Risk Factors in Patients with a Densitometric Diagnosis of Osteopenia and Osteoporosis

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Article

Risk Factors in Patients with a Densitometric Diagnosis of Osteopenia and Osteoporosis

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Abstract

Introduction: Osteoporosis is a chronic metabolic bone disease characterized by the progressive loss of bone mineral density and microstructural deterioration, leading to an increased risk of fractures. It has a significant impact on public health, particularly affecting postmenopausal wo amen due to estrogen deficiency.**Objective:** To determine the frequency of risk factors associated with osteopenia and osteoporosis in women attending a Regional Hospital in Cancún, Mexico.**Methods:** A descriptive, observational, and cross-sectional study was conducted at the Regional General Hospital No. 17 of the IMSS in Cancún, Quintana Roo. A calculated sample of 311 women aged 45 to 60 years with a densitometric diagnosis of osteopenia or osteoporosis was analyzed. Data were collected through questionnaires assessing demographic and clinical risk factors, followed by dual-energy X-ray absorptiometry (DXA) of the calcaneus to determine bone mineral density (BMD). **Results:** Most participants had completed secondary education (36.0%), and 77.8% were over 45 years old. The most prevalent risk factors were hypertension (34.3%), diabetes mellitus (31.2%), alcohol consumption (15.8%), smoking (14.5%), and systemic steroid use (9.1%). Only 28.2% reported engaging in regular exercise. Statistical analysis showed a significant difference in mean age between women with osteoporosis (59.56 ± 10.60 years) and those without osteoporosis (49.88 ± 10.68 years; $p < 0.001$). Age was negatively correlated with T-score ($r = -0.519$, $p < 0.01$). Regression analysis identified age as the only significant independent factor (OR = 6.44; 95% CI: 2.23–18.60; $p = 0.001$). **Conclusions:** Age was confirmed as the main independent risk factor for osteoporosis in the studied population. Although other evaluated factors did not show statistical significance, their clinical relevance justifies their consideration in preventive strategies to reduce the risk of osteoporosis and associated fractures.

Keywords: osteoporosis; osteopenia; risk factors; bone density; postmenopausal women

1. Introduction

Osteoporosis is a chronic metabolic bone disease characterized by the progressive loss of bone mineral density as well as alterations in bone microarchitecture, leading to an increased risk of fragility fractures. It primarily affects older individuals, with postmenopausal women being the most affected due to the decline in estrogen levels, a hormone that plays an essential role in maintaining proper bone metabolism [1].

The global prevalence of osteoporosis reflects a serious public health problem, with estimates indicating that more than 200 million people worldwide suffer from the condition. Current statistics suggest that approximately 33% of women and 20% of men over the age of 50 will experience at least one osteoporotic fracture during their lifetime. The most frequently affected anatomical sites are the spine, hip, and distal radius. These fractures carry significant economic and social consequences due to resulting disability, increased healthcare costs, loss of work productivity, and a negative impact on the physical and mental health of patients and their families [2].

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In Mexico, osteoporosis also represents a significant burden on the public healthcare system. Approximately one in twelve women and one in twenty men over the age of 50 will experience a hip fracture, which is the most common fracture type. These fractures cause a considerable decline in daily functionality, increasing dependency and the need for long-term care, specialized medical attention, and are associated with a significant increase in both in-hospital and out-of-hospital morbidity and mortality. In 2018 alone, the total cost of fragility fractures in four Latin American countries (Brazil, Mexico, Colombia, and Argentina) amounted to 1.17 billion US dollars, with the majority of costs covered by the public healthcare sector [3,4].

The presence of osteoporosis is closely linked to the process of bone architecture remodeling, which is regulated by osteoblasts and osteoclasts. During menopause, estrogen deficiency causes an imbalance in this process, favoring osteoclastic activity and increasing bone resorption. This leads to accelerated bone loss, thereby compromising bone strength and structural quality and increasing the risk of fragility fractures. A similar situation occurs in patients undergoing surgical procedures in which both ovaries are removed for prescribed medical conditions, resulting in a generalized suppression of ovarian estrogen production [5].

It is imperative to deepen the study and understanding of the frequency of risk factors in populations, enabling the timely identification of predictors of osteoporosis and the establishment of secondary prevention measures, significantly reducing the incidence of fractures and substantially improving the quality of life of affected individuals.

The objective of this study is to determine the frequency of risk factors associated with osteopenia and osteoporosis in women from a public hospital in Quintana Roo, Mexico.

2. Materials and Methods

A descriptive, observational, and cross-sectional study was conducted. The study population consisted of women treated at the Regional General Hospital No. 17 of the Mexican Social Security Institute (IMSS) in Cancún, Quintana Roo.

