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(RESEARCH ARTICLE)

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An assessment of the probability of patients experiencing bone pain for early prioritization to the rehabilitation clinic

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Abstract

Background: As a result of DEXA and risk factor-based evaluation, which rank patients according to their osteoporosis risk, risk assessment instruments such as the Osteoporosis Self-assessment Tool, Risk Assessment Instrument, and Simple Calculated Risk Estimation were created.

Aims: In two phases, the precision of evaluation instruments will be assessed: pre-test, post-test, and pre-diagnostic DEXA will be utilised to determine the accuracy of the assessment tools and pre-test, respectively.

Methods: From September to November 2021, this study examines osteoporosis patients at Prince Rashid bin Al-Hasan Military Hospital in Jordan. Bayes' theorem and osteoporosis screening methodologies are utilised to calculate the post-test probability of patients. Evaluation of AUROC and performance metrics will be conducted utilising a ROC curve. The term of the investigation is 2021-2021.

Results: The gender distribution of the 206 patients examined in the study was 5.87:1. AUCs SEMs for the binary logistic regression models incorporating independent variables (OST, ORAI, and BAQ) varied in response to the probability of FRAX≥3% versus <3%. FRAX% exhibited the following sensitivity indices: 0.02, 75%, 41.36%, 66.36%, and 41.03%. The innovative quotient (BAQ), which represents the ratio of body weight to age, had respective pre-test probabilities of 0.789±0.033, 0.484±0.042, and 0.254±0.037.

Conclusion: The research examined the probability of BLR_BAQ after the test was conducted using OST and ORAI references. Significant AUROCs were observed for all three osteoporosis instruments; however, the performance of the post-test probabilities for FRAX≥3% of the BLR_BAQ model was subpar, as evidenced by both the standards and ORAI inference.

Keywords: Osteoporosis assessment tools; Probability; Absorptiometry; Bone mineral density

1. Introduction

Healthcare providers commonly employ pre-tested assessment instruments in clinical practice to identify patients who are susceptible to developing osteoporotic fractures. The Osteoporosis Risk Assessment Instrument (ORAI) and the

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Osteoporosis Self-Assessment Tool (OST) are two frequently employed instruments. In this context, it is customary to employ a Dual X-Ray Absorptiometry (DEXA) in conjunction with pertinent medical histories, demographic information, and anthropometric measurements of the patients as dependable assessment instruments. Furthermore, recent advancements in biochemical testing are also considered [1-2]

In light of the fact that every diagnostic procedural test, regardless of radiological or non-radiological nature, has unique advantages and disadvantages, it is critical to choose the most beneficial diagnostic test for every individual patient. The primary application of Dual Energy X-ray Absorptiometry (DEXA), which is also referred to as bone densitometry, is the detection of osteoporosis. Two narrow x-ray beams are utilised in this procedure, angled at a 90° degree, to image the patient's heel (calcaneum), lower back (lumbar spine), or hip (specifically the head of the femur). One of the peaks emitted by the beam is absorbed by soft tissue unrelated to bones, whereas the other is absorbed by tissue unrelated to bones. [3-4]

In mathematical terms, the operation of deducting the absorption attributed to soft tissues from the total absorption can be likened to the determination of the mineral density of bone. Using reference values, this measurement is subsequently normalised in order to derive T and Z-scores. Recent years have seen an increase in the popularity of DEXA procedures as a dependable, practical, beneficial, and economical alternative, especially for elderly patients undergoing menopause and taking bone-loss medications. DEXA is a non-invasive, risk-free diagnostic method renowned for its substantial negative predictive value. Consequently, it is notably advantageous in excluding an elevated susceptibility to osteoporotic fractures. [5-6]

Over a ten-year period, the Fracture Risk Assessment Tool (FRAX) has been recognised as a more logical and practicable approach to determining the likelihood of vertebral and non-vertebral osteoporotic fractures. The FRAX questionnaire comprises elements that are relevant to the density and quality of bone. Healthcare professionals may implement the FRAX calculator to evaluate the fracture risk of a particular patient as an integral component of their clinical decision-making process. [7-8]

In order to ascertain eligibility for DEXA scans, the Osteoporosis Risk Assessment Instrument (ORAI) and the Osteoporosis Assessment Tools (OST) may be employed as pre-test predictors. By implementing this intervention, the volume of women undergoing screening can be significantly reduced, leading to a more efficient allocation of resources towards individuals who have higher risk profiles. Age, denoted in years, and body weight, in kilogrammes, are the two variables that exert an adverse influence on both of these evaluation instruments. In addition, oestrogen is presently employed in ORAI as opposed to OST. If the OST score is equal to or greater than +1, or if the ORAI score is equal to or greater than 9, bone densitometry should be performed. [9-10]

The ability of a diagnostic test to modify the initial probability that a patient has a particular condition is what determines its efficacy. The test should ideally either elevate the probability to a greater degree, thereby validating the diagnosis, or reduce it to an extent that permits the exclusion of the condition. Therefore, it is crucial to accurately assess the atypical OPF in order to efficiently allocate patients to the diagnostic procedure that provides the greatest expected clinical benefit. By calculating the pre-test probability (PTP) of a disease, OPF patients with a higher risk can be prioritised. The purpose of this research was to assess the degree to which the theoretical probability of our BMD-based BLR model differed from that of two reputable references, OST and ORAI.

2. Materials and methods

A retrospective observational investigation was undertaken at Prince Rashid bin Al-Hasan Military Hospital, which is affiliated with the Royal Medical Services, in Irbid, Jordan. Metastasis to the bone and renal or non-renal metabolic osteodystrophy are among the exclusion criteria. The assessment of overall functionality was conducted using the Functionality Grade system, whereas the burden of co-existing medical conditions was determined using the Age-adjusted Charlson Co-Morbidity Index (AACCI). In order to gather the data, Dual-emission X-ray absorptiometry (DEXA) examinations were performed on the anteroposterior spine and proximal femoral hip of the participants. From these scans, the Hip and Lumbar T and Z-Scores were derived.

In order to assess the degree of correlation, the proportion of total variations in the dependent variable that can be explained by the independent variables, and the accuracy of dependent variable prediction, the Binary Logistic Regression Test was executed. Between September 2021 and November 2021, a Binary Logistic Regression analysis was conducted on the Osteoporosis self-Assessment Tool (OST), the Osteoporosis Risk Assessment Instrument (ORAI), and a Body Weight to Age Quotient (BAQ) based on Binary Logistic Regression for Jordanian patients who attended the rehabilitation clinic at Prince Rashid bin Al-Hasan Military Hospital, Royal Medical Services, Irbid/Jordan.

