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Menopause and Long-Term Health in Vulnerable Populations

Disparities in osteoporosis care among postmenopausal women in the United States

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ABSTRACT

Osteoporosis and fragility fractures result in significant morbidity and mortality and contribute to substantial healthcare costs. Despite being a treatable disease, osteoporosis remains both underdiagnosed and undertreated in the US general population, with significant disparities in care between non-White and White women. These disparities are evident from screening to post-fracture treatment. Non-White women are less likely to be screened for osteoporosis, to be prescribed pharmacotherapy, or to receive treatment post-fracture; furthermore, the mortality rate after fracture is higher in non-White women. Given existing diagnostic and treatment disparities, additional studies and interventions are needed to optimize the bone health of Asian, Black, Hispanic, and Native American women, and to reduce morbidity and mortality from osteoporosis and fragility fractures.

1. Introduction

Osteoporosis represents one of the leading causes of morbidity and mortality among older adults in the United States (US), and is often associated with decreased quality of life, loss of mobility, and chronic pain [1–3]. Among the eleven million individuals who are affected by osteoporosis in the US, over two-thirds are postmenopausal women, with estimates that one-half of this population will experience an osteoporosis-related fracture during their lifetime [3,4].

However, osteoporosis is both preventable and treatable [5]. To this end, both the United States Preventative Services Task Force (USPSTF) and the National Osteoporosis Foundation (NOF) have broadened their guidelines over the past two decades to include screening of all women $\geq$ 65 years and postmenopausal women $\leq$ 65 years with known risk factors for osteoporosis [4,6]. To minimize financial barriers to screening, Medicare (the US federal program that provides health insurance for adults $\geq$ 65 years) reimburses routine bone mineral density testing every 2 years [2]. Nevertheless, osteoporosis remains both underdiagnosed and undertreated in all populations, with the widest gap noted among non-White women [5]. A 2003 survey of patients with osteoporosis found that 34% of White women who met NOF screening criteria had received a dual-energy X-ray absorptiometry (DXA) scan, compared to 8% of Black women who met these criteria [7]. Although historical data suggest that White women have higher rates of fracture than Asian, Black, and Hispanic women, a study of US Medicare data from 2010 to 2016 found that compared to White women with fragility fractures, Black women with fragility fractures had a higher proportion of femoral and hip fractures, as well as increased risk of mortality and debility one-year after fracture [3,8]. These findings are supported by other studies that show that Black women experience greater mortality risk following fracture compared to White women [3,5,9,10].

There is a growing body of literature calling attention to the severe complications of osteoporosis in non-White populations, and the related need to address screening and treatment disparities. The goal of this review is: (1) to review trends in screening and treatment of osteoporosis among postmenopausal women from underrepresented racial/ethnic

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groups; (2) to explore how established risk factors for osteoporosis may further contribute to noted disparities in diagnosis and treatment; and (3) to identify gaps in the literature needing further study.

2. Disparities in osteoporosis screening

Both USPSTF and NOF guidelines recommend osteoporosis screening for all women aged 65 years and older, as well as younger women with identified risk factors for osteoporotic fracture [4,6]. The American Association of Endocrinology (AACE) recommends clinical assessment for osteoporosis and fracture risk for all postmenopausal women aged 50 years and older [11]. Nonetheless, there is a robust body of literature demonstrating significant racial/ethnic differences in screening rates for osteoporosis despite clear guidelines. An assessment of claims-based data from 1.6 million women nationwide found that Black women were least likely to undergo screening for osteoporosis compared with women of other racial/ethnic backgrounds across the three age brackets that were assessed: 50–64, 65–79 and 80+ years [2]. These differences persisted after adjusting for socioeconomic status, insurance type, medical comorbidities, healthcare utilization, and geographic area. Similarly, fewer Black women were referred for DXA scans (OR 0.71) among a cohort of 1000 Black and White women aged 60 years and older from 1998 to 2009 [12]. As the women included in the study were evaluated at the same primary care sites, possible confounding related to access to care or insurance was reduced. In a third retrospective cohort study of over 35,000 female Medicare recipients in New York, Florida, and Illinois who developed hip fracture(s), Black women were 48% less likely to have undergone prior bone density testing compared to non-Hispanic White women, while Hispanic women were 34% less likely compared to non-Hispanic White women [13]. These findings – particularly of the discrepancy between testing "at risk" Black and White women – have been confirmed by other studies assessing data from the National Health and Nutrition Examination Survey (NHANES), large regional health maintenance organization records, and research from academic and suburban hospitals [5,14–17].