The sample size was calculated using the formula for proportions in infinite populations, considering an expected prevalence of 50% for the presence of risk factors associated with osteopenia and osteoporosis, with a 95% confidence level, a 5% margin of error, and a statistical power of 94%. An initial sample size of 267 subjects was estimated; considering an expected loss rate of 15%, the sample was adjusted to a total of 314 participants. However, 311 women who met the established criteria were ultimately included.

Inclusion criteria were women between 45 and 60 years of age with a densitometric diagnosis of osteopenia or osteoporosis. Exclusion criteria included women younger than 45 or older than 60 years, those with a history of fractures due to high-impact trauma, diagnosis of secondary osteoporosis due to another pathology, as well as those who refused to complete the questionnaire or withdrew from undergoing bone densitometry. Patients who presented with three or more fractures, fractures related to motor vehicle accidents, or who declined to respond to the survey after giving consent were removed from the analysis.

Once the protocol was approved by the institutional ethics committee, women identified during a bone densitometry screening campaign were invited to participate. Each participant was informed about the study's objective and importance, and written informed consent was obtained prior to the administration of the questionnaire and the bone densitometry examination.

A questionnaire was designed to identify the main risk factors associated with low bone mass, including: age, hormonal status (pre- or postmenopausal), personal history of fracture, family history of osteoporosis, presence of chronic diseases (diabetes mellitus, hypertension, obesity), smoking, alcohol consumption, habitual intake of caffeinated beverages, educational level, previous use of steroids, and gynecological surgical history such as bilateral salpingo-oophorectomy.

Subsequently, densitometric evaluation was performed using dual-energy X-ray absorptiometry (DXA) of the calcaneus. The T-score value was used for classification of bone status, according to

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World Health Organization criteria: normal bone mass (T ≥ –1.0), osteopenia (–2.5 < T < –1.0), and osteoporosis (T ≤ –2.5) (15).

Anthropometric variables —weight (kg) and height (cm)— were measured following standardized techniques in order to calculate the body mass index and its possible association with bone mineral status.

3. Results

A total of 311 patients were analyzed, distributed according to various sociodemographic and clinical factors. Regarding educational level, most participants had completed secondary school (36.0%), followed by high school (25.1%) and primary school (18.3%). Only a small percentage had professional studies (15.8%) or postgraduate education (0.6%), and 2.9% had no formal education. This distribution suggests a tendency toward medium educational levels, which may influence knowledge about bone health, prevention, and timely treatment.

With respect to age, 77.8% of the patients were over 45 years old, an age group with a higher risk of bone loss and a greater incidence of comorbidities such as diabetes and hypertension. This finding is consistent with the pathophysiology of osteoporosis, in which advanced age is one of the main risk factors.

Among the clinical risk factors identified, diabetes mellitus (31.2%) and hypertension (34.3%) were the most frequent comorbidities. Smoking (14.5%) and alcoholism (15.8%), both recognized as factors that negatively affect bone metabolism, were also prevalent in the population. Systemic steroid use was reported in 9.1% of patients, which is clinically relevant due to its adverse effect on bone mineral density. Only 28.2% of participants reported engaging in regular physical exercise, indicating a significant opportunity for preventive intervention.

A total of 16.1% had a history of hysterectomy with bilateral salpingo-oophorectomy, which can contribute to estrogen loss and, consequently, to osteoporosis (Table 1).

Table 1. Frequency of factors.

			IC 95%	
Variable Name	n	%	**Lower**	**Upper**
Education				
None	9	2,9	1,3	5,1
Primary school	57	18,3	13,7	22,6
Secondary school	**112**	**36,0**	**31,1**	**41,5**
High school	78	25,1	20,6	29,6
Bachelor's degree	49	15,8	11,8	19,9
Master's degree	2	0,6	0,0	1,6
Age				
<45 years	69	22,2	17,7	26,7
>45 years	242	77,8	73,3	82,3
Positive smoking history	45	14,5	11,2	18,7
Positive alcohol consumption	49	15,8	11,9	19,7
Positive diabetes mellitus	97	31,2	26,4	35,8
Positive hypertension	106	34,3	28,4	39,2
Positive systemic steroid use	28	9,1	5,9	12,7
Positive history of hypertension + bilateral salpingo-oophorectomy	50	16,1	11,3	20,4

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Regular exercise (Yes)	87	28,2	23,3	34,1

Note: [IC95% min – max]

A statistically significant difference was observed in the mean age between patients with a densitometric diagnosis of osteoporosis (59.56 ± 10.60 years) and those without osteoporosis (49.88 ± 10.68 years), with a p-value of 0.000. This indicates that patients with osteoporosis tend to be significantly older, reinforcing the role of age as a determining factor in the development of the disease (Table 2).

Table 2. Comparison of age and presence of Osteoporosis.