The objective of the analysis was to ascertain the correlation between the aforementioned factors and the 10-year probability of hip osteoporotic fracture (OPF), as classified by the Fracture Risk Assessment Tool (FRAX) as 3% (indicating a positive state) or less than 3% (indicating a negative state). Greater evidence supports a positive actual state is indicated by higher values of the ORAI tested variable, while lower values of the OST and BLR_BAQ tested variables indicate the opposite. In order to determine the area under the receiver operating characteristic (ROC) curves (AUROCs) for the Osteoporosis self-assessment Tool (OST), Osteoporosis Risk Assessment Instrument (ORAI), and our investigated Binary Logistic Regression based body weight to age quotient (BAQ), ROC analysis was conducted.

Patients were categorised into two separate groups according to their Fracture Risk Assessment Tool (FRAX) scores, which indicated the likelihood of developing a hip osteoporotic fracture within a decade. Cohort I comprised individuals whose FRAX scores were below 3%, whereas Cohort II comprised individuals whose FRAX scores were equal to or exceeded 3%. The statistical analysis of the comparative variable data between the two cohorts under investigation was conducted utilising the Chi-Square Test, with a predetermined significance level of $p < 0.05$. The findings were presented in the form of numerical values and percentages. An alternative term for the measure of associations was odds ratios (OR). In order to determine the Pearson chi-square statistic (χ 2), the square root of the discrepancy between the expected and observed frequencies is utilised. The logarithm of the ratio between two likelihoods is employed by the G-Test of independence, which is alternatively referred to as the Goodness of Fit, to evaluate the extent to which observed frequencies correspond to their expected values. The correlations, expressed as value± standard error of value, were represented ordinal by ordinal (Spearman, ρ) and interval by interval (Pearson, r).

The post-test probability was calculated for each patient utilising Bayes' theorem, denoted as $P(A|B) = [P(B|A) \times P(A)] / P(B)$. P(A|B) denotes the post-test probability in relation to the pre-test probability (P(A)), while P(B) signifies the probability ascertained through the test employed. The statistical analysis was performed utilising version 25.0 of the Statistical Package for the Social Sciences (SPSS) software. The predetermined level of statistical significance was 5%.

3. Results

Around 53.398% of the 206 patients who underwent testing were allocated to Cohort I, comprising 110 patients, whereas 46.601% of the examined patients were allotted to Cohort II, comprising 96 patients.

In this investigation, the gender distribution was as follows: 5.87 females to 1 male. Furthermore, no statistically significant distinctions were observed between Cohort I and Cohort II (5.47:1 and 6.38:1, respectively; · 2=0.588, p=0.698; 0.857 (95% CI: 0.393-1.870), -0.027±0.069. There are no statistically significant differences between the two cohorts, as shown by the results.

The following describes the binary logistic regression models for the three independent variables (OST, ORAI, and BAQ) in relation to the likelihood of FRAX≥3% as opposed to ≥3%: The following are the respective values: e (-0.152-0.246×OST)/[1+ e (-0.152-0.246×OST)], e (-1.778+0.128×ORAI)/[1+ e (-1.778+0.128×ORAI)], and e (1.810-1.886×BAQ)/[1+ e (1.810-1.886×BAQ)].

The area under the curve (AUC) and standard error of the mean (SEM) for the three prognosticators assessed in comparison to the probability of FRAX≤3% versus ≤3% were as follows: 0.690±0.038 (95% confidence interval [CI]: 0.616-0.763), 0.660±0.040 (95% CI: 0.582-0.738), and 0.697±0.038 (95% CI: 0.624-0.771), respectively.

In contrast, the previously specified predictors' sensitivity indices for FRAX% were as follows: (41.03%), (0.02, 75%, 41.36%, 66.36%, and 41.03%); (8.50, 100%, 41.35%, 41.35%, and 34.73%); and (1.0250, 77.1%, 38.90%, 61.82%, and 63.79%). These indices comprise the optimal thresholds, sensitivities, specificities, as well as positive and negative predictive values.

The following were the outcomes of comparing the initial likelihood and ultimate likelihood of our innovative quotient (body weight to age quotient, BAQ) when both the ORAI and OST were considered: Comparatively, 0.789±0.033 (95% CI: 0.725-0.852) is lower than 0.254±0.037 (95% CI: 0.182-0.327) and 0.484±0.042 (95% CI: 0.401-0.567).

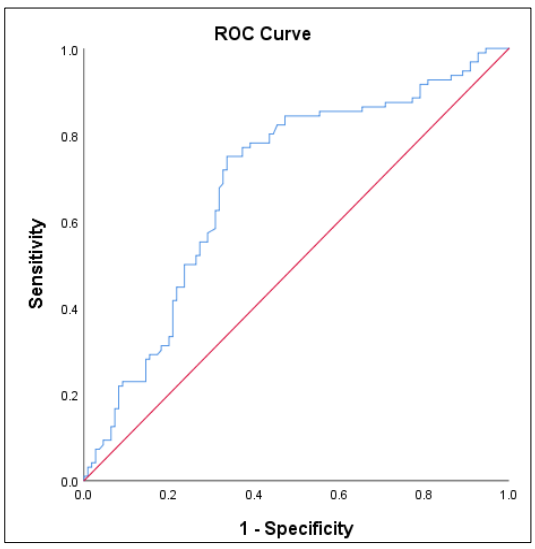
The information obtained from all of the results was presented in their entirety in Tables 1 through 4 and Figures 1 through 5.

Table 1 The Binary Logistic Regression analyses for the Jordanian patients who attended the rehabilitation clinic at Prince Rashid bin Al-Hasan Military Hospital, Royal Medical Services, Irbid/Jordan, between September 2021 and November 2021

Tested predictors	B±SEM	Wald	Sig	Exp (B)	95% C.I.for EXP(B)		χ^2 (df)	Variation range	%Cases
					Lower	Upper			
FRAX≥3% vs <3%	e (-0.152-0.246×OST)/ [1+ e (-0.152-0.246×OST)]								
OST (-20 to +20)	-0.246±0.059	17.607	.000	0.782	0.697	0.877	(8) 16.080	(9.6%-12.8%)	64.6%
Constant	-0.152±0.147	1.068	.301	0.859					
FRAX≥3% vs <3%	e (-1.778+0.128×ORAI)/ [1+ e (-1.778+0.128×ORAI)]								
ORAI (0-26)	0.128±0.034	14.453	0.000	1.136	1.064	1.213	(7) 99.459	(8.3%-11.1%)	65.1%
Constant	-1.778±0.439	16.412	0.000	0.169					
FRAX≥3% vs <3%	e (1.810-1.886×BAQ)/ [1+ e (1.810-1.886×BAQ]								
BLR_BAQ	-1.886±0.591	10.190	0.001	0.152	0.048	0.483	(8) 27.167	(6.1%-8.1%)	65.5%
Constant	1.810±0.615	8.664	0.003	6.109					