Thus, despite clear recommendations for universal screening of all women $\geq$ 65 years, osteoporosis screening rates are lower among Black women even after adjusting for insurance or access to medical care. Notably, there are fewer studies of osteoporosis screening in uninsured women or those with reduced access to healthcare. Importantly, socioeconomic variables have been reported as independent risk factors for osteoporotic fracture, likely compounding vulnerability among these women [16,18,19]. The reason for these racial and ethnic disparities in screening remains unclear. A retrospective chart review of over 200 Black and White women $\geq$ 65 years of age found that providers were much less likely to mention osteoporosis in the charts of Black patients (OR 0.27, 95% CI), though when referred, Black and White women had similar DXA completion rates [5]. On this front, provider-level factors that may be contributing to screening differences include medical decision-making (i.e. regarding patient life expectancy or perceived risk), communication barriers, discrimination (i.e. implicit vs explicit bias), and lack of knowledge regarding reimbursements for screening [2,12]. On the patient level, individual preferences and beliefs, medical mistrust, and varied adherence to recommended therapies are possible contributory elements to outcome gaps [20]. Nonetheless, there is need for further study of the systems and provider-patient level factors that are contributing to osteoporosis screening disparities among older Black women despite unambiguous screening recommendations.

For women $\leq$ 65 years of age, current guidelines introduce uncertainty into clinical decision-making by reserving screening for patients who are at increased risk of osteoporotic fracture. As stated in the 2005 Surgeon General Report on *Bone Health and Osteoporosis*, however, most of these widely accepted risk factors are based upon studies of primarily older White women [21]. The US Study of Osteoporotic Fractures (SOF), a large multi-site study that occurred between 1986 and 2017,aimed to assess risk factors for osteoporotic fracture among postmenopausal women [22]. SOF's conclusions have informed the most widely used osteoporosis screening tools – yet up until 1997, only White women were included in the analysis due to this patient population having the highest perceived risk. As described below, the lack of comprehensive data assessing other variables that may impact fracture risk among women of different racial/ethnic backgrounds may be contributing to observed disparities in outcomes.

3. Reexamining risk factors for osteoporosis and their impact on health disparities

3.1. Impact of race/ethnicity-based assessments on T-scores, FRAX calculations, and other osteoporosis screening tools

DXA is widely considered the gold standard test for diagnosing osteoporosis, which is defined by a bone mineral density (BMD) 2.5 standard deviations below the mean value for a reference population of young, healthy women (*T*-score ≤ -2.5) [23,24]. Although BMD is a reliable predictor of hip fracture risk within racial/ethnic groups, studies indicate that it does not account for differences in fracture risk *between* these groups, and thus may be an inaccurate predictor of overall fracture risk [8,25]. It is important to note that most, but not all, bone density centers calculate *T*-scores using a young White women database [26], in accordance with International Society for Clinical Densitometry guidelines [11]. The universal application of a White reference database, versus using a race/ethnicity-specific reference database, tends to lead to higher calculated *T*-scores for Black and Hispanic women, and thus reduces the number of Black and Hispanic women who are identified as having osteoporotic *T*-scores. Indeed, the Women's Health Initiative found that osteoporosis predictions based on *T*-scores (calculated from White reference databases) underestimate fracture risk in all racial groups, with the largest magnitude of underestimation in Black women [24].

Other clinical factors can impact fracture risk independently of bone density, and therefore fracture risk calculators have been developed to stratify high-risk patients. In particular, the Fracture Risk Assessment Tool (FRAX), developed in 2008 at the University of Sheffield, represents one of the most ubiquitous osteoporosis screening tools worldwide, with models available in over 60 countries [27]. FRAX's algorithm incorporates twelve independent risk factors for fracture identified in meta-analyses from 2004 to 2005: age, sex, weight, height, femoral neck BMD, prior fragility fracture, parental hip fracture, current tobacco smoking, alcohol use, history of long-term oral glucocorticoid use, rheumatoid arthritis, and other causes of secondary osteoporosis [28]. These risk factors were validated in 11 cohorts in four continents to yield a model that estimates an individual's ten-year probability of major osteoporotic fracture (spine, humerus, wrist or hip) and hip fracture [28–30]. Given variation in fracture incidence with population demographics, the various FRAX calculators are calibrated to regional data on hip fracture and mortality rates [31].

