



Review Article

Diagnostic devices for osteoporosis in the general population: A systematic review



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ABSTRACT

Introduction: A diagnostic gap exists in the current dual photon X-ray absorptiometry (DXA) based diagnostic approach to osteoporosis. Other diagnostic devices have been developed, but no comprehensive review concerning the applicability of these diagnostic devices for population-based screening have been performed.

Material and methods: A systematic review of Embase, Medline and the Cochrane Central Register for Controlled Trials was performed for population-based studies that focused on technical methods that could either indicate bone mineral density (BMD) by DXA, substitute for DXA in prediction of fracture risk, or that could have an incremental value in fracture prediction in addition to DXA. Quality of included studies was rated by QUADAS 2.

Results: Many other technical devices have been tested in a population-based setting. Five studies aiming to indicate BMD and 17 studies aiming to predict fractures were found. Overall, the latter studies had higher methodological quality. The highest number of studies was found for quantitative ultrasound (QUS). The ability to indicate BMD or predict fractures was moderate to minor for all examined devices, using reported area under the curve (AUC) of Receiver Operating Characteristic curves values as standard.

Conclusions: Of the methods assessed, only QUS appears capable of perhaps replacing DXA as standalone examination in the future whilst radiographic absorptiometry could provide important information in areas with scarcity of DXA. QUS may be of added value even after DXA has been performed. Evaluation of proposed cutoff-values from population-based studies in separate population-based cohorts is still lacking for most examination devices.

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Contents

1.	Introduction	59
2.	Materials and methods	60
2.1.	Studies	60
2.2.	Interventions.	60
2.3.	Comparison	60
2.4.	Outcomes	60
2.5.	Search strategy and flow	60
2.6.	Assessment of methodological quality and data abstraction	60
3.	Results	60
3.1.	Identification of studies	60
3.2.	General characteristics of included studies to predict osteoporosis.	61
3.3.	General characteristics of included studies to predict fractures	61
3.4.	Overall quality and effect measure of included studies	61

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3.5.	Quantitative ultrasound (QUS)	62
3.5.1.	Diagnostic use: QUS for indication of BMD by DXA	62
3.5.2.	Prognostic use: QUS for prediction of fractures	62
3.5.3.	Quantitative ultrasound for fracture risk assessment when BMD by central DXA is already known	62
3.6.	Phalangeal radiographic absorptiometry (RA) and forearm peripheral DXA	63
3.6.1.	Diagnostic use: phalangeal radiographic absorptiometry or forearm peripheral DXA for indication of BMD by DXA	63
3.7.	Prognostic use: phalangeal radiographic absorptiometry or forearm peripheral DXA for prediction of fractures	63
3.7.1.	Phalangeal radiographic absorptiometry or peripheral DXA for fracture risk assessment when BMD by central DXA is already known	63
3.8.	Calcaneal single or dual X-ray absorptiometry	63
3.8.1.	Diagnostic use: calcaneal single or dual X-ray absorptiometry for indication of BMD by DXA	63
3.8.2.	Prognostic use: calcaneal single or dual X-ray absorptiometry for the prediction of fractures	63
3.8.3.	Phalangeal radiographic absorptiometry or peripheral DXA for fracture risk assessment when BMD by central DXA is already known	63
3.9.	Quantitative computed tomography (QCT)	63
3.9.1.	Diagnostic use: QCT for indication of BMD by DXA	63
3.9.2.	Prognostic use: QCT for prediction of fractures and QCT for fracture risk assessment when BMD by central DXA is already known	64
3.10.	HR-pQCT	64
3.10.1.	Diagnostic use: HR-pQCT for indication of BMD by DXA	64
3.10.2.	Prognostic use: HR-pQCT for prediction of fractures	64
3.10.3.	HR-pQCT for fracture risk assessment when BMD by DXA is already known	64
3.11.	Dental Panoramic Radiographs (PR)	64
3.11.1.	Diagnostic use: PR for indication of BMD by DXA	64
3.11.2.	Prognostic use: PR for the prediction of fracture risk	64
3.11.3.	PR for fracture risk assessment when BMD by central DXA is already known	64
3.12.	Hand dynamometer	64
3.12.1.	Diagnostic use: hand dynamometer for indication of BMD by DXA	64
3.12.2.	Prognostic use: hand dynamometer for the prediction of fracture risk	64
3.12.3.	Hand dynamometer for fracture risk assessment when BMD by central DXA is already known	64
3.13.	Trabecular bone score (TBS)	64
3.13.1.	Diagnostic use: TBS for indication of BMD by DXA	64
3.13.2.	Prognostic use: TBS for prediction of fracture risk and TBS for fracture risk assessment when BMD by central DXA is already known	64
3.14.	Nontraditional DXA results	66
3.14.1.	Prognostic use: nontraditional or derived DXA results for the prediction of future fractures	66
4.	Discussion	66
	Disclosures	68
	Acknowledgments	68
	Appendix A. Supplementary data	68
	References	68