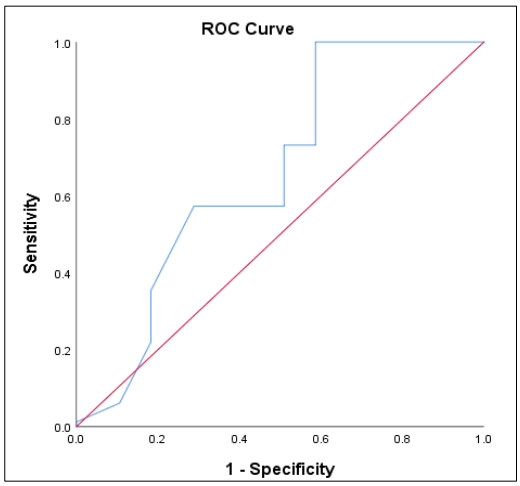
ORAI: Osteoporosis Self-Assessment Tool; OST: Osteoporosis Risk Assessment Instrument; BAQ: Body weight to age quotient; FRAX: Fracture Risk Asesment Tool; BLR_BAQ" Binary logistic regression for our proposed body to age quotient

The Binary Logistic Regression Test was employed to examine the strength of correlations, the extent to which the independent variables account for the overall variability in the dependent variable, and the accuracy of the dependent variable prediction.



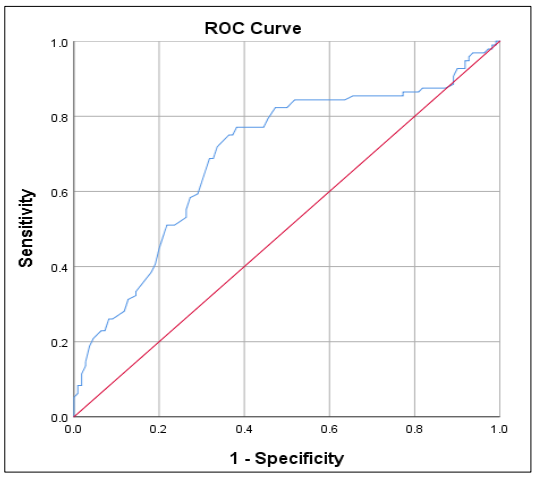
OST	
Positive	96
Negative	110
Missing	3

AUC±SEM	p-Value
0.690±0.038 (95% CI; 0.616-0.763)	0.000



ORAI	
Positive	82
Negative	104
Missing	23

AUC±SEM	p-Value
0.660±0.040 (95% CI; 0.582-0.738)	0.000



BLR_BAQ	
Positive	96
Negative	110
Missing	3

AUC±SEM	p-Value
0.697±0.038 (95% CI; 0.624-0.771)	0.000

Figure 1 The area under the receiver operating characteristic curve analysis

ORAI: Osteoporosis Self-Assessment Tool; OST: Osteoporosis Risk Assessment Instrument; BAQ: Body weight to age quotient; FRAX: Fracture Risk Asesment Tool; BLR_BAQ" Binary logistic regression for our proposed body to age quotient