	Positive Osteoporosis	Negative Osteoporosis	p-value +
Mean age	59.56 ± 10.60 [57.35 – 62.50]	49.88 ± 10.68 [48.40 – 51.19]	0.000

Note: ± Standard Deviation [95% CI min – max] + Independent samples t-test

A significant negative correlation was found between age and T-score ($r = -0.519$, $p < 0.01$), which implies that the higher the age, the lower the bone mineral density. This result aligns with the pathophysiology of bone aging, which is exacerbated by the presence of comorbidities, where bone remodeling mechanisms are altered, favoring a net loss of bone mass. The magnitude of the correlation can be considered moderate, suggesting that age partially explains the variability in the T-score, but other factors also play a role (Table 3).

Table 3. Correlation between group T-score and age.

	Age	T-score	Pearson Correlation
Mean	52.06 ± 11.39 [50.72 – 53.31]	-1.69 ± 0.95 [0.85 – 1.044]	-0.519** p = 0.000

Unless otherwise indicated, the self-reported results are based on 311 bootstrap samples.

*** The correlation is significant at the 0.01 level (two-tailed).*

BMI was compared, and it was found that in the group of patients with a densitometric diagnosis of osteoporosis, the body mass index was lower (27.18 ± 5.15 kg/m²) compared to the group without such a diagnosis (29.22 ± 5.82 kg/m²). The comparison of means using Student's t-test showed a statistically significant difference ($p = 0.012$). The data are consistent with an inverse association between BMI and the presence of osteoporosis; in other words, BMI values are relatively lower and occur more frequently in individuals with osteoporosis (Table 4).

Table 4. Correlation between group BMI and diagnosis of osteoporosis and osteopenia.

	Diagnosis	BMI (Mean) ± SD	p-value +
Mean	Osteoporosis	27.18 ± 5.15	~0.012
	Osteopenia	29.22 ± 5.82	

Note: ± Standard Deviation [95% CI min – max] + Independent samples t-test

A multivariate analysis using logistic regression was performed to identify independent factors associated with the diagnosis of osteoporosis. The only factor that showed a statistically significant

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association was age, with an odds ratio (OR) of 6.44 (95% CI: 2.23–18.60, p = 0.001), suggesting that older patients are more than six times as likely to have osteoporosis compared to younger patients.

None of the other variables (diabetes, hypertension, steroid use, bilateral hysterectomy, physical exercise, smoking, or alcohol consumption) showed a statistically significant association with osteoporosis in this model. This could be attributed to various factors, such as sample size, collinearity between variables, or the intensity of exposure.

The model presented a Cox and Snell R^2 of 0.073, indicating that it explains approximately 7.3% of the variability in the diagnosis of osteoporosis, suggesting that other factors not included in the model also contribute to the development of the disease (Table 5).

Table 5. Regression model for independent factors of osteoporosis.

		CI for Exp(B)		
Variable	**Exp(B)**	**Lower**	**Upper**	**p-value**
Age	6.44	2.23	18.60	0.001
Diabetes Mellitus	1.61	0.89	2.91	0.110
Arterial Hypertension	0.97	0.53	1.77	0.941
Steroid Therapy	0.99	0.37	2.65	0.996
History of hysterectomy with bilateral salpingo-oophorectomy	1.14	0.54	2.41	0.718
Lack of Exercise	1.42	0.74	2.71	0.289
Smoking	0.67	0.28	1.59	0.370
Alcohol Consumption	1.53	0.71	3.31	0.274
Constant	0.02	—	—	0.000

Model Summary: -2 log likelihood = 301.138[a], Cox and Snell R^2 = 0.073

a. Estimation terminated at iteration number 5 because parameter estimates changed by less than .001.

4. Discussion

This study evaluated the frequency and relevance of various risk factors associated with osteopenia and osteoporosis in women treated at the General Regional Hospital No. 17 of the IMSS in Cancún, Quintana Roo. The findings obtained are consistent with the existing literature, confirming that advanced age is the main independent risk factor associated with osteoporosis.

The mean age of patients with a densitometric diagnosis of osteoporosis was significantly higher than that of those without this diagnosis (59.56 years vs. 49.88 years, respectively), a statistically significant result ($p < 0.001$). This association is supported by previous studies that emphasize the importance of age as a key factor in the progressive decrease in bone mineral density (BMD), mainly due to hormonal changes typical of menopause and the generalized aging of bone [1,5].

A moderate, significant negative correlation between age and densitometric T-score ($r = -0.519$, $p < 0.001$) was also identified, reinforcing the idea that aging is a central determinant in the pathophysiology of osteoporosis by influencing the progressive alteration of bone metabolism and the deterioration of bone structural quality [8,9].