1. Introduction

Osteoporosis is characterized by low bone mass and micro-architectural deterioration of bone tissue leading to increased risk of fractures [1]. One in three women and one in six men will suffer at least one osteoporotic fracture during their lifetime [2]. The disease is silent until the event of a fracture. Cross-sectional studies have consistently found that osteoporosis is under-diagnosed both in the general population [3] and in high-risk groups [4,5]. The diagnostic gap is further exaggerated by the fact that even in industrialized countries such as the US, examination rates for osteoporosis and prescription of pharmacological therapy for osteoporosis have been declining [6]. Even though Fracure Liasion Services are cost-effective and most likely also cost-saving [7], these coordinated services are lacking in many institutions.

The current gold standard for diagnosing osteoporosis is dual photon X-ray absorptiometry (DXA), defined as bone mineral density (BMD) >2.5 standard deviations below the mean of young reference populations [8]. Fracture risk is inversely related to BMD [9], but as BMD is normally distributed, a much larger proportion of the population has osteopenic BMD values (i.e. in the range from -1 to -2.5 SD) rather than values in the osteoporotic range. Therefore, the majority of fractures occur in the osteopenic group despite a lower individual risk of fracture [10]. Furthermore, the elements of altered bone quality and individual risk of falling, both of which have substantial impact on the risk of fractures [11,12], are not captured by DXA, thus potentially reducing the predictive value of an examination. Finally, DXA is not universally available in all countries or healthcare systems. Therefore, the search for other tools capable of either differentiating patients at high risk of

future osteoporotic fractures or alternatively identifying the same high risk groups as DXA by employing simpler, more accessible methods is ongoing and could help narrow the diagnostic gap in osteoporosis. Previously, we performed a systematic review of the fracture risk prediction of different algorithms based on clinical risk factors, finding that more complex algorithms did not perform better than simpler ones [13]. Recently, reviews of selected technical equipment designed to be used as an alternative or adjunct to DXA have been performed [14–16]. Though interesting, most comparisons of technical devices against DXA have been performed in non-population based settings, or by combining population-based with non-population-based studies. This poses a problem as diagnostic performance is critically dependent on the disease prevalence in the evaluated population. Furthermore, different populations have been used as reference populations amongst manufacturers of the same equipment, leading to differences in reported standard deviations [17]. This has further added to the confusion and made the search for a common diagnostic T-score cutoff an act of futility. Finally, the correlation between methodologies cannot be assumed to be independent of artifacts such as osteoarthritis that may have an uneven influence between devices and between measurement sites. Thus, the utility of technical devices for population-based screening for osteoporosis has not been thoroughly addressed.

We aim to provide a systematic review of existing technical methods to indicate DXA-defined osteoporosis, tested in a population-based setting using a properly documented methodology. Specifically we wish to answer three questions: Which technical methods may indicate DXA defined osteoporosis? Which technical methods may substitute for DXA for the prediction of fracture risk? Furthermore, which technical

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