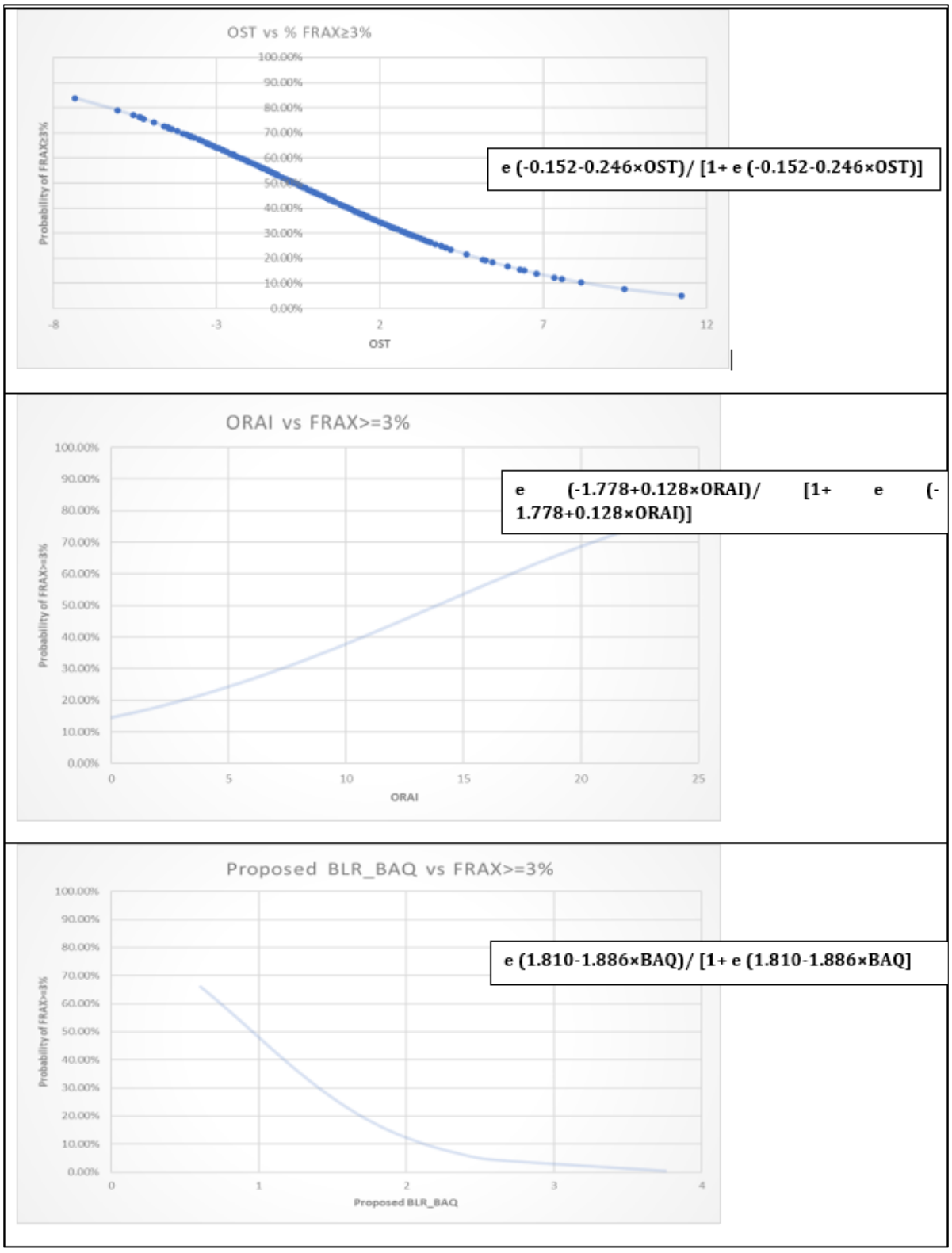


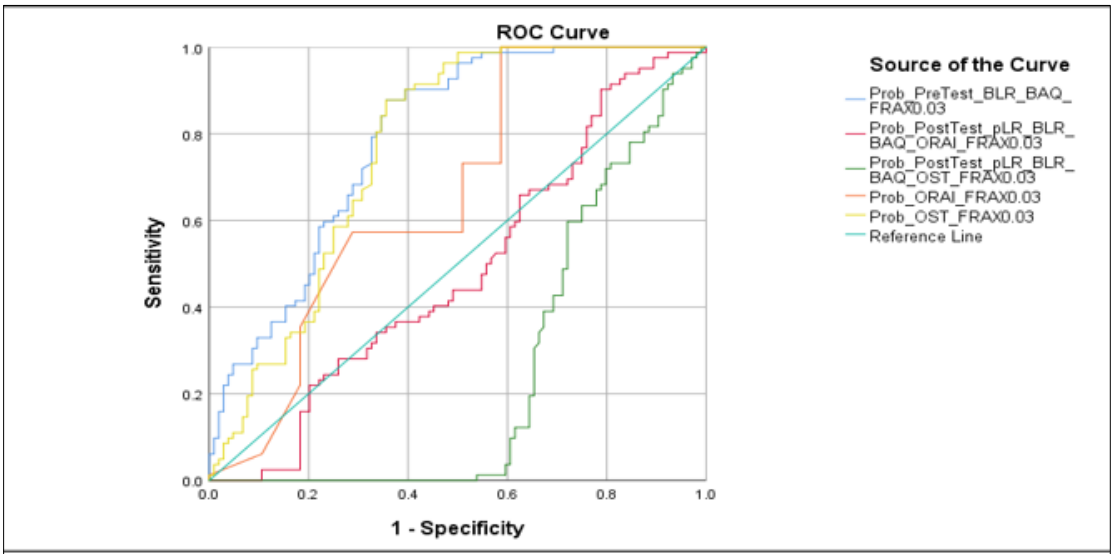
Figure 2 The Binary Logistic Regression diagrams

ORAI: Osteoporosis Self-Assessment Tool; OST: Osteoporosis Risk Assessment Instrument; BAQ: Body weight to age quotient; FRAX: Fracture Risk Asessment Tool; BLR_BAQ" Binary logistic regression for our proposed body to age quotient

Table 2 The optimal cut-off points, sensitivities, specificities, positive and negative predictive values, likelihood ratios, and Youden and accuracy indices

Prognostic Indicator	Cutoff	TPR	FPR	YI	TNR	PPV	NPV	NLR	PLR	AI
OST (-20-20)	0.02	75%	33.6%	41.36%	66.36%	41.03%	89.48%	37.67%	222.97%	68.42%
ORAI (0-26)	8.50	100%	58.7%	41.35%	41.35%	34.73%	100.0%	0.00%	170.49%	55.30%
BLR_BAQ	1.0250	77.1%	38.2%	38.90%	61.82%	63.79%	75.56%	37.07%	201.88%	68.93%

TPR: True positive rate (sensitivity); FPR: False positive rate; YI: Youden index; TNR: True negative ratio (specificity).NLR: Negative likelihood ratio; PPV: Positive predictive value; NPV: Negative predictive value; AI: Accuracy index; PLR: Positive likelihood ratio.



Tested variables	AUROC±SEM	P-Value
Prob_ORAI	0.660±0.040 (95% CI; 0.582-0.738)	0.000
Prob_OST	0.767±0.035 (95% CI; 0.698-0.835)	0.000
Prob_PreTest_BLR_BAQ	0.789±0.033 (95% CI; 0.725-0.852)	0.000
Prob_PostTest_pLR_BLR_BAQ_ORAI	0.484±0.042 (95% CI; 0.401-0.567)	0.710
Prob_PostTest_pLR_BLR_BAQ_OST	0.254±0.037 (95% CI; 0.182-0.327)	0.000

Figure 3 The area under the receiver operating characteristic (ROC) curves

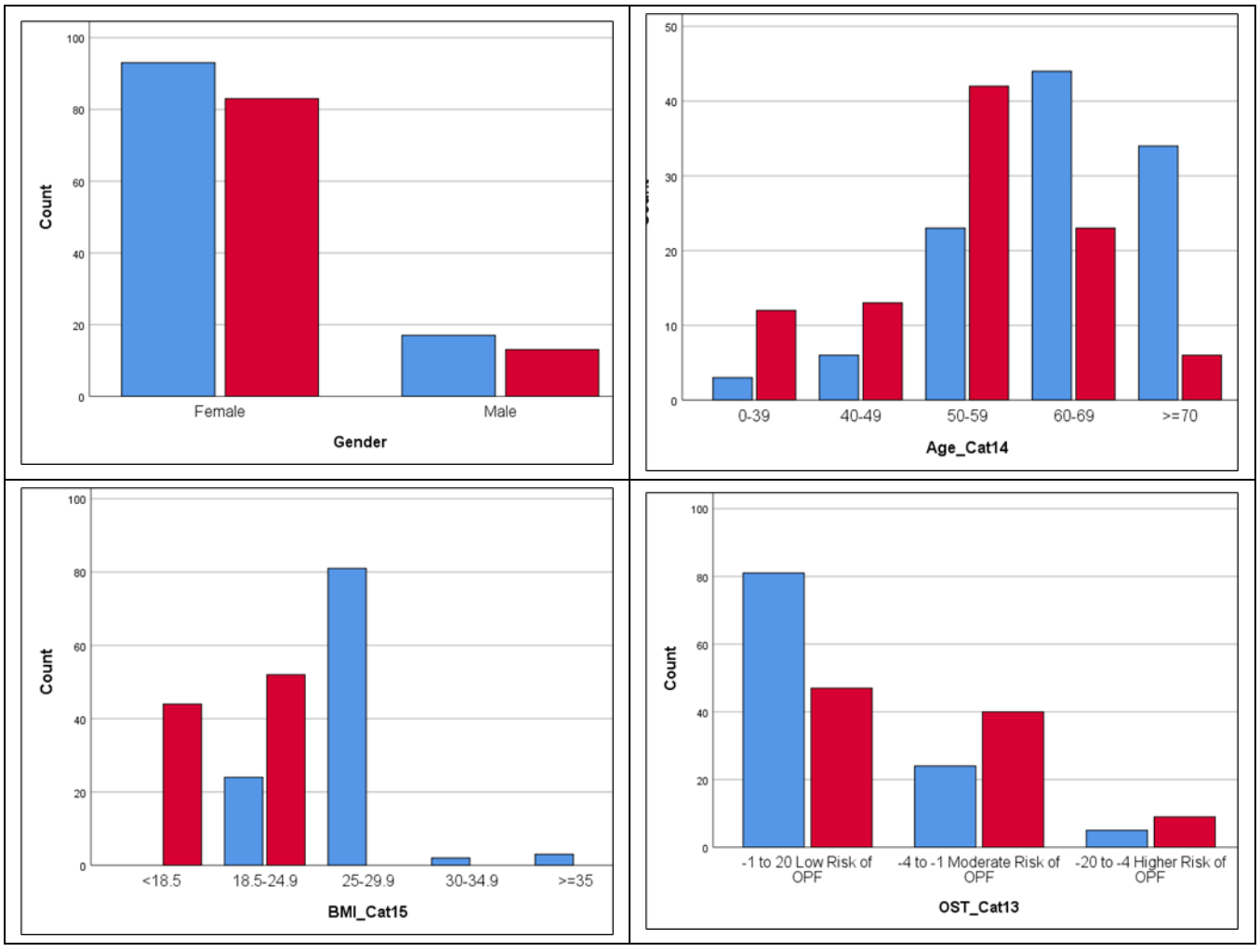
ORAI: Osteoporosis Self-Assessment Tool; OST: Osteoporosis Risk Assessment Instrument; BAQ: Body weight to age quotient; BLR_BAQ" Binary logistic regression for our proposed body to age quotient

