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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.

Contents

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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 manufactures 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 osteoarthrosis 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