Regarding other evaluated risk factors, although their prevalence was considerable (diabetes mellitus 31.2%, arterial hypertension 34.3%, smoking 14.5%, alcoholism 15.8%, and steroid use 9.1%), no statistically significant association was found in the multivariate logistic regression model. These results partially contrast with previous evidence indicating that chronic conditions such as diabetes and hypertension may have direct or indirect effects on bone quality, particularly through chronic inflammatory mechanisms, oxidative stress, or adverse effects of prolonged treatments [6,7,9].

Recent research has highlighted the importance of addressing prevalent conditions such as diabetes mellitus, essential arterial hypertension, excessive alcohol and tobacco consumption, sedentary lifestyle, and specific nutritional deficiencies—particularly calcium and vitamin D. These

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conditions contribute to the progressive deterioration of bone quality and significantly increase the risk of osteoporotic fractures [6].

In the specific case of type 2 diabetes mellitus, which is gaining importance due to its rising incidence in middle-aged and older populations, various studies have clearly documented its association with a higher incidence of osteoporosis and fractures. This is attributed not only to the decrease in bone mineral density but also to alterations in bone quality induced by complex metabolic mechanisms, including the accumulation of advanced glycation end-products, chronic oxidative stress, and the involvement of inflammatory cytokines such as IL-6, TNF-α, and CRP, which significantly impair bone matrix formation [7].

Likewise, essential hypertension has also been identified as a condition frequently associated with a higher prevalence of osteoporosis. It has been observed that hypertensive patients present significantly lower bone mineral density compared to healthy subjects, a finding particularly evident in older women. This phenomenon appears to be linked both to shared lifestyle factors and the direct effect of certain antihypertensive medications on bone metabolism, with calcium ions playing an important role [9].

Additionally, recent studies have placed special attention on the importance of oxidative stress and ferroptosis, a regulated form of iron-dependent cell death, in the pathogenesis of postmenopausal osteoporosis. Research has shown that postmenopausal estrogen deficiency promotes iron accumulation in bone cells, inducing osteocyte cell death through ferroptosis. This triggers increased osteoclastic activity and a marked acceleration of bone mineral loss, leading to greater bone fragility [8].

The limited association of other factors such as smoking and alcohol consumption also contrasts with multiple international studies documenting their negative impact on bone mass. However, this finding could be attributed to specific characteristics of the sample or underreporting of these factors due to reporting bias.

The low prevalence of regular exercise (28.2%) among participants highlights an important opportunity for non-pharmacological preventive interventions. Numerous studies emphasize the effectiveness of regular physical activity in improving BMD, reducing bone loss, and preventing osteoporotic fractures [11]. Therefore, promoting physical activity could represent a valuable strategy for the prevention and comprehensive management of this disease in this specific population.

The lack of statistical significance for these factors could be due to limitations related to sample size, possible collinearity between variables, or variability in the intensity and duration of exposure to the analyzed risk factors. Nevertheless, these factors should not be clinically underestimated, given their potential cumulative impact on bone health as suggested by recent international literature [7,10].

Furthermore, the importance of regular physical exercise as a fundamental preventive and therapeutic strategy for osteoporosis has been highlighted. Different exercise modalities, particularly weight-bearing activities, have been shown to significantly increase bone mineral density through continuous bone remodeling, improve bone biomechanics, and reduce fracture risk in both young and older adults. These physical interventions promote osteoblastic activity, demonstrating their relevance as an effective non-pharmacological measure to prevent and treat osteoporosis [11].

In populations such as that of Quintana Roo, which represents a cosmopolitan population with inhabitants from all over the country, there is a clear variation in the presentation of osteopenia and osteoporosis of almost a decade. We also observed that patients have a progressive deficit that is not diagnosed in a timely manner and that no interventions are carried out to prevent deterioration. This leads us to recommend the need to implement awareness and training programs aimed at women and the empowerment of their health for two important reasons. The first is that populations worldwide have a male-to-female ratio of approximately 1:1, and in some cases, the female population is greater, which, in projection, means that this problem—representing a challenge in Latin American countries with potentially non-aged populations—will become an unsustainable situation for health systems and for patients and their families within 30 years. In 2023 alone, the estimated average cost of a hip fracture requiring surgical management was 123,689 Mexican pesos.

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The second reason is that first- and second-level health systems must incorporate programs aimed at the prevention of osteoporosis immediately and not merely establish screening measures.

5. Conclusions

In conclusion, this study confirmed that advanced age is the most important and significant risk factor for the development of osteoporosis in women from the analyzed population. Although other evaluated risk factors showed high prevalence, they did not reach statistical significance as independent predictors of osteoporosis in this specific model. Nonetheless, from a clinical and preventive perspective, it remains essential to comprehensively consider these factors in primary and secondary prevention programs, especially in women over 45 years of age, with the aim of reducing the incidence of osteoporosis and associated fractures, improving quality of life, and decreasing the social and economic burden derived from this disease.

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Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

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