Table 3 The variables that were compared between Cohort I and Cohort II

	Cohort I [FRAX<3%] (110, 53.398%)	**Cohort II [FRAX≥3%] (96, 46.601%)**	**Total (206, 100%)**	**OR**	**R P**	**χ 2 G-Test**	**p-Value**
Gender							
Female	93 (84.5%)	83 (86.5%)	176 (85.4%)	0.857 (95% CI; 0.393-1.870)	-0.027± .069* -0.027±0.069*	0.151 0.151	0.698 0.697
Male	17 (15.5%)	13 (13.5%)	30 (14.6%)				
Female: Male	5.47: 1	6.38: 1	5.87: 1				
Age (Yrs)							
0-39	3 (2.7%)	12 (12.5%)	15 (7.3%)	NA	-0.413±0.058* -0.429±0.059*	38.943 41.436	0.000 0.000
40-49	6 (5.5%)	13 (13.5%)	19 (9.2%)				
50-59	23 (20.9%)	42 (43.8%)	65 (31.6%)				
60-69	44 (40.0%0	23 (24.0%)	67 (32.5%)				
>=70	34 (30.9%)	6 (6.3%)	40 (19.4%)				
BMI (Kg/m2)							
<18.5	0 (0.0%)	44 (45.8%)	44 (21.4%)	NA	-0.773±0.024* -0.813±0.021*	140.011 189.829	0.000 0.000
18.5-24.9	24 (21.8%)	52 (54.2%)	76 (36.9%)				
25-29.9	81 (73.6%)	0 (0.0%)	81 (39.3%)				
30-34.9	2 (1.8%)	0 (0.0%)	2 (1.0%)				
≥35	3 (2.7%)	0 (0.0%)	3 (1.5%)				
OST (-20-20)							
Low risk (-1-20)	81 (73.6%)	47 (49.0%)	128 (62.1%)	NA	0.238±0.067* 0.251±0.067*	13.284 13.390	
Moderate risk (-4- -1)	24 (21.8%)	40 (41.7%)	64 (31.1%)				
High risk (-20- -4)	5 (4.5%)	9 (9.4%)	14 (6.8%)				
BLR vs OST							
Under-Estimation	34 (30.9%)	55 (57.3%)	89 (43.2%)	0.333 (95% CI; 0.188-0.591)	-0.266±0.067* -0.266±0.067*	14.541 14.682	0.000 0.000
Over-Estimation	76 (69.1%)	41 (42.7%)	117 (56.8%)				
ORAI (0-26)							

Low risk (0-8)	43 (41.3%)	0 (0.0%)	43 (23.1%)	NA	0.415±0.057* 0.412±0.060*	44.376 60.378	
Moderate risk (9-15)	42 (40.4%)	53 (64.6%)	95 (51.1%)				
High risk (16-25)	19 (18.3%)	29 (35.4%)	48 (25.8%)				
BLR vs ORAI							
Under-Estimation	26 (25.0%)	21 (25.6%)	47 (25.3%)	0.968 (95% CI; 0.498-1.884)	-0.007±0.073 -0.007±0.073	0.009 0.009	0.924 0.924
Over-Estimation	78 (75.0%)	61 (74.4%)	139 (74.7%)				

OST: The Osteoporosis self-Assessment Tool; BLR: Our constructed Binary Logistic Regression model; ORAI: The Osteoporosis Risk Assessment Instrument; BMI: Body mass index in Kg per m2; FRAX: Fracture Risk Assessment Tool.