The US-FRAX calculator is notably based on 1989–1992 data from Olmsted County, Minnesota – which was a mostly White and well-educated population – and subsequently updated with 2006 hospital discharge data from non-Hispanic White individuals in the National Inpatient Sample (NIS) [30,32]. Summarily, the FRAX-USA model is based primarily on data from White databases. Nonetheless its calculations have significant clinical consequences for patients of other racial/ethnic backgrounds, as the US-FRAX calculator provides different calculations of fracture risk based on race/ethnicity. These race/ethnicity correction factors were not derived as part of the original FRAX model, but instead represent *fixed* race-based fracture and mortality statistics published from outside datasets that are relatively old [32,33]. As recently reported, holding all other risk factors equal, FRAX computes lower risk of osteoporotic fracture in Black (by a factor of 0.43), Asian (by a factor of 0.50), and Hispanic (by a factor of 0.53) as compared to White women [34]. NOF's treatment guidelines specify

that anti-osteoporosis therapy should be considered in patients with ≥ 20% ten-year fracture risk [6]. Based on the race-correction embedded in the FRAX-USA model, non-White women are much less likely to meet this threshold for consideration of treatment initiation [35]. While it might be argued that lower treatment rates are appropriate based on the epidemiology of fragility fractures in non-White women, it also should be acknowledged that the datasets used to generate these fixed correction factors were external to the FRAX cohorts and may be out of date. Furthermore, significant biologic and cultural variability is present within the given race/ethnicity categorizations, and the categories cannot account for individuals of mixed race [36,37].

Of note, several other osteoporosis screening tools, including the Simple Calculated Osteoporosis Risk Estimation (SCORE) and the Foundation for Osteoporosis Research and Education (FORE), include race in their calculations; however, they still fall short when addressing race differences [12]. A prior study compared the accuracy of SCORE with another screening tool, the Osteoporosis Risk Assessment Instrument (ORAI), among Black and Hispanic women [7]. Ultimately, while the measurement tools were thought to be similarly accurate across all groups of women in the study, SCORE did not identify 70% of Black women with osteoporosis.

3.2. Other risk factors that contribute to disparities in osteoporosis outcomes

Even when DXA is obtained, most fractures occur in patients with BMD values above the threshold to diagnose osteoporosis. Analysis of SOF data showed that among 243 participants who experienced a hip fracture over the 5-year study period, less than half had a *T*-score ≤ − 2.5 at baseline screening [38]. This implies a broad array of additional risk factors to consider for increased fracture risk that may not have been incorporated into screening tools. Racial and ethnic disparities in the prevalence of these comorbidities may further compound the misidentification of fracture risk in non-White populations.

For example, several observational studies have identified type 2 diabetes mellitus and other metabolic disorders as independent risk factors for fracture [39–44]. Despite 5–10% higher BMD in patients with type 2 diabetes, women with type 2 diabetes mellitus have been found to have an over twofold increased risk of fracture, with multifactorial reasons posited, including direct insulin anabolic effects, vascular complications on bone mass, and diabetic neuropathy predisposing to falls [45,46]. Notably, fracture risk calculators such as FRAX underestimate the risk of fracture among patients who have diabetes. [47] Thus, the higher prevalence of type 2 diabetes mellitus among non-White populations may further exacerbate disparities in osteoporosis outcomes [48,49].

Along similar lines, the prevalence of chronic kidney disease (CKD) is higher among Black versus White adults [50]. Patients with CKD are notably at increased risk of developing osteoporosis, and per some reports, have four times higher risk of fracture than the general population [51]. This risk appears to increase with disease progression, as osteoporosis is twice as common in patients with Egfr < 60 mL/min than those with greater filtration [52]. The abnormal metabolism in CKD patients is multifactorial, and is related to secondary hyperparathyroidism, adynamic bone, and Vitamin D deficiency, among other hypothesized mechanisms [51]. The unique pattern of bone loss in CKD is also clinically significant. While CKD is largely characterized by cortical bone loss from the mid-radius, post-menopausal osteoporosis is commonly associated with cancellous bone loss from the axial skeleton [53]. DXA may therefore have less clinical utility in advanced stages of kidney disease. Moreover, as with type 2 diabetes mellitus, FRAX does not include CKD or Egfr in its risk algorithm. The exclusion of these variables as risk factors may thus underestimate fracture risk among populations who are at higher risk of CKD.

