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ORIGINAL ARTICLE

Predicting the risk of osteopenia for women aged 40–55 years

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Background/purpose: Osteoporosis has been linked to an increased fracture risk and subsequent mortality in the later life. Previous prediction models have focused on osteoporosis in postmenopausal women; however, a prediction tool for osteopenia is needed. Our objective was to establish a prediction model for osteopenia risk in women aged 40–55 years.
Methods: This was a cross-sectional study. A total of 1350 Taiwanese women aged 40–55 years were recruited from a health checkup center from 2009 to 2010. The main outcome measure was osteopenia ($-1 \geq$ bone mineral density T-score > -2.5).
Results: The Osteoporosis Preclinical Assessment Tool (OPAT) developed in this study was based on variables with biological importance to osteopenia and variables that remained significant ($p < 0.05$) in the multivariable analysis, which include age, menopausal status, weight, and alkaline phosphatase level. The OPAT has a total score that ranges from 0 to 7, and categorizes women into high-, moderate-, and low-risk groups. The predictive ability of the OPAT (area under the receiver operating characteristic curve = 0.77) was significantly better than that of the Osteoporosis Self-assessment Tool for Asians (area under the receiver operating characteristic curve = 0.69). The inclusion of serum total alkaline phosphatase level in the model, which is easy to obtain from routine health checkups, significantly enhanced the sensitivity (McNemar test, $p = 0.004$) for detecting osteopenia in women aged 40–55 years.

Conflicts of interest: The authors have no conflicts of interest relevant to this article.

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Conclusion: Our findings provide an important tool for identifying women at risk of osteoporosis at the preclinical phase.

Introduction

Osteoporosis is a serious global health issue due to the rapid increase in the size of the aging population.[1] Osteoporosis-related fractures have been found to be associated with significant costs, increased morbidity and mortality, reduced quality of life, and loss of independence.[2] Approximately 21% of women aged 50–84 years have osteoporosis, which is three times higher than the prevalence observed in men.[3] In the USA, the prevalence of osteoporosis in postmenopausal women aged $\geq$ 50 years has been found to be 15.8% in non-Hispanic whites, 7.7% in non-Hispanic blacks, and 20.4% in Mexican Americans.[4] Among postmenopausal women, the average bone mineral density (BMD) was found to be highest among African Americans, followed by among Hispanics, native Americans, and Asians.[5] In Taiwan, the prevalence of osteoporosis among women aged $\geq$ 40 years has been estimated at 10.1% and 7.5% based on the BMD of the spine and femoral neck, respectively.[6] Despite the availability of diagnostic tools and treatment protocols, osteoporosis remains underdiagnosed and undertreated.[7] Women reach peak bone mass between the ages of 20 years and 30 years. Then, BMD decreases gradually and continues to decline rapidly after menopause.[8] Therefore, predicting the risk of osteoporosis at an earlier age (e.g., premenopausal) or a preclinical phase (i.e., osteopenia) is crucial for early prevention of osteoporosis.

Current guidelines from the US Preventive Services Task Force recommend that women younger than 65 years be screened for osteoporosis using dual-energy X-ray absorptiometry (DXA) if their 10-year risk of a major osteoporotic fracture is greater than or equal to that of a 65-year-old white woman without additional risk factors.[9] To determine fracture risk, the US Preventive Services Task Force suggests the use of the World Health Organization Fracture Risk Assessment Tool to estimate the 10-year risk of fractures. However, the World Health Organization Fracture Risk Assessment Tool was developed as a fracture risk assessment tool to guide treatment decisions rather than as an osteoporosis risk assessment tool. In addition, after a reduction of medical reimbursements in the USA and Ontario, Canada, a decline in the rate of DXA testing for osteoporosis screening was observed, which may lead to a decrease in the diagnosis and treatment of osteoporosis.[10,11] Therefore, there is a need to develop a valid and cost-efficient predictive tool for identifying women at risk of osteoporosis, who would benefit from a DXA scan at a younger age.

Some risk assessment or prediction tools for osteoporosis have been established previously (Table 1). Factors used to create these tools include weight and age in the Osteoporosis Self-assessment Tool (OST)[12,13] and OST for Asians (OSTA),[13,14] with the further addition of current estrogen therapy in the Osteoporosis Risk Assessment Instrument,[15] estrogen therapy and past history of minimal trauma fractures in the Osteoporosis Index of Risk,[16] and estrogen therapy, race, rheumatoid arthritis, and fracture history in the simple calculated osteoporosis risk estimation.[17] A recent Canadian study used a weight of $\leq$ 70 kg, $\geq$ 1 postmenopausal years, a history of a fragility fracture after the age of 40 years, and an age of $>$ 51 years to predict the risk of low BMD (T-score $<$ −2) in women aged 40–60 years.[18] Other risk factors not included in these prediction tools but known to be related to the risk of osteoporosis include anthropometric measures (e.g., body mass index and waist circumference), calcium and vitamin D supplements, physical inactivity, cigarette smoking, alcohol consumption,[19] low-density lipoprotein cholesterol level,[20] hypertension,[21] and renal dysfunction.[22] Despite the fact that there are several prediction tools for osteoporosis, none has been developed for osteopenia probably because the factors incorporated into previously developed tools are less sensitive for predicting osteopenia. Therefore, a tool that includes easily accessible factors may be a plausible approach to predict the risk of osteopenia.

Current prediction tools (OST, OSTA, Osteoporosis Index of Risk, and simple calculated osteoporosis risk estimation) focus on osteoporosis risk in postmenopausal women.[12,14,15] Some biomarkers (e.g., blood or urine markers) can easily be obtained during routine health checkups and improve the sensitivity in predicting osteoporosis at the preclinical phase (i.e., osteopenia). However, biomarkers are rarely included in the currently available prediction tools. Therefore, this study aimed to develop a simple and accurate prescreening tool for identifying premenopausal and early postmenopausal women (aged 40–55 years) with a high risk of osteopenia via the incorporation of biomarkers. We also compared this tool with the aforementioned existing tools. Our findings provide an important tool for the prediction of osteopenia for women aged 40–55 years and will help facilitate early identification of women who are at a high risk of developing osteoporosis.

Materials and methods

Study population

This cross-sectional study included a total of 1413 Taiwanese women aged 40–55 years who were recruited from the MJ Health Management Institution in Taipei, Taiwan, between October 2009 and August 2010. Each participant completed a self-reported questionnaire and provided a

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