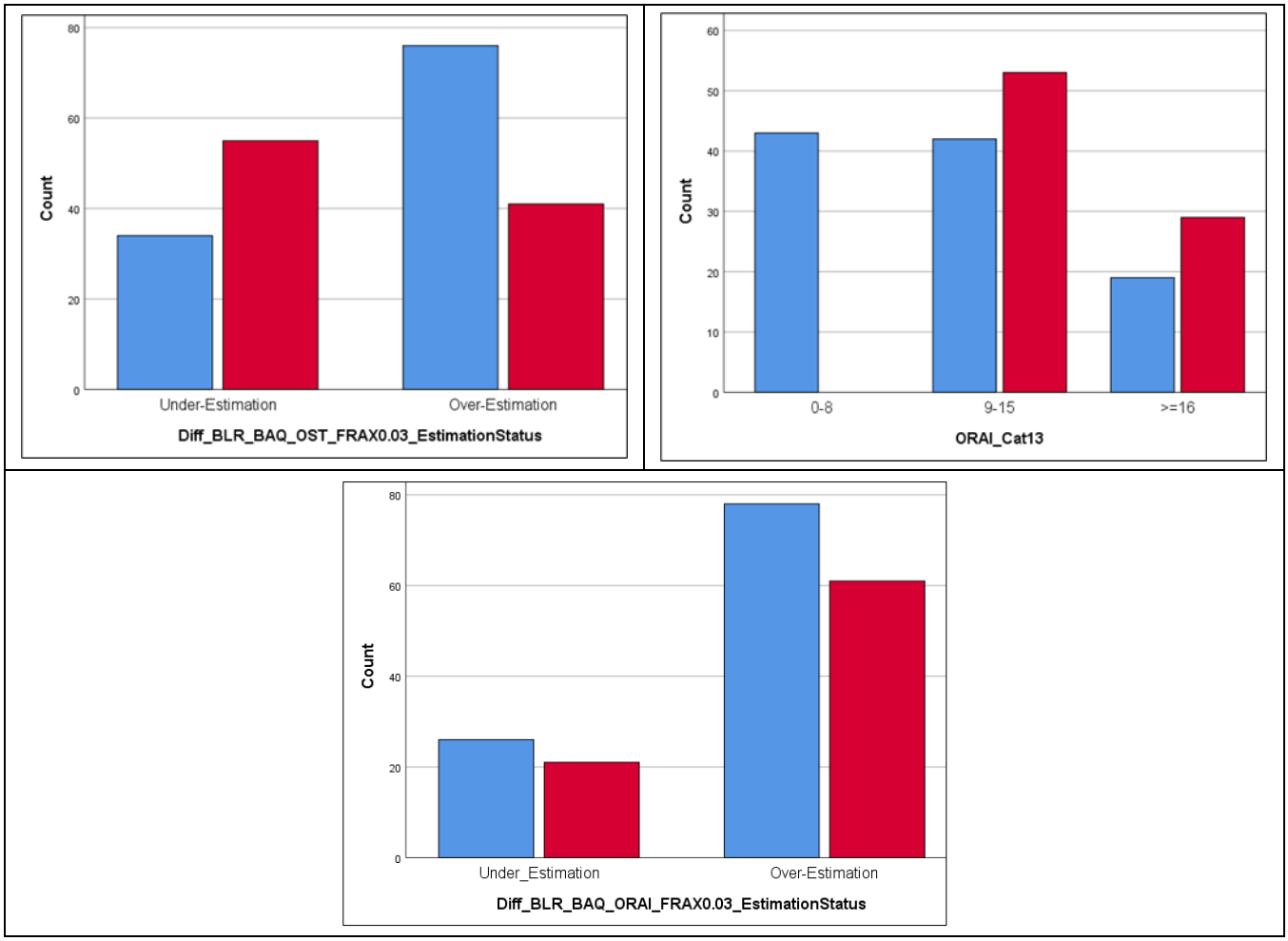


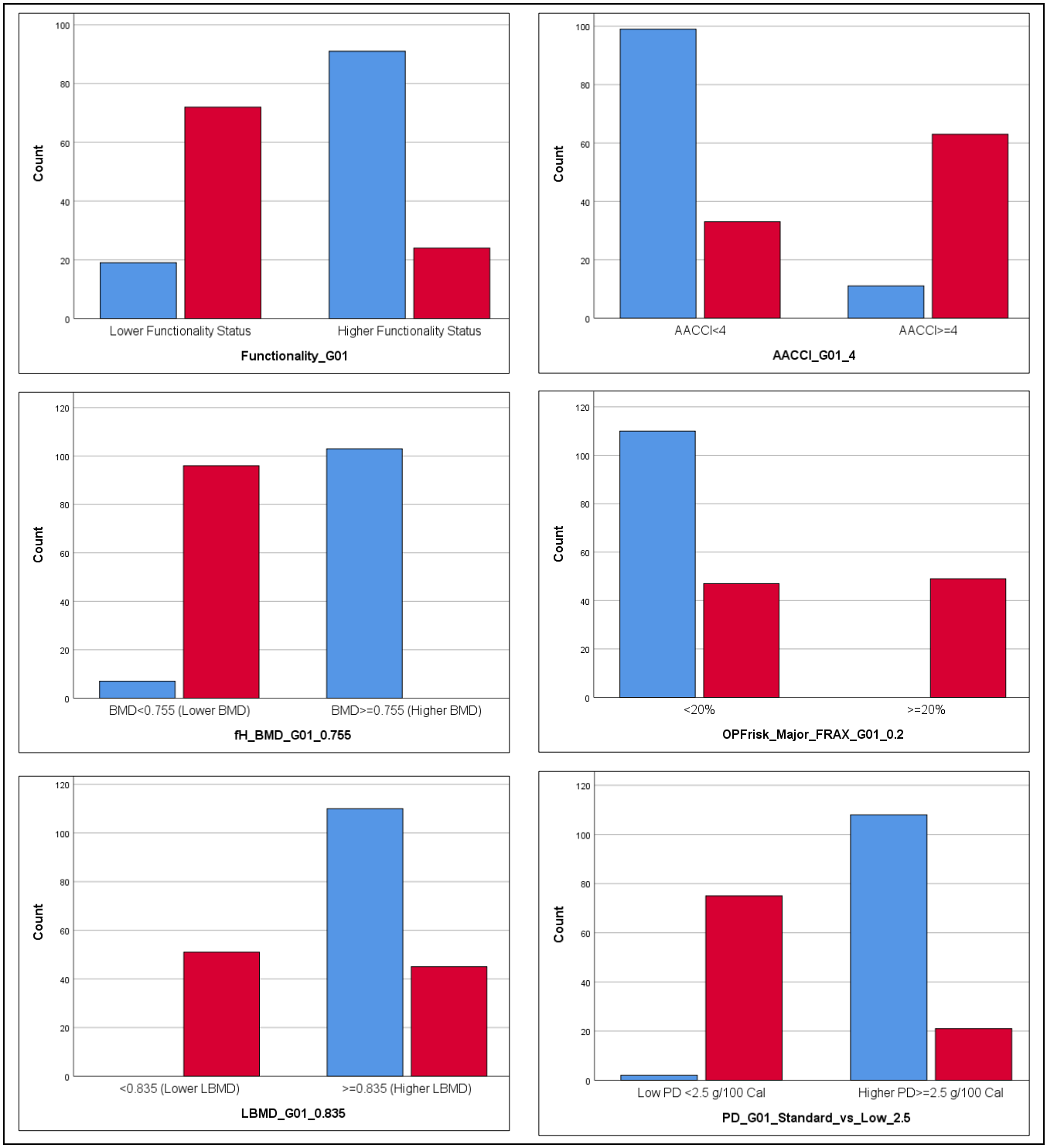
Figure 4 Bar chart representations of the patients analysed in Cohorts I-II;

