Evaluating an AI software for Opportunistic Low Bone Mineral Density and Osteoporosis Screening: A Validation Study

Milin Patel BHSc[1]; Angela Auriat PhD[1,2]; Richard Aviv MD PhD [1,2].
1.Department of Radiology, Radiation Oncology and Medical Physics, Faculty of Medicine, University of Ottawa, Canada
2.The Ottawa Hospital Research Institute, Ottawa, Canada

Introduction

- The detection of **low bone mineral density (BMD)** is key to early diagnosis and management of osteoporosis (1).
- In Canada, less than 20% of osteoporosis-related fracture patients undergo a diagnostic test or receive adequate treatment for osteoporosis, highlighting a significant gap in healthcare delivery (2). This issue is exacerbated in **marginalized populations**.
- **DEXA scans** are considered the clinical gold standard for measuring BMD, their implementation is limited (3).
- **X-rays** are a part of routine clinical practice and are **widely available** including in marginalized communities.
- **Rho** is a Health Canada and FDA authorized Software-as-a-Medical-Device (SaMD) that can **interface** with standard X-rays to identify patients at **increased risk** of low bone density (4). This technology can increase screening at a population level and specifically in communities challenged by DXA access.

Hypothesis

The goal of this study was to independently validate the Rho software in a real world setting by evaluating its performance against DXA gold standard in a retrospective cohort of patients served by our institution.

Methods

- Retrospective study of 4,878 patients at the Ottawa Hospital over the age of 50 with DEXA acquired within 1 year of lumbar spine, thoracic spine, chest, pelvis, hand/wrist, or knee radiograph between January 1, 2013 - December 31, 2022.
- The area under the curve was calculated to evaluate the performance of Rho in identifying patients at risk for low BMD (T-Score<-1) and osteoporosis (T-Score<=-2.5).

Results

Table 1. AUC and optimal Rho Score thresholds for low BMD and osteoporosis in total dataset.

Low BMD						
	Number of Datapoints			AUC (95% CI)	Optimal Rho Score Cutpoint (95% CI)	p-value
Analysis group	Total	Low BMD	Normal BMD			
Entire Study	9925	7449	2476	0.840 (0.831-0.848)	6 (6-6)	
By x-ray Locations						
Chest	1718	1326	392	0.829 (0.806-0.850)	7 (6-7)	**<.0001**
Hand	1437	1118	319	0.791 (0.763-0.819)	6 (6-6)	**<.0001**
Knee	2500	1819	681	0.805 (0.787-0.823)	6 (6-6)	**<.0001**
Lumbar	1135	866	269	0.858 (0.833-0.882)	6 (6-6)	**0.0171**
Pelvic	2649	1938	711	0.892 (0.879-0.905)	6 (6-6)	*Reference*
Thoracic	486	382	104	0.855 (0.820-0.889)	7 (7-8)	0.0523
Osteoporosis						
	Number of Datapoints			AUC (95% CI)	Optimal Rho Score Cutpoint (95% CI)	p-value
Analysis group	Total	Osteoporosis	No Osteoporosis			
Entire Study	9925	2506	7419	0.815 (0.806-0.824)	7 (7-8)	
By x-ray Locations						
Chest	1718	499	1219	0.794 (0.771-0.815)	8 (7-8)	**<.0001**
Hand	1437	318	1119	0.764 (0.734-0.791)	7 (7-8)	**<.0001**
Knee	2500	540	1960	0.785 (0.763-0.805)	7 (7-7)	**<.0001**
Lumbar	1135	333	802	0.822 (0.796-0.846)	7 (7-7)	**0.0002**
Pelvic	2649	661	1988	0.876 (0.862-0.889)	8 (8-8)	*Reference*
Thoracic	486	155	331	0.800 (0.759-0.843)	8 (8-9)	**0.0005**

a) Overall **AUC** for predicting **low BMD** was **0.840** (95% CI: 0.831-0.848).
b) Overall **AUC** for **predicting osteoporosis** was **0.815** (95% CI: 0.806-0.824).

Table 2. AUC and the optimal Rho Score thresholds for low BMD and Osteoporosis in males and females.

Low BMD						
	Number of Datapoints			AUC (95% CI)	Optimal Rho Score Cutpoint (95% CI)	p-value
Analysis group	Total	Low BMD	Normal BMD			
Male	1987	1325	662	0.848 (0.830-0.865)	5 (5-5)	0.2576
Female	7938	6124	1814	0.836 (0.827-0.847)	6 (6-6)	
Osteoporosis						
	Number of Datapoints			AUC (95% CI)	Optimal Rho Score Cutpoint (95% CI)	p-value
Analysis group	Total	Osteoporosis	No Osteoporosis			
Male	1987	467	1520	0.833 (0.813-0.852)	6 (6-7)	0.2458
Female	7938	2039	5899	0.820 (0.810-0.830)	8 (8-8)	

a) The AUC for Rho performance was **consistently high** (>0.80) in both men and women

Results

Table 3. AUC and the optimal Rho Score thresholds for Low BMD and osteoporosis in rural and urban communities.

Low BMD						
	Number of Datapoints			AUC (95% CI)	Optimal Rho Score Cutpoint (95% CI)	p-value
Analysis group	Total	Low BMD	Normal BMD			
Urban	9394	7081	2313	0.837 (0.828-0.846)	6 (6-6)	**0.0341**
Rural	531	368	163	0.873 (0.839-0.902)	6 (5-6)	
Osteoporosis						
	Number of Datapoints			AUC (95% CI)	Optimal Rho Score Cutpoint (95% CI)	p-value
Analysis group	Total	Osteoporosis	No Osteoporosis			
Urban	9394	2371	7023	0.812 (0.802-0.821)	8 (7-8)	**0.0025**
Rural	531	135	396	0.865 (0.829-0.897)	7 (7-8)	

a) The AUC for Rho performance was **consistently high** (>0.80) in the rural and urban groups.
b) AUC was **higher** for **rural** versus urban groups for both low BMD and for osteoporosis screening (p = 0.03 and 0.003).

Conclusion

- **Rho demonstrated high diagnostic** performance in identifying patients at risk for low BMD and osteoporosis.
- The findings support Rho as an opportunistic screening tool and may **fill a clinical gap in marginalized communities** lacking access to DXA.
- Integration of AI tools such as Rho into standard routine practice can increase screening at a broader level.

References

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