4. Disparities in osteoporosis treatment

Black women experience nearly twice greater mortality after sustaining a hip fracture compared to their White counterparts – a paradigm not fully explained by BMD [5,14]. These varying clinical outcomes urge us to examine disparities in osteoporosis treatment once the diagnosis is made. Importantly, osteoporosis pharmacotherapy has been demonstrated to be effective in reducing risk of fracture [54]. There is nonetheless abundant data that Black women who have osteoporosis are less likely to be appropriately treated [12,55–62]. For example, Black women who have been diagnosed with osteoporosis were less likely to be prescribed pharmacotherapy than White women [12]. Analysis of NHANES data from 2005 to 2010 also showed that among individuals ≥ 50 years of age with osteoporosis (either by BMD or self-report), Black women were less likely to receive treatment (including bisphosphonates, selective estrogen receptor modulators, teriparatide, calcitonin, or hormone replacement therapy) than White women or women of other races [60]. Similar findings have been noted with regards to Vitamin D or calcium supplementation [63].

Treatment disparities persist even after an osteoporotic fracture has occurred and remain significant in the post-fracture stage. An analysis of Medicare patients with fragility fracture found that among those who were “attention naïve” - defined as having no testing or pharmacotherapy prior to fracture - about 12% received post-fracture care [64]. This was defined as having bone density testing or pharmacotherapy 6 months after index fracture. Attention naïve patients were more likely to be of non-White background and less likely to receive post-fracture care [64]. These data clearly demonstrate that we have a large osteoporosis treatment gap even among high-risk patients who have sustained prior fractures, and that the treatment gap is even larger for racial/ethnic minority populations.

5. Areas for further study

Our review revealed a paucity of studies exploring osteoporosis screening and treatment data for non-White and non-Black US women. This gap has partly been attributed to the difficulty of sufficiently powering analyses given the relatively smaller population sizes of Asian, Hispanic, and Native American women [2]. In any case, more robust quantitative and qualitative osteoporosis screening information for diverse US populations is needed. From the available literature, it is clear that disparities in screening and treatment are causing clinically significant outcomes for women. Areas for further investigation include:

(1) Defining osteoporosis outcomes among women of other racial/ethnic backgrounds:
   - Publications that address disparities in osteoporosis have focused on comparisons between White and Black women; thus, data for other minority groups are scarce.
   - Investigation that includes Hispanic people has focused on Mexican American individuals, with much less data being available for other Hispanic groups.
   - Data for Native American people are limited, with some research suggesting similar bone density in Native American compared to White women while other suggesting the opposite.
   - Data in Asian individuals are limited and have focused on East Asian populations with limited data for Pacific Islander and/or South Asian populations.

(2) Identifying the root cause(s) of disparities in screening and treatment.

(3) Determining if race/ethnicity matched *T*-scores predict fracture better than *T*- or *Z*-scores that are calculated from a White database.

(4) Investigating if small bone size masks a higher BMD in certain populations, particularly to explain the discrepancy in fracture

risk noticed in Asian women, who often have lower BMD without parallel increased fracture risk.

Studying if the inclusion of type 2 diabetes mellitus, CKD, fall history, lumbar spine BMD, social determinants of health, and additional granularity (i.e., dose of glucocorticoids, recency of fracture) [65] increases the predictive value of fracture risk calculators.

6. Summary: relevant points for providers

- There are unambiguous osteoporosis screening guidelines for women $\geq$ 65 years of age, however, screening is still low among all women within this age demographic, with particular disparity noted among Black women.
- The reasons for racial/ethnic disparities in osteoporosis diagnosis and treatment are not clearly described in the literature, but are likely multifactorial, reflecting systems, provider, and patient level factors. Based on the reviewed literature, provider level variables represent a particular area of interest for further study.
- Widely accepted risk factors for osteoporosis were primarily validated in older White populations. There is a growing body on literature on other risk factors that are critical to assess in multiethnic populations to evaluate osteoporotic fracture risk, including type 2 diabetes mellitus and chronic kidney disease.

Contributors

Karina N. Ruiz-Esteves performed literature review and assisted with writing and editing the manuscript.

Jimmitti Teysir performed literature review, assisted with writing and editing the manuscript, and contributed to final edits.

Daria Schatoff performed literature review and assisted with writing and editing the manuscript.

Elaine W. Yu performed literature review, assisted with writing and editing the manuscript, and contributed to final edits.

Sherri-Ann M. Burnett-Bowie performed literature review, assisted with writing and editing the manuscript, and contributed to final edits. All authors read and approved the final manuscript.

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The authors declare that they have no competing interests.

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