Table 4 The variables that were compared between Cohort I and Cohort II

	Cohort I [FRAX<3%] (110, 53.398%)	**Cohort II [FRAX≥3%] (96, 46.601%)**	**Total (206, 100%)**	**OR**	**R ρ**	**χ^2 G-Test**	**p-Value**
Functionality status							
Lower	19 (17.3%)	72 (75.0%)	91 (44.2%)	0.070 (95% CI; 0.035-0.137)	-0.580±0.057*	69.271	0.000
Higher	91 (82.7%)	24 (25.0%)	115 (55.8%)		-0.580±0.057*	73.565	0.000
ACCI							
<4	99 (90.0%)	33 (34.4%)	132 (64.1%)	17.182 (95% CI; 8.10-36.444)	0.578±0.055*	68.907	0.000
≥4	11 (10.0%)	63 (65.6%)	74 (35.9%)		0.578±0.055*	73.955	0.000
fH_BMD (g/cm^2)							

<0.755	7 (6.4%)	96 (100.0%)	103 (50.0%)	0.068 (95% CI; 0.033-0.139)	-0.934±0.024*	179.782	0.000
≥0.755	103 (93.6%)	0 (0.0%)	103 (50.0%)		-0.934±0.024*	233.468	0.000
Major OPF							
FRAX<20%	110 (100.0%)	47 (49.0%)	157 (76.2%)	0.299 (95% CI; 0.236-0.380)	0.598±0.041*	73.669	0.000
FRAX≥20%	0 (0.0%)	49 (51.0%)	49 (23.8%)		0.598±0.041*	92.983	0.000
LBMD (g/cm^2)							
<0.835	0 (0.0%)	51 (53.1%)	51 (24.8%)	3.444 (95% CI; 2.693-4.406)	-0.614±0.041*	77.665	0.000
≥0.835	110 (100.0%)	45 (46.9%)	155 (75.2%)		-0.614±0.041*	97.868	0.000
PD (g/100 Cal)							
<2.5	2 (1.8%)	75 (78.1%)	77 (37.4%)	0.005 (95% CI; 0.001-0.023)	-0.787±0.039*	127.520	0.000
≥2.5	108 (98.2%)	21 (21.9%)	129 (62.6%)		-0.787±0.039*	151.453	0.000
FVC							
Intermittent	0 (0.0%)	21 (21.9%)	21 (10.2%)	2.467 (95% CI; 2.072-2.937)	-0.361±0.040*	26.794	0.000
Regular	110 (100.0%)	75 (78.1%)	185 (89.8%)		-0.361±0.040*	34.822	0.000
HTN							
No	101 (91.8%)	0 (0.0%)	101 (49.0%)	11.667 (95% CI; 6.247-21.79)	0.916±0.026*	172.933	0.000
Yes	9 (8.2%)	96 (100.0%)	105 (51.0%)		0.916±0.026*	223.198	0.000
Anti-HTN							
CCBs	0 (0.0%)	33 (34.4%)	33 (31.4%)	NA	-0.390±0.081*	18.685	0.002
CCBs+BBs	0 (0.0%)	27 (28.1%)	27 (25.7%)		-0.362±0.068*	18.805	0.002
CCBs+ACEIs or ARBs	2 (22.2%)	12 (12.5%)	14 (13.3%)				
CCBs+Thiazide	3 (33.3%)	17 (17.7%)	20 (19.0%)				
BBs+ACEIs or ARBs	3 (33.3%)	6 (6.3%)	9 (8.6%)				
ACEIs or ARBs+Thiazide	1 (11.1%)	1 (1.0%)	2 (1.9%)				

ACCI: Age-adjusted Charlson Comorbidity Index; HTN: Hypertensive status; Anti-HTN: Anti-hypertensive medications; CCBs: Calcium channel blockers; BBs: Beta-Blockers; fH_BMD: Femoral hip bone mineral density in g per cm2; FRAX: Fracture risk assessment tool; LBMD: Lumbar bone mineral density; OPF: Osteoporotic fracture; FVC: Fruit vegetables consumption pattern; ACEIs: Angiotensin converting enzyme inhibitors; ARBs: Angiotensin receptor blockers; PD: Protein density in gram per 100 Cal.


Count
Lower Functionality Status
Higher Functionality Status
Functionality_G01
Count
AACCI<4
AACCI>=4
AACCI_G01_4
Count
BMD<0.755 (Lower BMD)
BMD>=0.755 (Higher BMD)
fH_BMD_G01_0.755
Count
<20%
>=20%
OPFrisk_Major_FRAX_G01_0.2
Count
<0.835 (Lower LBMD)
>=0.835 (Higher LBMD)
LBMD_G01_0.835
Count
Low PD <2.5 g/100 Cal
Higher PD>=2.5 g/100 Cal
PD_G01_Standard_vs_Low_2.5

