than that of the no-multimorbidity group). When both fragility fracture and multimorbidity are included in the model, the impact on the health-related quality of life score is a decrease of 0.055 points. Fragility fracture adjusted for multimorbidity also increased disability. Specifically, women with at least 1 previous fragility fracture had a 0.145-points higher mean HAQ score (representing more disability) than those in the no-Fragility fracture group.

4. Discussion

This study aimed to evaluate the association between multimorbidity and previous fragility fracture in women aged 50 years and older in Portugal. In this population, we found a higher prevalence of multimorbidity (74.6%) in patients with at least 1 previous fragility fracture than in those with no previous fragility fracture, after adjusting for confounding variables (age, marital status, NUTS II region, and education level). Furthermore, women with multimorbidity had a 38% higher odds of fragility fracture, when compared with women with just 1 or no self-reported non-communicable chronic diseases. Our results, therefore, suggest that multimorbidity is an important factor associated with fragility fracture in older women (≥ 50 years) in Portugal. Both multimorbidity and a previous fragility fracture had a notable impact, resulting in worse health-related quality of life and physical functioning. These findings contrast with those of a prior study, which surprisingly detected no association between previous fragility fracture and health-related quality of life in women over 65 years of age (Rodrigues et al., 2018c). However, our results are in line with several studies in literature, reporting that multimorbidity is significantly associated with poor health-related quality of life (Bao et al., 2019; N'Goran et al., 2017). The association between fragility fractures and worst health-related quality of life is also well established (Ciubean et al., 2018; Borhan et al., 2019; Abimanyi-Ochom et al., 2015). Patients with multimorbidity are more likely to have physical functioning decline (Calderón-Larrañaga et al., 2019). Lower levels of health-related quality of life and lower levels of physical function were found in patients with osteoporosis and fragility fractures (Stanghelle et al., 2019). The simultaneous presence in patients of multimorbidity and fragility fractures will inevitably result in worse health-related quality of life and worse functional capacity.

With life expectancy increasing, it is estimated that multimorbidity and fragility fracture will become increasingly common. The burden of fragility fracture and multimorbidity in Portuguese women in upcoming years will be a true challenge for the public health system. It is urgent to develop effective patient-centred management plans with a multidisciplinary approach for these patients to reduce their impact on both the healthcare system (e.g., costly long-term medical care) and individual patients (e.g., health-related quality of life and physical functioning).

Table 3
Quality of life and physical functioning of women with or without at least 1 previous fragility fracture.

	Quality of life (EQ-5D score)				Physical function (HAQ score)			
	$\hat{\beta}$ (*SE*)	*p* value	$\hat{\beta}_{adj}$ (*SE*)	*p* value	$\hat{\beta}$ (*SE*)	*p* value	$\hat{\beta}_{adj}$ (*SE*)	*p* value
Model 1[a]	−0.091 (0.012)	<0.001	−0.062(0.012)	**<0.001**	0.257(0.031)	<0.001	0.162(0.030)	**<0.001**
Model 2[b]	−0.212(0.009)	<0.001	−0.157(0.010)	**<0.001**	0.533(0.024)	<0.001	0.370(0.024)	**<0.001**
Model 3[c]	−0.728(0.012)	<0.001	−0.055(0.012)	**<0.001**	0.211(0.029)	<0.001	0.145(0.029)	**<0.001**

Sample size: EQ-5D[a,c] unadjusted (n = 3593), EQ-5D[a,c] adjusted (n = 3214), EQ-5D[b] unadjusted (n = 3730), EQ-5D[b] adjusted (n = 3330), HAQ[a,c] unadjusted (n = 3624), HAQ[a,c] adjusted (n = 3236), HAQ[b] unadjusted (n=3763), HAQ[b] adjusted (n = 3352).

[a] EQ-5D: Fragility fracture adjusted for age group, education level, alcohol consumption, body mass index, and physical activity; HAQ: adjusted further for NUTS II region. Reference class: No fragility fracture.

[b] EQ-5D: Multimorbidity adjusted for age group, education level, alcohol consumption, body mass index, and physical activity; HAQ: adjusted further for NUTS II region. Reference class: No multimorbidity.

[c] EQ-5D: Fragility fracture adjusted for multimorbidity, age group, education level, alcohol consumption, body mass index, and physical activity; HAQ: adjusted further for NUTS II region. Reference class: No fragility fracture. HAQ, Health Assessment Questionnaire; EQ-5D, EuroQol 5-dimension; SE, standard error.

There is also a pressing need to increase health literacy in our population to empower patients and their caregivers to adopt healthy lifestyles and promote active ageing.

A notable strength of this study is the use of a large sample, which is representative of the Portuguese women population. Nevertheless, this study has limitations that may affect its interpretations. For example, the presence of non-communicable chronic diseases was self-reported, which may under- or overestimate the true prevalence of these diseases. However, this type of assessment is important because it represents the individual's beliefs about their chronic diseases, which may influence their self-management behaviours (Sheridan et al., 2019). Fragility fractures were also self-reported and assessed using the EpiReuma questionnaire. Unfortunately, no information was available regarding how the reported fragility fractures was diagnosed. Another limitation was the lack of available information regarding the participants' pre-fracture functional status. In addition, we assessed the presence of a relatively limited number of non-communicable chronic diseases ($n = 10$), including somatic and mental diseases. Nevertheless, the ideal number of assessed chronic diseases is not standardized in the literature, and there is also no consensus regarding which diseases should be considered. Furthermore, we assigned equal importance and weight to all of these diseases. We also note that the cross-sectional nature of this study limits inference on causality in terms of the exposure and outcomes since both are evaluated at the same time. Lastly, although several potential confounding variables were included in the analyses, it is possible that we did not capture all factors that may influence the odds of fragility fracture.

5. Conclusion

This study showed that women 50 years and older in Portugal with multimorbidity had a significantly higher odds of fragility fracture, when compared with women of the same age with just 1 or no self-reported chronic non-communicable diseases. Considering the high prevalence of multimorbidity in our population and the demonstrated negative effects of fragility fracture on health-related quality of life and physical functioning, our results reinforce the need to increase research on this concerning public health problem to help prevent the occurrence of fragility fracture in this group of patients. These results emphasize the need to redesign health services to optimize patient care in order to prevent non-communicable chronic diseases and fragility fracrures, especially in women 50 years of age and older.

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CRediT authorship contribution statement

AB wrote the first draft of the manuscript, which was then reviewed and edited by all authors. The study was conceptualized by AB and AR. The statistical analyses were performed by DL with the advice, support, and critical interpretation of the results by AB and AR.

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