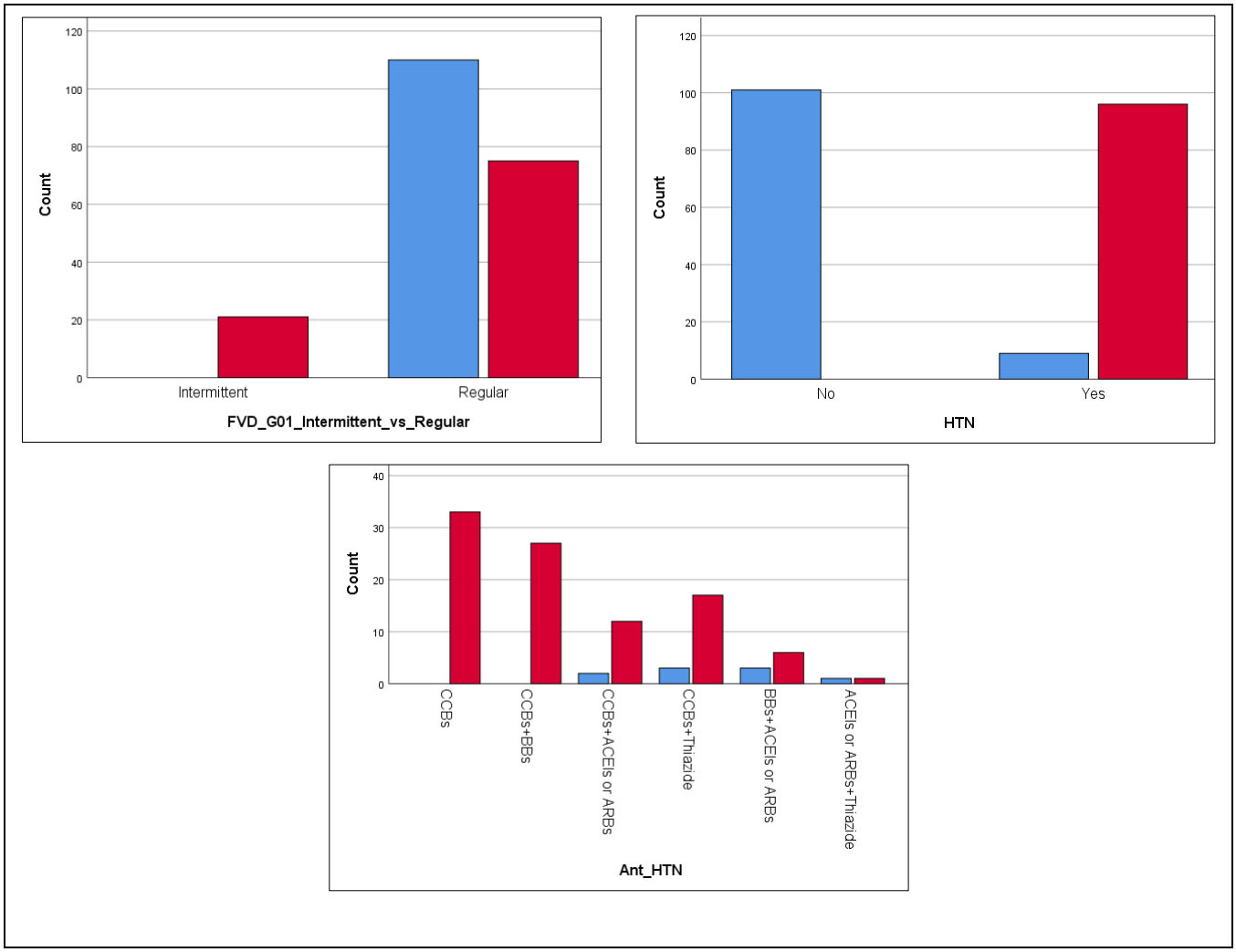


Figure 5 Bar chart representations of the patients analysed in Cohorts I-II; individuals **Discussion**

Osteoporosis screening methods encompass the utilisation of straightforward questionnaires to evaluate risk factors including advanced age, ethnic heritage, body mass index, and hormone replacement therapy usage. These methods successfully mitigate the concerns associated with high costs and restricted availability of apparatus. Fracture Risk Assessment Tools, including WEIGHT, SCORE, ABONE, ORAI, OSTIRIS, OPERA, MOST, MORES, and others, are employed to identify women who have osteoporosis and low bone mineral density (BMD). [11-12]

It is essential to observe, nevertheless, that MORES is intended exclusively for males. Additionally, fracture risk estimation instruments like FRAX and fracture scores are available. The focus of the research is the development of instruments for assessing bone mineral density (BMD) in postmenopausal women. WEIGHT (1996), SCORE (1998), ABONE (2000), ORAI (2000), OSTA (2001), OSIRIS (2002), OPERA (2004), MORES (2007), and MOST (2010) comprise the set of instruments. Women who weighed more than 71 kg were found to have a decreased probability of developing osteoporosis in comparison to those who weighed less than 64 kg, according to WEIGHT (1996). [13-14]

Six variables were utilised in the SCORE (1998) model: age, weight, race, rheumatoid arthritis (RA), fracture history, and oestrogen therapy utilisation. A questionnaire was utilised by ABONE (2000) to assess the factors associated with osteoporosis. Baseline data from the Canadian Multicenter Osteoporosis Study, which was carried out in Ontario, were utilised by ORAI (2000). OSTA (2001) collected information from a sample of 860 Asian women residing in eight countries who had attained menopause. [15-16]

The research A comprehensive analysis of risk factors linked to osteoporosis was undertaken by OSIRIS (2002), which documented a notable prevalence of the condition. The data utilised in the OPERA (2004) investigation came from a cohort of 1,522 Italian women aged 50 and above who had completed menopause. MORES (2007) employed risk factor data in their research to ascertain males who are at a heightened risk of developing osteoporosis. [17]

The MOST study, which was undertaken in 2010, investigated the correlation between clinical risk factors and low bone mineral density (BMD) in 586 healthy women aged 45 and older. A comparative analysis was undertaken to determine the efficacy of six osteoporosis risk assessment instruments (SCORE, ORAI, ABONE, BMOS, MOST, OSTA) in Malaysian postmenopausal women for the purpose of osteoporosis screening. The outcomes demonstrated varying degrees of sensitivity and specificity, with SCORE outperforming the other instruments. Utilising less complex instruments may result in improved usability, according to the study. FRAX was initiated by the University of Sheffield in 2008. This instrument computes the 10-year risk of significant osteoporotic fractures and hip fractures in untreated patients aged 40 to 90. Clinical risk factors and bone mineral density (BMD) are utilised in the computation of these figures. It has undergone verification in 26 distinct groups and is accessible via the DXA software and the internet. FRAX, a clinical instrument utilised for the evaluation of fracture risk, possesses specific constraints. The aforementioned concerns encompass restricted applicability to patients who have undergone treatment, doubts surrounding the extent of errors that may occur, and an absence of validation pertaining to bone mineral density (BMD) measurements. An important diagnostic instrument for identifying osteoporosis, vertebral fracture assessment (VFA) increases the risk of subsequent fractures, especially in the hip. Vertical force analysis (VFA) and bone mineral density (BMD) evaluation may be performed simultaneously. [18-20]

Our research findings indicate that the predictors for FRAX% possess sensitivity indices of 0.02, 8.00, and 1.0250. These indices encompass positive and negative predictive values, optimal thresholds, sensitivities, and specificities. When both ORAI and OST were taken into account, the initial probabilities of the innovative quotient (BAQ, body weight to age quotient) were 0.789±0.033, 0.484±0.042, and 0.254±0.037, respectively.

4. Conclusion

The post-test probability of the BLR_BAQ under investigation was calculated using two distinct references: the OST and the ORAI. Significant AUROCs±SEMs were observed for the three osteoporosis instruments that were compared, namely the OST, ORAI, and the pre-test BLR_BAQ. The post-test probabilities for FRAX≥3% of our constructed BLR_BAQ exhibited suboptimal performance (AUROC<0.5) for both the OST and ORAI references, with the underperformance being insignificant in the case of ORAI inferential.

Compliance with ethical standards

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Disclosure of conflict of interest

There is no conflict of interest in this manuscript.

Statement of ethical approval

There is no animal/human subject involvement in this manuscript.

Statement of informed consent

Owing to the retrospective design of this study, the informed consent form was waived.

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